Efficacy of exercises to rehabilitate dysphagia: A critique of the literature

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Abstract

Purpose: This review critiques the benefit of commonly used rehabilitative exercises for dysphagia.

Method: Common goals of rehabilitation for dysphagia and principles of neuroplasticity are introduced as they apply to swallowing and non-swallowing exercises. A critique of published studies is offered regarding their evidence for showing benefit from the exercise.

Result: One of five swallow exercises had preliminary evidence for long-term benefit and two of four non-swallow exercises have strong evidence for long-term benefit.

Conclusion: Only a minority of exercises prescribed for patients with dysphagia have sufficient evidence for long-term improvement in swallowing.

Keywords: Dysphagia, efficacy, therapy

Introduction

Exercise rehabilitation has long been a treatment for patients with dysphagia. A variety of exercises exist, ranging from direct to indirect, isolated to combined and those incorporating swallowing or non-swallowing exercises. Rehabilitative exercises are those meant to change and improve the swallowing physiology in force, speed or timing, with the goal being to produce a long-term effect, as compared to compensatory interventions used for a short-term effect. Rehabilitative exercises also involve retraining the neuromuscular systems to bring about neuroplasticity, since pushing any muscular system in an intense and persistent way will bring about changes in neural innervation and patterns of movement (Burkhead, 2003; Sapienza, & Rosenbek, 2007; Clark, 2003; Fox, Ramig, Ciucci, Sapir, McFarland, & Farley, 2006; Kleim & Jones, 2008; Robbins, Butler, Daniels, Gross, Langmore, Lazarus, et al., 2008).

The purpose of this paper is to highlight where the field stands on rehabilitative exercises for dysphagia with emphasis on one question: What is the evidence? With the field of speech pathology growing and many clinicians creating new treatments for their patients, it is easy to fall into the trap of using a homegrown or popular rehabilitative treatment. However, while it is tempting to use anecdotes, clinical experience and popularized methods, clinicians must remember that the best treatment is one that has not only been tried, but tested.

There are several models regarding levels of evidence one can turn to when critiquing any particular study (Liddle, Williamson, & Irwig, 1996; Lohr, 2004; Robey, 2004). The lowest level of evidence comes from a study where one group of patients is tested before and after the intervention. Stronger evidence is achieved when two groups of subjects are compared in some fashion. The ultimate test of any exercise is to evaluate its efficacy in a controlled study where two groups of subjects are studied prospectively. Efficacy is usually studied in an ideal setting such as a controlled environment with two similar groups of subjects where clinician and subject bias is minimized, like a randomized controlled trial. A critical component of the study design is to compare the experimental treatment to another treatment or to no treatment to determine its relative benefit as measured by some concrete variable or outcome. Such proof increases the likelihood that the exercise will have effectiveness or will work in a real-world setting (i.e. at home or in a nursing facility with a variety of patients). Herein lies the empirical foundation of evidence-based prac-

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tice. This paper aims to review and critique the current evidence for efficacy of exercises for dysphagia rehabilitation. It is not a formal systematic review but a narrative review with a focus on evidence of efficacy of the intervention as a long-term benefit.

Why do we need well-designed studies to prove a treatment works?

Every patient is unique. Different factors play a role in each patient's background, medical condition and prognosis. Age, morbidities, time post-onset, motivation and compliance are just a few of the factors that affect a particular patient's status. A well-designed study will define the patient population, allowing clinicians to decide if their specific patient fits the description of the study's patients. If not, this lessens the probability that the same exercise will work on a patient who is very different from those described in the published study. Of note, many studies have tested the effect of an exercise on normal, healthy individuals but not in patients with dysphagia. This is a severe limitation when generalizing the results to a patient population.

Clinical experience introduces bias (Cochrane, 1972; Gray, 1997; Sackett, Richardson, Gray, Haynes, & Rosenberg, 1996). As clinicians create a toolbox of strategies, they begin to form biases to certain treatments they have seen work well with prior patients. Using clinical experience as a tool is an important strategy and creates valuable knowledge, but must be used with caution. What works for one particular clinician and patient is not going to necessarily work for another. Well-designed studies should control for bias by blinding both clinicians and patients to treatment where possible or at least having independent persons assess outcome measures without knowledge of the treatment arm to which the subjects/patient was assigned. Rather than comparing two groups of patients who underwent two or more different pre-determined treatments, it is preferable to randomize patients into experimental and sham or control groups so that the outcomes are not tied to patient-specific factors. The results of such a design drive clinical work by proving treatments to be efficacious in the absence of bias.

It is easier, but misleading, to follow the "experts" instead of the evidence. Experts provide wisdom and experience, but their word is not gold. The advice for them is the same as for a beginning clinician: use external evidence to judge the appropriateness of an intervention for your particular patient. A dangerous trap is to "do what the experts do". However, just like a poorly designed study, an expert's opinion may have flaws as well.

Thus, it is a clinician's responsibility to look for the highest levels of evidence, such as controlled trials. The gold standard design is a randomized controlled trial (RCTs) where patients are randomly assigned to an experimental or control group. There are many requirements of a clinical trial to qualify as an RCT. All these precautions are aimed at reducing bias or confounding factors that may influence which treatment arm is proven better. Even though RCTs remain the gold standard of research, other study designs, including case-control cohort studies and even single-subject designs, have potential to be well done if they are controlled studies, designed to limit bias, and have enough power in their sample size (Wheeler-Hegland, Frymark, Schooling, McCabe, Ashford, Mullen, et al., 2009).

What are the physiologic goals in rehabilitation for a patient with dysphagia?

Defining goals for the dysphagic patient can be challenging because it requires the creation of a concrete outcome for an abstract entity. That is, how does one define a "better swallow"? Is it simply a safe outcome of no aspiration or better clearance and reduced residue? Even when a concrete outcome is selected, measuring it can be challenging. For example, for an outcome of reduced aspiration, how would it be measured? Which measurement technique or scale would be used, what bolus(es) and what would the cut-off point be to distinguish normal from abnormal? Unfortunately, there is no set prescription, making goal-setting difficult and unstandardized. However, that does not mean goals should not be set. Clinicians should decide if the outcomes reported in the published study are appropriate and meaningful for their patients.

The goals a clinician sets for a dysphagic patient should be based on his/her limitations and main problem(s). One goal may be to make the swallow stronger. This goal could involve measuring the strength of the tongue with an Iowa Oral Performance Instrument (IOPI) using normative data (Clark, O'Brien, Calleja, & Newcomb, 2009; Robbins, Kays, Gangnon, Hind, Hewitt, Gentry, et al., 2007) or using manometry to measure the pressures generated by the pharyngeal walls (Doeltgen, Macrae, Huckabee, 2011; Doeltgen, Witte, Gumbley, & Huckabee, 2009; Lazarus, Logemann, Song, Rademaker, & Kahrilas, 2002). Another goal may be to improve endurance over the meal or over the day. This may involve challenging the system with tougher foods, like a dry cracker or steak, to fatigue the muscles and build endurance, as long as it does not pose a safety concern for airway protection. Leaders in the field have outlined the differences between power and endurance in their comprehensive and useful tutorial articles on exercise (Burkhead et al., 2007; Clark, 2003). Another goal may involve making the onset of the swallow faster or better timed with bolus flow. A "controlled swallow" is an example of this technique as it teaches the patient how to reduce spillage of the bolus prior to swallow onset and to swallow the bolus in a timelier manner.

Other non-physiologic goals are part of the bigger picture: improving the diet to include more consistencies, improving the patient's social life, gaining weight and preventing aspiration pneumonia. While these goals are not direct outcomes of rehabilitation exercise, they are the ultimate goal aiming to positively impact the patient's life.

Exercise rehabilitation

The principles of exercise rehabilitation have been widely documented and neuroplasticity is at the core of all of them. Neuroplasticity is best defined as the ability of the brain and nervous system to change, structurally and functionally (see Table I). These changes can be brought about from any form of input, including exercise. Neuroplasticity does not accompany compensatory techniques because these are, by definition, temporary; if the compensation is removed, the swallow will return to its baseline state. Therefore, in order to achieve a long-term effect, the intervention (the exercise) needs to be "rehabilitative" and induce permanent change in the swallow. This paper aims to explore the evidence for efficacy of two types of exercises, swallowing and non-swallowing exercises. It is valuable to first discuss how the neuroplasticity principles apply to each. The specific principles described here were taken from Kleim and Jones (2008) and Robbins and colleagues (2008) excellent reviews of neuroplasticity and their application to swallowing.

Swallowing exercises

Swallowing exercises, or swallow manoeuvres, as they are often called, follow many of the principles of neuromuscular rehabilitation. First, *use it or lose it* is applicable because failure to use a swallow will result in degradation of the swallowing musculature and diminished innervation (Kleim, Cooper, & Vanderberg, 2002). This is best seen in deconditioning after surgery and in gastrointestinal-tube feeders. Second, *use it and improve it* applies in that training drives plasticity. This has been documented in many other applications (Cohen, Ziemann, Chen, Classen, Hallett, Gerloff, et al., 1998; Rioult-Pedotti, Friedman, & Donoghue, 2000). Its application to swallowing implies that patients should purposefully swallow more often to improve swallowing.

The third principle (*specificity*) is most directly related to swallowing exercises. The specific task of

Table I. Selected principles of neuroplasticity applied to exercises for dysphagia.

Neuroplasticity principle*	Swallowing exercises	Non-swallowing exercises
Use It or Lose It	1	
Use It and Improve It	\checkmark	
Specificity	✓	
Transference	\checkmark	1
Intensity	1	\checkmark

*Robbins et al. (2009).

swallowing recruits specific motor units; hence, training that task will reinforce the motor units and their involved neuronal pathways (Clark, 2003; Clark and Shelton, 2011; Robbins et al., 2008). An analogy might be found in running: to be a great runner, one needs to practice running. However, a great runner also should lift weights to improve strength, and this is where the fourth principle, transference, fits into swallowing exercises (Burkhead et al., 2007; Robbins et al., 2008). Other motor units can learn to participate in the task (perhaps by increasing overall strength) or even take over the task (for example after a stroke when non-damaged adjacent cortical areas or homologous areas in the non-damaged hemisphere may get involved) as transference occurs (Robbins et al., 2008).

Underlying any swallowing exercise program is a fifth principle of *intensity*. Put simply, "engaging in exercise that is not intense enough to push the system beyond the level of activity to which it is accustomed will not result in adaptation. The swallowing exercise task must exceed usual levels of activity and be performed for an adequate duration" to have an effect (Burkhead et al., 2007, p. 255). Warren, Fey, and Yoder (2007) address the issue of intensity. Their systematic review concludes that "treatment intensity research is of utmost importance in developing optimally efficacious interventions and ... it has nevertheless been virtually non-existent to date" (p. 76).

There are other neuroplasticity principles, such as repetition and time, that require more evidence when applied to swallowing exercises. The field is still unclear on how much, how often, and how intense the exercises should be. An expert panel at the 2011 ASHA conference clearly stated, "We don't know!" Studies report varying degrees of dosage, ranging from once a day, three times per week, to three times a day, 7 days per week (Easterling, Grande, Kern, Sears, & Shaker, 2005; Shaker, Easterling, Kern, Nitschke, Massey, Daniels, et al., 2002; Woo, Won, & Chang, 2014). According to Burkhead et al. (2007), at least 5 weeks of strength training must take place for a sufficient degree of strength gains to be realized in skeletal muscle. The majority of the suggested dosages are based on literature on the limb musculature, however, and may not be directly applicable to the smaller bulbar muscles.

Non-swallowing exercises

Non-swallowing exercises are those that do not involve the act of swallowing, for example tongue strengthening exercises. They do not meet as many principles of neuroplasticity as the swallowing exercises (see Table I), yet the evidence for their efficacy is relatively good. These exercises aim to strengthen specific muscle groups, such as the suprahyoids in the Shaker exercise (Shaker, Kern, Bardan, Taylor, Stewart, Hoffman, et al., 1997), and then transfer the gains to the act of swallowing. They rely heavily on the principle of *transference*. One particular benefit is that it is easier to make the exercises more "intense" because they are more easily measured (e.g., tongue strength can be measured in kPa), whereas the act of swallowing is more complex and is difficult to "measure". Increasing or decreasing the "resistive load" of swallowing is an elusive challenge. Thus, the principles of *intensity*, *repetition* and *time* are most easily met with non-swallowing exercises. Further, non-swallowing exercises may be easier to learn because swallowing is often understood as a one-dimensional task that is difficult to perform differently. Finally, non-swallowing exercises can be done by patients who cannot eat orally (are tube fed) or those post-surgery who are temporarily restricted from eating orally.

Table I provides a checklist of the neuroplasticity principles applied to swallowing and non-swallowing exercises.

Criteria used in this review for evaluating the evidence

Immediate or long-term effect

What are the criteria for determining that an exercise works? This is an issue especially for those studies that have focused on "swallowing" exercises. The swallow "manoeuvres", as these are often called, will always have an immediate or compensatory effect. It will alter the swallow immediately because the person is swallowing with more effort, holding it out longer, or holding the breath earlier. However, if the swallow manoeuvre is taught with the purpose of making the swallow permanently stronger or faster, then it becomes an exercise.

If a swallow or non-swallow exercise is effective, this means that, after performing the exercise for 4–6 weeks at a given intensity, the swallow will be stronger. If a swallow manoeuvre was the target exercise, the swallow will be stronger even when the manoeuvre is no longer used, Simply put, the swallow will be stronger because it has strengthened the muscles used in swallowing. The authors of this review have restricted their critique to studies that looked at the long-term effect of exercises only (patients are rated at baseline and after 4–6 weeks of exercise).

Use of healthy subjects

An important limitation in the literature is that many exercises have only been trialled in healthy subjects. These studies are, indeed, important as proof of principle, but such evidence is only vaguely suggestive of what may occur if the exercise is used over time in patients with dysphagia. After all, healthy persons execute a swallow with appropriate strength and speed and may not alter their usual swallow after an unnecessary exercise. The authors aimed to focus on studies that enrolled patients with dysphagia, although, if a very well-designed clinical trial (RCT or well controlled clinical trial) was done on healthy subjects, it was also mentioned.

Combining exercises

One other limitation in critiquing the research in this area is that most exercises have been prescribed in the context of a set of multiple exercises, such as Pharyngocise (Carnaby-Mann, Crary, Schmalfuss, & Amdur, 2012). While this makes a lot of sense in the clinical world, scientifically it becomes very difficult to evaluate the specific effect of the exercise of interest. In this review, only exercises that were practiced in isolation were evaluated, with one exception (Carnaby-Mann & Crary, 2010).

Use of a control group of subjects

This issue speaks to the adequacy of the design of the study. If subjects undergo a treatment and get better, it *may* be due to the treatment or it may be due to some other, associated factor such as a change in duration or intensity of the exercise, or even due to the placebo effect. There must be a control for such confounding variables. While the randomized clinical trial is the highest level of design, the authors considered any controlled study using two groups of patients (for example, a matched case-control design).

A summary of the evidence for efficacy of exercise rehabilitation of frequently used swallowing and non-swallowing exercises is shown in Tables II and III. While there are dozens of published studies that have assessed these exercises, the tables are limited only to those studies that have investigated the selected exercises (1) over time, (2) using a high-quality controlled research design and (3) on patients with dysphagia, with some exceptions due to the limited amount of evidence. Also listed in the tables is each study's population to allow clinicians to assess generalizability to their patients. Finally, notes regarding the study design are shown that will hopefully guide clinicians in selecting well-designed studies. The last column in the tables suggests whether or not a clinician should use the exercise with confidence based solely on the criteria discussed in this paper. This recommendation indicates which exercises have well-supported evidence for their use. This review is not absolutely comprehensive, as it was not a formal Systematic Review.

Swallowing exercises: Effortful swallow, Mendelsohn, super-supraglottic, Masako, McNeill dysphagia treatment protocol

Effortful swallow. The authors of this review were only able to identify two studies that investigated the Effortful Swallow as an exercise over time. Clark and Shelton (2014) conducted a well-designed 3-arm

RCT whereby the participants exercised for 4 weeks. One group practiced the Effortful Swallow in isolation, whereas the other two groups performed a related tongue exercise, immediately followed by the Effortful Swallow. After training, subjects in all three groups demonstrated greater, albeit non-significant, increases in lingual pressures when performing effortful swallows. Non-effortful swallows were not as strong. While the study design carried out in this study was excellent, two major limitations impede its clinical utility. It was done on healthy, normal subjects; thus, the results cannot be generalized to patients with dysphagia. Related to this is the finding that their "normal" swallows did not get significantly stronger-likely because they were appropriately strong already.

A second study using the Effortful Swallow was considered for this review (Felix, Correa, & Soares, 2008). It was done on patients with Parkinson's disease. The patients practiced the Effortful Swallow for 2 weeks and showed improved pharyngeal manometric pressures. However, the design was a small cohort study and only prescribed the exercise for 2 weeks; thus it was not included in Table II.

Masako. This manoeuvre involves swallowing while protruding the tongue beyond the lips and holding it between one's teeth. It is intended to target the base of tongue and pharyngeal walls at that level. Only one published study has investigated the

Masako as an exercise over time. A small cohort study (Oh, Park, Cha, Woo, & Kim, 2011) was carried out on a single group of normal subjects who underwent 4 weeks of exercise using the manoeuvre. It showed no long-term effect on swallowing. However, because the subjects were normal, their results cannot be generalized to patients with dysphagia. Its weak design (no control group) precluded it being listed in Table II.

McNeill dysphagia treatment protocol. This is a relatively new program in which swallowing "hard" is the single focus. This exercise appears similar to the Effortful Swallow, but details of the program have not been published. Thus, this exercise was conditionally considered. Reportedly, bolus sizes and volumes are increased in difficulty and the patient is encouraged to swallow faster and harder. This program has not been assessed in a RCT, but it has been tested in a small matched historical case-control study (Carnaby-Mann & Crary, 2010) and found to have positive effects on diet and clinical evaluation measures. Subsequent studies have been reported from the same group of investigators with positive results, but these were either from a single cohort of patients with dysphagia (Crary, Carnasby, LaGorio, & Carvajal, 2012) or an unmatched case-control (Lan, Ohkudo, Berretin-Felix, Sia, Carnaby-Mann, & Crary, 2012) where eight patients were compared to normal healthy controls. This review judged the matched case-con-

Fable	II.	Common	swallowing	exercises	(used o	over time,	not	including	immediate	effects)	and	evidence	for the	eir use.	
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Exercise	Relevant studies	Study population and duration	Outcome* (positive/negative)	Design of study	Use with confidence? (authors' suggestion)
Effortful swallow (in isolation only*)	Clark & Shelton (2014)	Normal healthy; 4 weeks of exercise	+ Increased oral pressures when using effortful swallow compared to non-effortful	RCT with 3 groups $(n = 40$ total subjects); only healthy subjects	No evidence yet with patients with dysphagia
Masako Manoeuvre	No controlled studies met criteria				No evidence from controlled trials
McNeill Dysphagia Treatment Protocol	Carnaby-Mann & Crary (2010)	Stroke and head-neck cancer patients with dysphagia; 3 weeks of exercise vs historical controls given traditional therapy	+ (MASA and FOIS)	Matched historical case-control; Small cohort (n = 24 total subjects); Exercise duration too short	Not enough evidence at this time
Mendelsohn Manoeuvre	McCullough (2012)	Stroke patients with dysphagia, 6 weeks to 22 months post-stroke; 2 weeks of exercise	+ (in 2 out of 10 fluoroscopy measures)	Small RCT of cross-over design $(n = 18$ total subjects)	Yes, but cautiously with stroke patients with dysphagia
Super-Supraglottic Swallow	No controlled studies met criteria				No evidence from controlled trials

RCT, randomized controlled trial; MASA, Mann Assessment of Swallowing Ability (Mann, 2002); FOIS, Functional Oral Intake Scale (Crary, Carnaby-Mann, & Groher, 2005); tx, treatment.

*Outcomes with a (+) indicate a finding that demonstrated statistically significant effects of the exercise by the authors at $p \le 0.05$, whereas (-) indicates that the study found no significant outcome.

trol to be of adequate quality and, thus, is included in Table II. Outcomes were positive, but the evidence is based on a relatively weak study design.

Mendelsohn. The Mendelsohn is a well-known swallow manoeuvre to target laryngeal excursion. It is often taught with some form of biofeedback to help the patient perform it correctly. The authors of this review could find evidence for the long-term effect of the Mendelsohn manoeuvre in only one study. McCullough et al. (2012) led a well-designed but small RCT (cross-over design) demonstrating limited beneficial effects of the Mendelsohn in improving the swallow in stroke patients. Two of 10 variables measured in the fluoroscopy studies significantly improved after treatment. These both measured hyoid movement, which is one of the primary targets of the exercise, so this was encouraging. The limitation of this study is that it only lasted 2 weeks.

The super-supraglottic swallow. This manoeuvre involves a person holding a tight breath, swallowing while keeping the airway tightly closed, then immediately coughing after the swallow. It has obvious compensatory effects of keeping the airway closed longer and is often taught to help prevent aspiration. There were no studies that investigated the long-term effect of this manoeuvre, although it is known that this manoeuvre has immediate effects on laryngeal and hyoid excursion (Kashara, Hanayama, Kodama, Aono, & Masakado, 2009: Ohmae, Logemann, Kaiser, Hanson, & Kahrilas, 1996) and, thus, it has the potential as an exercise.

Non-swallowing exercises: Shaker head lift, tongue strengthening, Lee Silverman voice treatment, expiratory muscle strength training

Shaker head lift. The Shaker Head Lift, a combination of an isometric and isokinetic exercise, has been shown to have favourable long-term effects by improving the strength of the suprahyoid muscles over time, and increasing the opening of the upper oesophageal sphincter in patients with dysphagia (Shaker et al., 1997, 2002). It improves both strength and endurance and has evidence of long-term effects. The study designs reviewed here were good quality and should instill strong support for this exercise to be used clinically with confidence. All three studies are RCTs, two of which enrolled patients with dysphagia (see Table III).

Tongue strengthening. Multiple studies have investigated tongue strengthening over time in a variety of patient populations (stroke, head and neck cancer). Exercising the tongue has great potential, yet the evidence for benefit has not yet been shown. Only one RCT has been conducted to test its long-term effect. This was done on head and neck cancer patients with dysphagia (Lazarus et al., 2014). The experimental group practiced the same exercises as the control group, but with an added tongue resistance

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	Table III. Comm	on non-swallowing exe	rcises (used over time	, not including immediat	te effects) and evidence for their use.
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Exercise	Relevant studies	Study population and duration	Outcome*	Design of study	Use with confidence? (authors' suggestion)
Shaker Head Lift	Shaker et al. (1997)	Healthy elderly; 6 weeks of exercise	+ (fluoroscopy and manometry)	RCT with decent sample size $(n = 31$ total subjects), but healthy subjects	Yes, with confidence in several patient types
	Shaker et al. (2002)	Severe dysphagia; mixed aetiologies; all tube fed 6 weeks of exercise	+ (fluoroscopy measures and return to oral feeding)	RCT $(n = 27 \text{ total subjects})$	
	Logemann, Rademaker, Pauloski, Kelly, Stangl-McBreen, & Antinoja (2009)	All subjects with dysphagia; mixed aetiologies; 6 weeks of exercise	+/- (Less aspiration; no other differences on fluoroscopy	RCT but small sample size of mixed aetiologies (n = 14 total subjects)	
Tongue strengthening	Lazarus et al. (2013)	Head-neck cancer patients with dysphagia. 1 month post-radiation; 8 weeks of exercise	 (Tongue strength and fluoroscopy measures) 	RCT but small sample size $(n = 23$ total subjects)	Negative evidence the head-neck cancer population; insufficient evidence in other groups
Lee Silverman Voice Treatment (LSVT)	No controlled studies m	tet criteria			No evidence from controlled trials
Expiratory Muscle Strength Training (EMST)	Troche et al. (2010)	Parkinson's patients with dysphagia; 4 weeks of exercise	+ (PAS and fluoroscopy measures)	RCT with large sample size $(n = 60)$	Yes, with Parkinson's patients

RCT, randomized controlled trial; PAS, Penetration-Aspiration Scale.

*Outcomes with a (+) indicate a finding that demonstrated statistically significant effects of the exercise by the authors at $p \le 0.05$, whereas (-) indicates that the study found no significant outcome.

exercise. After 8 weeks of exercise, the experimental group showed no benefit for swallowing, as measured by fluoroscopic studies or tongue strength. Other studies that were considered investigated tongue strengthening and reported good outcomes, but they were judged of lesser quality due to small sample sizes, enrolment of healthy subjects or an uncontrolled study design (Lazarus, Logemann, Huang, & Rademaker, 2003; Robbins, Gangnon, Theis, Kays, Hewitt, & Hind et al., 2005; Robbins et al., 2007).

Lee Silverman voice treatment (LSVT). One interesting study investigated the effect of a non-swallow program designed to improve vocal intensity (Lee Silverman Voice Treatment program; Scott, S., & Caird, F.L., 1983). One group of researchers investigated the potential for LSVT to carry-over to swallowing (El Sharkawi, Ramig, Logemann, Paulosji, Rademaker, Smith, et al., 2002). However, this study had a very small cohort of eight patients. While they did report several improvements in swallowing, there was no control group and the study design was insufficient to include in this review.

Expiratory muscle strength training (EMST). Finally, a non-swallow exercise called Expiratory Muscle Strength Training (Troche, Okun, Rosenbek, Musson, Fernandez, Rodriguez, et al., 2010) has reported positive effects on swallowing in a large, high-quality RCT of Parkinson's patients with dysphagia. EMST involves exhaling quickly and forcefully into a mouthpiece that is attached to a one-way valve, blocking the flow of air until the patient produces sufficient expiratory pressure. It is meant to strengthen the expiratory and sub-mental muscles by increasing the physiologic load. In this RCT, the control group underwent a sham respiratory treatment. They found that 4 weeks of EMST improved the patients' Penetration-Aspiration scores (Rosenbek, Robbins, Roecker, Coyle, & Woods, 1996) and several other physiologic measures of swallowing.

Conclusion

The field of dysphagia lacks sufficient well-designed large studies to support clinical utility of many swallowing and non-swallowing exercises for dysphagia rehabilitation. This review of the literature rated their rehabilitative potential by identifying and critiquing studies that have reported measurable outcomes of clinical studies using these exercises.

There was insufficient support for a long-term ("permanent") effect for several of the most commonly used swallow exercises: the Effortful Swallow, the Masako, the Super-Supraglottic exercise and the McNeill Dysphagia Treatment Protocol. The only swallowing exercise with limited but positive evidence from an RCT was the Mendelsohn manoeuvre. The other swallowing exercises have indeed been investigated, but not within the context of a welldesigned study to determine their long-term effects.

Two non-swallowing exercises, on the other hand, were found to have high-quality evidence from RCTs. Positive results were found in RCTs investigating the Shaker Head Lift and Expiratory Muscle Strength Training (EMST). Their efficacy, therefore, could be generalized to a patients with a variety of aetiologies, including stroke and head/ neck cancer (with the Shaker Head Lift) and to Parkinson's patients (for EMST). These two exercises can be recommended with confidence, while all the others have insufficient evidence to recommend their use. Tongue strengthening has had one large RCT to test its efficacy and the result was negative in the study's post-radiated head-neck cancer patients.

The current lack of efficacy for many of the exercises being taught and prescribed to patients with dysphagia should not imply that these should NOT be prescribed. It is simply a reminder that they have not yet been proven to help strengthen swallowing. Further, well-designed studies would be extremely helpful to guide clinicians who work with patients with dysphagia.

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