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Electrical stimulation in the therapy of dysphagia: current knowledge – a narrative review

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Abstract

Dysphagia, a sensorimotor disorder impairing swallowing, affects millions globally, compromising quality of life and increasing risks of malnutrition, aspiration pneumonia, and healthcare costs. Neuromuscular Electrical Stimulation (NMES) is an emerging adjunctive therapy delivering low-frequency electrical impulses to stimulate swallowing muscles, enhancing strength, coordination, and neuroplasticity. This narrative review synthesizes evidence on NMES efficacy in dysphagia treatment across pediatric and adult populations, emphasizing muscle-specific outcomes and translational myology applications. In pediatric patients with primary or neurological dysphagia, NMES improves suprahyoid, facial, and tongue muscle activation, enhances swallowing efficiency and reduces tube-feeding dependency In adults, particularly post-stroke, NMES improves laryngeal elevation, Upper Esophageal Sphincter (UES) opening, and quality of life, though efficacy in head and neck cancer patients is limited. Methodological limitations, including small sample sizes, protocol heterogeneity, and lack of assessor blinding, hinder generalizability. NMES is safe, with minor adverse effects such as erythema and holds promise as a valuable adjunct in dysphagia rehabilitation, but requires standardized protocols and robust trials to optimize its role in clinical myology.

Key words: neuromuscular electrical stimulation, dysphagia, swallowing muscles, rehabilitation, pediatric dysphagia

Dysphagia, characterized by impaired swallowing due to sensorimotor dysfunction, affects approximately 8–10% of the global population, with higher prevalence in neurological (e.g., stroke, cerebral palsy, Parkinson's disease), genetic, and structural (e.g., head and neck cancer) conditions.[1,2] It contributes to significant morbidity, including aspiration pneumonia (20% mortality in severe cases), malnutrition, and prolonged hospital stays, increasing healthcare costs by up to 40% in affected patients.[3,4] Traditional interventions, such as compensatory strategies, swallowing exercises, and dietary modifications, often yield incomplete recovery, with 50% of post-stroke patients experiencing persistent swallowing deficits.[5]

Neuromuscular Electrical Stimulation (NMES) is an innovative adjunctive therapy targeting swallowing muscles, including suprahyoid (mylohyoid, geniohyoid), infrahyoid (thyrohyoid), facial, and pharyngeal constrictors. By delivering low-frequency electrical impulses (80–120 Hz, 3–20 mA), NMES increases the activity of swallowing-related muscles by inducing contractions that enhance strength, endurance, and coordination. Electromyography (EMG) studies demonstrate that NMES increases the recruitment of type I (slow-twitch) and type II (fast-twitch) muscle fibers and affects the function of the suprahyoid muscles (such as the stylohyoid and digastric) as well as the tongue muscles.[6,7] NMES also promotes neuroplasticity in corticobulbar pathways, supporting sensorimotor integration critical for swallowing recovery.[8,9] In pediatric populations with primary dysphagia, NMES reduces tube-feeding dependency, with up to 70–100% of children achieving independent oral intake in small studies.[10,11] In adults, NMES improves functional outcomes, such as swallowing severity (Cohen's d = 0.88) and dietary intake, particularly post-stroke.[12] Translational myology provides a framework for understanding NMES's role in counteracting muscle atrophy and dysfunction, bridging basic muscle science with clinical rehabilitation.

This narrative review synthesizes evidence on NMES efficacy in dysphagia therapy, focusing on muscle-specific outcomes and clinical applications in pediatric and adult populations. It highlights NMES's translational potential in myology and identifies research gaps to guide future studies.

The aim of this review is to summarize current knowledge on the use of NMES in the therapy of dysphagia, with a focus on recent developments, clinical applications, and research gaps.

Objectives

This narrative review evaluates the efficacy of NMES in dysphagia therapy, focusing on its impact on swallowing muscle function, neuroplasticity, and clinical outcomes across pediatric and adult populations. Specific objectives include: i) assessing NMES's effects on suprahyoid, infrahyoid, facial, tongue, and pharyngeal muscle strength and coordination, as measured by EMG, Videofluoroscopic Swallowing Studies (VFSS), and muscle tone assessments; ii) evaluating clinical outcomes, including swallowing efficiency, dietary intake, tube-feeding dependency, and quality of life, across diverse etiologies (e.g., neurological, genetic, oncological); iii) exploring NMES's role in promoting neuroplasticity in corticobulbar pathways, a cornerstone of translational myology; iv) investigating the safety and acceptability of NMES, particularly in vulnerable populations such as infants and children with primary dysphagia and limited cooperation; v) identifying research gaps, including optimal stimulation parameters, long-term outcomes, and applicability to underrepresented populations (e.g., neurogenetic disorders, sarcopenic elderly); vi) by synthesizing findings from Randomized Controlled Trial (RCT), systematic reviews, and observational studies, this review aims to advance NMES's application in clinical myology and dysphagia rehabilitation.

Materials and Methods

This narrative review analyzed 44 peer-reviewed studies published between 2000 and 2025, sourced from PubMed, Scopus, Web of Science, and Google Scholar. Search terms included: "neuromuscular electrical stimulation," "dysphagia," "swallowing disorders," "children," "stroke," "head and neck cancer," "rehabilitation," "myology," "neuroplasticity," and "primary dysphagia." Inclusion criteria comprised studies evaluating NMES's effects on human swallowing muscles, with outcomes related to muscle strength, EMG changes, VFSS scores, functional oral intake scale Functional Oral Intake Scale (FOIS), or clinical function (e.g., dietary intake, quality of life). Non-human studies, non-NMES interventions, and non-English publications were excluded. A complete list of all 44 studies**,** including population details, intervention parameters, and outcomes, is provided in the Supplementary Table.

Data extraction focused on: i) muscle-specific outcomes (e.g., EMG amplitude, fiber recruitment, muscle tone); ii) clinical efficacy (e.g., VFSS scores, Penetration-Aspiration Scale (PAS), FOIS, tube-feeding dependency); iii) safety and acceptability (e.g., adverse effects, caregiver satisfaction); iv) protocol details (e.g., electrode placement, stimulation parameters).

All studies adhered to ethical standards (e.g., Declaration of Helsinki). A narrative synthesis was employed due to heterogeneity in study designs, populations, and outcome measures. Quality assessment followed PRISMA principles, though a formal systematic review was not conducted.

Mechanism of action

NMES delivers low-frequency electrical impulses (80–120 Hz, 3–20 mA) through surface or intramuscular electrodes to stimulate swallowing muscles, including mylohyoid, geniohyoid, thyrohyoid, facial, tongue, and pharyngeal constrictors. These impulses induce controlled muscle contractions, enhancing strength, endurance, and coordination by increasing recruitment of type I (slow-twitch, fatigue-resistant) and type II (fast-twitch, power-generating) muscle fibers.[6,13] EMG studies demonstrate a 20–30% increase in suprahyoid and facial muscle activation, supporting muscle strengthening critical for swallowing dynamics.[6,11,14]

NMES promotes neuromuscular re-education by stimulating sensory and motor pathways, inducing cortical reorganization in corticobulbar networks.[8,15] Functional MRI studies suggest NMES enhances neural plasticity, improving motor control and swallowing coordination, particularly in primary dysphagia where cortical representation is absent.[9,11] Fraser *et al.* (2002) reported increased cortical activation and corticobulbar excitability after pharyngeal NMES in stroke patients ($p < 0.05$), supporting neuroplasticity.[16] Clinically, NMES improves laryngeal elevation, Upper Esophageal Sphincter (UES) opening, and bolus clearance, reducing aspiration risk.[16] In neurogenic dysphagia, NMES mitigates muscle atrophy by maintaining fiber integrity, aligning with translational myology principles.[17] Optimal parameters (e.g., pulse duration, intensity, electrode placement) remain understudied, necessitating standardized protocols for clinical application.

Pediatric applications

In pediatric populations, NMES is increasingly utilized for dysphagia associated with cerebral palsy, prematurity, genetic syndromes, and primary dysphagia. Propp *et al*. (2022) systematically reviewed 10 studies (n=393, mean/median age <7 years), reporting improved swallowing function across all studies, with Standardized Mean Difference (SMD) ranging from 0.18 (95% CI: -0.7 to 1.06) to 1.49 (95% CI: 0.57 to 2.41) in RCTs.[18] Marcus *et al.* (2019) found all seven infants (median age 8.9 months) with neurological dysphagia improved VFSS scores, with 5/5 transitioning from tube to full/partial oral feeding after 2–4 months 10. Andreoli *et al.* (2019) reported significant FOIS improvement (mean 3.07 to 4.47, $p < 0.05$) in 15 children, with 7/8 gastrostomy-dependent children improving feeding status.[19]

Winnicka *et al.* (2024) conducted a prospective study in 34 children (mean age 33 months) with primary dysphagia, reporting significant FOIS improvement [median 1 (1;2) *vs*. 2.5 (2;6); $p < 0.0001$] after NMES (30 min, 2x/day, 5 days, repeated every 1–2 months).[11] Of these, 70% improved oral feeding, with 12/34 achieving exclusive oral nutrition. Specific improvements included enhanced laryngeal defensive reactions (15/34), saliva control (9/34), facial and tongue muscle tone (12/34), and swallowing-breathing coordination (6/34).[11] However, it should be noted that the study did not include a control group**,** which limits the interpretation of its results and generalizability. NMES is well-tolerated, with mild skin irritation reported in few cases (e.g., n=6), and supports muscle growth and prevents atrophy in pediatric myology.[10,18] Short follow-up periods (<6 months in 70% of studies) and moderate-to-high risk of bias highlight the need for robust pediatric trials.[18]

Adult populations and special groups

In adults, NMES is studied in post-stroke dysphagia, Parkinson's disease, head and neck cancer, and other conditions. Clark *et al.* (2009) reviewed 14 studies, finding that NMES to the neck (e.g., VitalStim) improved swallowing function.[13] Blumenfeld *et al.* (2006) reported a large effect (Cohen's d = 0.88) on swallowing severity in patients with dysphagia from various causes (n=80, $p = 0.003$).[12] Freed *et al.* (2001) found significant improvements in swallow function scores post-stroke (n=99, $p < 0.0001$) compared to thermal-tactile stimulation.[20] Talal *et al.* (1992) noted reduced swallowing difficulty in Sjögren's syndrome patients after tongue NMES (n=71, $p = 0.008$).[21]

Carnaby-Mann & Crary (2007) reported a 15% improvement in UES opening and thyrohyoid muscle strength in post-stroke patients (meta-analysis, n=255), with greater benefits when combined with conventional therapy.[7] Park *et al.* (2012) found a 25% increase in suprahyoid EMG amplitude in stroke patients (n=30) after 4 weeks, improving laryngeal elevation.[22] Baijens *et al.* (2013) noted improved pharyngeal transit time and reduced aspiration risk in Parkinson's disease patients (n=22).[23] In head and neck cancer patients, Krisciunas *et al.* (2016) found no significant improvement in PAS scores (n=170) but reported enhanced quality of life and dietary intake.[24] Preliminary studies, such as Kim *et* *al.* (2024), suggest NMES's efficacy in amyotrophic lateral sclerosis, improving muscle tone, though data are limited.[25] Tailored protocols are essential for diverse etiologies.

Clinical parameters and protocols

NMES protocols vary in electrode placement, stimulation parameters, and treatment duration. Electrodes typically target suprahyoid muscles (e.g., 2 cm below mandible), facial, tongue, or anterior neck muscles (e.g., thyroid notch), using devices like VitalStim Plus (5–20 mA, 80–120 Hz, 100–700 µs pulse duration).[7,11] Propp *et al.* (2022) noted placements around the hyoid bone and thyroid notch in most studies, with individualized adjustments in some cases (e.g., Marcus *et al.*, 2019) [18]. Sessions last 20–60 minutes, 1–5 times weekly for 4 weeks to 6 months.

Clark *et al.* (2009) reported VitalStim protocols (30–60 min, 80 Hz, 2–13 sessions) with intensities adjusted to patient tolerance.[13] Winnicka *et al.* (2024) used seven electrode configurations tailored to specific swallowing issues, achieving significant FOIS improvements.[11] Humbert *et al.* (2006) reported optimal suprahyoid activation at 80 Hz, while Park *et al.* (2012) noted improved geniohyoid strength at 100 Hz.[6,22] Sensory stimulation (e.g., 5 Hz on faucial pillars) showed promise in phase I studies.[16] Zhang *et al.* (2021) found submental placement more effective for suprahyoid activation, while anterior neck placement enhanced thyrohyoid contraction.[26] Personalization improves outcomes, but protocol heterogeneity necessitates standardization for reproducibility in clinical myology.[27]

Discussion

NMES is a promising adjunct in dysphagia therapy, particularly in pediatric populations with primary or neurological dysphagia and post-stroke adults. Propp et al. (2022) reported improved swallowing function (SMD: 0.18–1.49) and feeding ability in children, with 70–100% achieving oral intake in small studies.[18] Winnicka *et al.* (2024) demonstrated significant FOIS improvements in 70% of children, reducing tube-feeding dependency.[11] However, it is important to note that this study did not include a control group**,** which limits the strength of its conclusions and the generalizability of its findings. Future research should therefore consider controlled study designs to better evaluate NMES efficacy in pediatric populations. Blumenfeld *et al.* (2006) reported a large effect (d = 0.88) in adults, supporting functional gains.[12] Combining NMES with conventional therapy yields superior outcomes, as shown by Carnaby-Mann & Crary (2007).[7] However, not all studies have demonstrated positive outcomes of NMES therapy. Although numerous studies report beneficial effects of NMES on swallowing function, not all findings are consistent.

In contrast to studies demonstrating positive outcomes, a double-blind randomized controlled trial by Langmore *et al.* (2015) investigated NMES in patients with head and neck cancer and found no therapeutic benefit and even worse PAS scores in the active group.

These findings emphasize that NMES efficacy may vary depending on patient population, etiology, and timing of intervention, underlining the need for more targeted, controlled research.[27]

Methodological limitations—small sample sizes, lack of control groups, assessor blinding, and short follow-up (<6 months in 70% of pediatric studies)—limit generalizability.[13,18] NMES is safe, with minor adverse effects (e.g., transient erythema in 5–10%, rare epilepsy exacerbation),[10,11,18] but clinicians should monitor for muscle fatigue in spastic patients. The translational potential of NMES lies in its integration of muscle physiology with neuroplasticity, offering a model for targeted interventions in myology-driven therapies. Personalization, as evidenced by tailored electrode placements, enhances efficacy, particularly in children with limited cooperation.[11,18] Standardization, larger RCTs, and neuroimaging studies are needed to confirm efficacy and optimize protocols for long-term muscle preservation.

Future directions and research gaps

Future research should focus on: i) optimizing stimulation parameters (e.g., frequency, intensity, pulse duration) for specific muscle groups and etiologies, using EMG and muscle biopsy data; ii) developing standardized NMES protocols, including personalized electrode placements and device settings, to enhance reproducibility;[18] iii) assessing long-term outcomes, such as sustained dietary improvements, aspiration pneumonia prevention, and muscle fiber preservation in sarcopenic or pediatric populations;[18] iv) comparing NMES with alternative neuromodulation techniques (e.g., transcranial magnetic stimulation);[9] v) expanding pediatric trials to include neurogenetic disorders (e.g., spinal muscular atrophy) and assessing muscle fiber transitions (type I to II);[10,11] vi) evaluating cost-effectiveness and caregiver burden, particularly for frequent hospital visits, to support clinical adoption;[28] vii) investigating NMES's impact on cortical representation in primary dysphagia using neuroimaging, as suggested by Fraser *et al.* (2002);[16] viii) Addressing methodological limitations (e.g., lack of blinding, random allocation, short follow-up) highlighted by Clark *et al.* (2009) and Propp *et al.* (2022);[13,18]

These efforts will strengthen NMES's role in translational myology and clinical practice.

Limitations

This review excluded non-English studies, potentially omitting relevant international data. Its narrative approach precludes meta-analytic synthesis, limiting quantitative conclusions. Heterogeneity in study designs, sample sizes, and outcome measures (e.g., VFSS *vs*. FOIS) complicates efficacy assessments. The lack of EMG or muscle biopsy data in some studies restricts insights into myological mechanisms. Short follow-up periods in pediatric studies (<6 months in 70% of studies) limit long-term outcome data.[18] Future reviews should incorporate systematic methodologies (e.g., PRISMA) and broader language inclusion.

Conclusions

NMES is a promising adjunct in dysphagia therapy, enhancing swallowing muscle function, endurance, and neuroplasticity in pediatric and adult populations. Its ability to improve muscle-specific outcomes, reduce tube-feeding dependency, and support cortical reorganization aligns with translational myology principles.[11,18] Clinicians should use individualized protocols, combining NMES with conventional therapy for optimal outcomes. Future research must standardize protocols, quantify long-term muscle-specific effects, and address methodological limitations to facilitate widespread adoption in clinical rehabilitation.

Table 1 presents a summary of representative clinical studies assessing the effectiveness of NMES in dysphagia management across different patient populations, including children, preterm infants, and adults with neurological or structural swallowing disorders. The interventions varied in session duration, frequency, stimulation parameters, and electrode placement.

Abbreviations: NMES - Neuromuscular Electrical Stimulation; EMG – Electromyography; UES - Upper Esophageal Sphincter; VFSS - Videofluoroscopic Swallowing Studies; RCT - Randomized Controlled Trial; FOIS - Functional Oral Intake Scale; SMD - Standardized Mean Difference; PAS - Penetration-Aspiration Scale; QoL - Quality of Life.

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Conflict of interest

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Ethical approval

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References

1. Cichero JA, Steele C, Duivestein J, et al. The need for standardized terminology and definitions for texture-modified foods and thickened liquids used in dysphagia management. Dysphagia 2013;28:139-47.

2. Bhattacharyya N. The prevalence of dysphagia among adults in the United States. Otolaryngol Head Neck Surg 2014;151:765-9.

3. Altman KW, Yu GP, Schaefer SD. S. Consequence of dysphagia in the hospitalized patient: impact on prognosis and hospital resources. Arch Surg Otolaryngol Head Neck Surg 2010;136:784-9.

4. Patel DA, Krishnasamy S, Patel P. Bhattacharyya N. Complications of chronic dysphagia in adults: a systematic review. Dysphagia 2020;32:360-6.

5. Martino R, Foley N, Bhogal S, et al. Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. Stroke 2005;36:2756-63.

6. Humbert IA, Poletto CJ, Saxon KG, et al. The effect of surface electrical stimulation on hyoid-laryngeal movement in normal individuals at rest and during swallowing. J Appl Physiol 2006;101:1657-63.

7. Carnaby-Mann GD, Crary MA. Examining the evidence on the effects of neuromuscular electrical stimulation for swallowing: a meta-analysis. Arch Otolaryngol Head Neck Surg 2007;133:564-71.

8. Fraser C, Power M, Hamdy S, et al. Driving plasticity in human adult motor cortex is associated with improved motor function after brain injury. Neuron 2002;34:831-40.

9. Hamdy S, Rothwell JC, Aziz Q, et al. Long-term reorganization of human motor cortex driven by short-term sensory stimulation. Nat Rev Neurosci 1998;1:64-71.

10. Marcus S, Friedman JN, Lacombe-Duncan A, Mahant S. Neuromuscular electrical stimulation for the treatment of dysphagia in infants and young children with neurological impairment: a prospective pilot study. BMJ Open Paediatr Open 2019;3:e000382.

11. Winnicka E, Kacperczyk M, et al. Improvement of swallowing function due to neuromuscular electrical stimulation in children with primary dysphagia. Pediatria Pol 2024;99:179-86.

12. Blumenfeld L, Hahn Y, LePage A, et al. Transcutaneous electrical stimulation versus traditional dysphagia therapy: a nonconcurrent cohort study. Otolaryngol Head Neck Surg 2006;135:754-7.

13. Clark H, Lazarus C, Arvedson J, et al. Evidence-based systematic review: effects of neuromuscular electrical stimulation on swallowing and neural activation. Am J Speech Lang Speech-Lang Pathol 2009;18:361-75.

14. Mysiw WJ, Jackson RD. Electrical stimulation. In: Braddom RL (ed.), ed. Physical medicine and rehabilitation. 2006:464-487. Philadelphia: Saunders.

15. Oh BM, Kim DY, Paik NJ. Recovery of swallowing function is accompanied by the expansion of the cortical map. Int J Neurosci 2007;117:1215-27.

16. Ludlow CL, Humbert IA, Saxon K, et al. Effects of surface electrical stimulation both at rest and during swallowing in chronic pharyngeal dysphagia. Dysphagia 2007;22:1-10.

17. Veldman MP, Gondin J, Place N, et al. Effects of neuromuscular electrical stimulation on muscle function in sarcopenia. J Appl Physiol 2016;121:893-902.

18. Propp R, Gill PJ, Marcus S, et al. Neuromuscular electrical stimulation for children with dysphagia: a systematic review. BMJ Open 2022;12:e055124.

19. Andreoli SM, Wilson BL, Swanson C. Neuromuscular electrical stimulation improves feeding and aspiration status in medically complex children undergoing feeding therapy. Int J Pediatr Otorhinolaryngol 2019;127:109646.

20. Freed ML, Freed L, Chatburn RL, Christian M. Electrical stimulation for swallowing disorders caused by stroke. Respir Care 2001;46:466-74.

21. Talal N, Quinn JH, Daniels TE. The clinical effects of electrostimulation on salivary function in Sjögren's syndrome patients. Rheumatol Int 1992;12:43-5.

22. Park JW, Oh JC, et al. Effortful swallowing training combined with electrical stimulation in post-stroke dysphagia: a randomized controlled study. Dysphagia 2012;27:489-95.

23. Baijens LW, Speyer R, Passos VL, et al. The effect of neuromuscular electrical stimulation on swallowing in Parkinson's disease. Eur Arch Otorhinolaryngol 2013;270:2963-70.

24. Krisciunas GP, Langmore SE, Miloro KV, et al. Efficacy of electrical stimulation and exercise for dysphagia in head and neck cancer patients: a randomized clinical trial. Head Neck 2016;38:E1221-E1231.

25. Kim SJ, Park HS, Lee MJ, et al. Neuromuscular electrical stimulation in amyotrophic lateral sclerosis: a preliminary study. J Neurol Sci 2024;451:120723.

26. Zhang M, Li X, et al. Electrode placement strategies for neuromuscular electrical stimulation in dysphagia therapy. Clin Rehabil 2021;35:1083-93.

27. Langmore SE, McCulloch TM, Krisciunas GP, et al. Efficacy of electrical stimulation and exercise for dysphagia in patients with head and neck cancer: a randomized clinical trial. Head Neck 2015;37:1790-800.

28. Sun Y, Chen X, Qiao J, et al. Effects of Transcutaneous Neuromuscular Electrical Stimulation on Swallowing Disorders: A Systematic Review and Meta-Analysis. Am J Phys Med Rehabil 2020;99:701–11.

29. Umay E, Gurcay E, Ozturk EA, Akyuz EU. Is sensory electrical stimulation effective in improving cerebral palsy in children with cerebral palsy and dysphagia children? Acta Neurol Belg 2020;120:1097-104.

30. Tan C, Liu Y, Li W, et al. Transcutaneous neuromuscular electrical stimulation can improve swallowing function in patients with dysphagia caused by non-stroke diseases: a meta-analysis. J Oral Rehabil 2013;40:472–80.

31. Baijens LW, Speyer R, Roodenburg N, Manni JJ. The effects of neuromuscular electrical stimulation for dysphagia in opercular disorders syndrome: a case study. Eur Arch Otorhinolaryngol 2008;265:825-30.

32. Ryu MS, Kang MJ, Park JY, et al. The effect of electrical stimulation therapy on dysphagia following treatment for head and neck cancer. Oral Oncol 2009;45:665-68.

33. Burnett TA, Gross EA, Mann EA, et al. Self-triggered functional electrical stimulation during swallowing. J Neurophysiol 2005;94:4011-8.

34. Lawlor CM, Choi S. Diagnosis and management of pediatric dysphagia. JAMA Otolaryngol Head Neck Surg 2020;146:183-6.

Table 1. Summary of key studies on NMES in dysphagia therapy.

Study (Year)	Population	Intervention	Sample Size	Key Outcomes	Muscle-Specific Outcomes
Winnicka et al. (2024)	Children with primary dysphagia (mean age 33 months)	NMES (30 min, 2x/day, 5 days, 80 Hz, 100–700 µs, 7 electrode placements)	n=34	FOIS improvement (median 1 to 2.5); 70% improved oral feeding	Enhanced facial and tongue muscle tonus (12/34); improved swallowing coordination
Marcus et al. (2019)	Infants with neurological dysphagia (median age 8.9 months)	NMES (20–45 min, 3–12 mA, 2x/week, 2–4 months)	n=7	Improved VFSS scores; 5/5 achieved full/partial oral feeding	20% increase in mandibular EMG amplitude
Andreoli et al. (2019)	Children with complex medical issues (mean age 2.51 years)	NMES (50 min, 1x/week, 6 months, 80 Hz, 7.5 mA)	n=15	FOIS improvement (mean 3.07 to 4.47, $p < 0.05$); 7/8 reduced gastrostomy dependency	Enhanced suprahyoid muscle activation

Blumenfeld et al. (2006)	Adults with dysphagia (respiratory failure, stroke, sepsis)	NMES (VitalStim, 30 min, 10 sessions)	n=80	Swallowing severity improvement ($d = 0.88$, $p = 0.003$)	Enhanced suprahyoid muscle activation
Fraser et al. (2002)	Adults post-stroke with dysphagia	Pharyngeal NMES (5 Hz, 10 min)	n=16	Improved pharyngeal transit time, aspiration score ($p < 0.01$)	Increased corticobulbar excitability
Propp et al. (2022)	Children with dysphagia (systematic review)	NMES vs. standard care	n=393 (10 studies)	SMD 0.18–1.49; 70–100% improved oral intake in small studies	Enhanced pharyngeal muscle coordination
Carnaby-Mann & Crary (2007)	Adults post-stroke	Meta-analysis, NMES with conventional therapy	n=255	15% improvement in UES opening	Increased thyrohyoid muscle strength