ACE BRIEF FOR NEW AND EMERGING HEALTH TECHNOLOGIES

Phagenyx to improve swallowing in severe post-stroke dysphagia

Document Number: HSB-M 07/2025

Date: September 2025

ACE agency for care effectiveness

Contents

Summary of Key Points

- Dysphagia is a significant post-stroke complication that occurs in 29% to 81% of stroke patients in Singapore. About half of affected patients develop chronic swallowing difficulties, resulting in increased healthcare burden and affecting patients' quality of life (QoL).
- Patients with post-stroke dysphagia are typically managed using dietary, behavioural, nutritional, and oral health care interventions, however, achieving consistent adherence remains a challenge. Alternative neuromodulation techniques such as neuromuscular electrical stimulation (NMES) are used locally as an adjunct or second-line treatment.
- Phagenyx Neurostimulation System (Phagenesis Ltd) is a pharyngeal electrical stimulation (PES) device that delivers personalised neurostimulation to pharyngeal sensory nerves to help restore neurological swallowing control in patients with severe post-stroke dysphagia, without requiring active patient participation.
- Key evidence comprised a NICE report (IPG781) and two systematic review and meta-analyses including eight unique randomised controlled trials comparing PES with sham or conventional care.
- Compared to sham, PES showed minimal safety concerns, despite a higher rate of non-serious device- or treatment-related adverse events (14% *vs.* 9%). No significant difference was reported in the cumulative risk of all-cause death between the two groups.
- In terms of effectiveness, PES demonstrated some benefits over sham especially in certain sub-populations, but its benefits over NMES is currently unproven.
    - No direct comparative study was identified for PES *vs.* NMES. A network meta-analysis showed that PES performed worse than NMES in improving swallowing outcomes (standardised mean differences [SMD], -4.58; 95% CI, -6.68 to -2.38) and QoL(SMD, -3.86; 95% CI, -7.15 to -0.57). Similar findings were reported when comparing PES with routine rehabilitation, although some were not significant.
    - Compared to sham, PES significantly improved short-term overall treatment effect and swallowing outcomes up to two weeks, but the effects did not sustain beyond three months. No significant between-group differences were reported for stroke severity, length of stay and QoL outcomes.
    - In tracheostomised patients with post-stroke dysphagia, PES significantly improved the likelihood of decannulation rates (risk ratio, 4.69; p=0.0003) when compared to sham.
- Key uncertainties in the evidence base include lack of direct comparison of PES to NMES, inconsistent reporting of dysphagia severity and potential bias from industry-funded studies. Three ongoing trials were identified comparing PES with sham.
- Cost effectiveness of Phagenyx remains unclear, with the indicative cost per multisession catheter use comparable to the cost of electrodes for 10 to 20 NMES

sessions (S$1,707 *vs.* S$598 to S$1,195), though the initial base station cost for Phagenyx is notably higher (S$17,074 *vs.* $4,088).

- Unlike other non-invasive neurostimulation modalities, Phagenyx requires nasal catheter insertion into the pharynx, making it potentially uncomfortable for patients. No major implementation issues were identified but training is needed to ensure proper use of the device.
- Several international guidelines conditionally recommend PES use in tracheostomised patients with severe post-stroke dysphagia, with key agencies including NICE advising its use under special arrangement with audit or primarily in clinical trial settings.

I. Background

Dysphagia, or difficulty in swallowing, is a significant post-stroke complication. It results from damage to neural structures involved in swallowing control, including the motor cortex, brainstem and cerebellum, leading to loss of functional motor abilities and compromising the efficacy and safety of deglutition.[1] Dysphagia typically presents as either oropharyngeal (difficulty initiating a swallow or passing food through the mouth or throat) or oesophageal (structural, inflammatory or motility disorders of the oesophageal body or oesophagogastric junction).[2] The severity of post-stroke dysphagia can vary significantly from mild to severe. In severe cases, feeding gastrostomy tubes or tracheostomy may be required, and can lead to serious complications including pneumonia, malnutrition, dehydration and increased mortality.[1, 3, 4]

In Singapore, stroke affects 4% of adults aged 50 years and above.[5] It ranks as the fourth leading cause of death and the leading cause of long-term disability.[5] Among patients with stroke, dysphagia occurs in 25% to 81% of cases, with approximately 11% to 50% developing chronic swallowing difficulties.[5-7] Post-stroke dysphagia significantly impacts healthcare resources through prolonged hospital stays and increases the need for long-term care, while also affecting patients' daily activities, independence and quality of life (QoL).[1, 8] In the US, the estimated annual incremental cost for ischaemic stroke patients with dysphagia ranges from US$4.61 billion (S$6.27 billion)[a] to US$20.11 billion (S$27.37 billion)[a], with per patient costs for acute hospital and post-hospitalisation care ranging from US$67,100 (S$91,276)[a] to US$112,400 (S$152,898)[a] in the first year.[9] Of note, length of hospital stay is one of the largest contributors to the direct cost.[9] Early effective management of dysphagia is essential to reduce complications and support better recovery for stroke survivors.

Current post-stroke dysphagia treatments include dietary and nutritional interventions, behavioural therapy and dedicated oral healthcare intervention. However, challenges such as sub-optimal patient compliance have limited the effectiveness of these treatments in severe cases. These limitations frequently arise from the severity of dysphagia itself or accompanying cognitive impairments that hinder patients' ability to fully participate in therapeutic interventions (Personal communication: Speech Therapist from Woodland Health, 4 October 2024). Neuromodulation techniques such as neuromuscular electrical stimulation (NMES)

[a] Based on the Monetary Authority of Singapore exchange rate as of September 2024 to August 2025: US$1=S$1.3603. Figures were rounded to the nearest dollar.

have emerged as promising adjunct therapies that target neural repair mechanisms. However, their effectiveness remains constrained by their reliance on indirect muscle stimulation through surface electrodes. These collective limitations underscore a clinical gap for an alternative treatment modality that includes precise reactivation of swallowing muscles without demanding active patient participation.

II. Technology

Phagenyx Neurostimulation System (Phagenesis Ltd; hereinafter referred to as Phagenyx) is a neurostimulation device that helps to restore neurological swallowing control in patients with severe post-stroke dysphagia by stimulating the afferent nerve fibres of the oropharyngeal mucosa with pharyngeal electrical stimulation (PES). The system (Figure 1) includes:

- A sterile single-patient use catheter that comprises two bipolar ring electrodes on its outer surface to deliver electrical stimulation and a feeding tube to facilitate delivery of nutrition or hydration
- A base station that comprises a touch-screen interface to facilitate the optimisation of stimulation levels for treatment and store patient and treatment information.

The catheter is inserted nasally and positioned to ensure that the bipolar ring electrodes align with the pharynx. Connected to the base station, the catheter delivers an optimised electrical stimulation level according to the patient's sensory capacity. Each treatment cycle consists of a 10-minute session daily over three consecutive days, with up to two cycles administered as clinically indicated. This targeted PES may activate swallowing muscles without active patient participation. The catheter can also be used as a feeding tube without needing to insert separate catheters for feeding and treatment.

Figure 1: Overview of Phargenyx Neurostimulation System (Figure from: https://www.phagenesis.com/)

Phagenyx offers a personalised neurostimulation approach that enhances swallowing function by directly stimulating the sensory nerves of the pharyngeal mucosa, increasing the excitability of the pharyngeal motor cortex for swallowing, and inducing and promoting neural plasticity.[10] Additionally, PES provides a combination of neurostimulation and feeding functions in a single catheter, streamlining the clinical workflow.

III. Regulatory and Subsidy Status

In September 2022, the US Food and Drug Administration (FDA) granted *de novo* clearance (DEN220025) to Phagenyx as a neurostimulation device for delivering electrical stimulation

to the oropharynx in addition to standard dysphagia care; as an aid to improve swallowing in patients with severe post-stroke dysphagia. It is the only device FDA-registered to stimulate the oropharynx for the treatment of post-stroke dysphagia.

IV. Stage of Development in Singapore

☒	Yet to emerge	☐	Established
☐	Investigational / Experimental (subject of clinical trials or deviate from standard practice and not routinely used)	☐	Established *but* modification in indication or technique
☐	Nearly established	☐	Established *but* should consider for reassessment (due to perceived no/low value)

V. Treatment Pathway

Based on the European Stroke Organisation (ESO) and European Society for Swallowing Disorders guidelines (ESSD),[7] patients with post-stroke dysphagia are managed with conventional therapies based on their specific swallowing impairments identified through either clinical bedside or instrumental assessments (see Table A1 in Appendix A). The therapies include:

I. dietary interventions, including the use of texture-modified diets and/or thickened liquids
II. behavioural interventions, including direct or indirect exercises and manoeuvres, such as rehabilitation exercises, compensatory intervention and acupuncture
III. nutritional interventions
IV. oral health care interventions

For patients with severe dysphagia, the European guideline[7] suggests neurostimulation techniques such as NMES and PES as an adjunct to conventional therapies, preferably within a clinical trial setting. A local clinician shared that NMES may also be considered as a second-line intervention when patients demonstrate limited improvement following conventional therapy alone. Of note, the timing and implementation of stimulation techniques ultimately depend on institutional protocols and clinical decision-making, which involve careful assessment of the patient's condition and thorough discussion between the healthcare team and family members (Personal communication: Principal Speech Therapist from Tan Tock Seng Hospital, 16 July 2025).

Locally, the introduction of Phagenyx may serve as an alternative to existing neurostimulation techniques such as NMES. It is estimated that approximately 10% of local patients with severe post-stroke dysphagia may be eligible for PES treatment based on specific requirements for PES tolerance, such as the need for nasal catheter insertion and the ability to maintain

sustained positioning throughout the duration of treatment (Personal communication: Principal Speech Therapist from Tan Tock Seng Hospital, 16 July 2025).

VI. Summary of Evidence

This assessment was conducted based on the Population, Intervention, Comparator and Outcome (PICO) criteria listed in Table 1. Literature searches were conducted in relevant international health technology assessment (HTA) databases, Cochrane Library and Embase.

The literature search identified 10 systematic reviews and/or meta-analyses (SRMAs) and an HTA report from Canada's Drug Agency (CDA; 2021)[11] and an HTA report from the National Institute for Health and Care Excellence (NICE; 2024).[12] Study selection was based on its coverage and recency. Additional searches did not identify new primary studies beyond those already included in the selected SRMAs and HTA reports.

The final evidence base for this report comprises two SRMAs (i) Lin et al. (2025),[10] a network meta-analysis (NMA) of 17 randomised clinical trials (RCTs); (ii) Liu et al. (2024),[13] an SRMA of six RCTs, and one NICE HTA (IPG781)[12] that included two SRMAs, five RCTs and one registry study. The study design and characteristics of the evidence base are presented in Table B1 and Table B2 in Appendix B.

Due to the scope of the assessments, there is significant overlap in the primary studies included in the selected evidence base. However, each provides complementary evidence (see Table B3 in Appendix B). NICE IPG781 (2024)[12] reported on pooled overall treatment outcomes, while Liu et al. (2024)[13] reported pooled overall and individual swallowing outcomes compared to sham treatment. Lin et al. (2025),[10] on the other hand, compared PES with conventional therapy and other stimulation therapies including NMES, repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS).

Most studies across the evidence base did not specify dysphagia severity.

Table 1: PICO criteria

Population	Patients with severe post-stroke dysphagia
Intervention	PES with standard dysphagia care
Comparator	Primary comparator: NMES with standard dysphagia care Secondary comparator: Standard dysphagia care
Outcome	● Safety (device-related discomfort or injury) ● Clinical effectiveness (e.g. swallowing functions and complications, degree of aspiration, dysphagia severity, feeding tube dependency, decannulation, quality of life and length of hospital stay) ● Cost and cost-effectiveness
Abbreviations: NMES, neuromuscular electrical stimulation; PES, pharyngeal electrical stimulation.	

Safety

Based on one RCT reported in NICE IPG781 (2024),[12] PES demonstrated minimal safety concerns when compared with sham. A higher rate of device- and treatment-related adverse events (AE) was shown for PES than sham (14% *vs.* 9%), however, all reported events were classified as non-serious (Table 2). There was no significant difference in the cumulative risk of all-cause death between both groups (hazard ratio [HR], 1.11; 95% CI, 0.34 to 3.59; p=0.86).[13] It is worth noting that NICE reported one serious adverse event (SAE; 0.4%) possibly related to PES that involved pneumonia from catheter insertion, leading to sepsis. This SAE was described in an analysis of a prospective registry of 252 people with dysphagia from various neurological causes, including stroke.

Across the evidence base, common SAEs reported in the PES group included cardiac, pneumonia, gastrointestinal and sepsis; however, all events were deemed unrelated to the device or treatment.

Table 2: Summary of PES-related adverse events

Safety outcome	Bath et al. (2016)			Dziewas et al. (2018)		
	PES	Sham	p-value	PES	Sham	p-value
Device-related and treatment-related						
AEs, % (n/N)[a]	—	—	—	14% (8/35)	9% (3/34)	—
Device-unrelated and treatment-unrelated						
SAE, % (n/N)	25.9% (22/87)	26.9% (18/75)	1.00	29% (12/35)	24% (9/34)	NS

[a] All device-related and treatment-related AE are deemed non-serious.

Abbreviations: AE, adverse event; NS, not significant; PES, pharyngeal electrical stimulation; SAE, serious adverse event.

Data adapted from NICE IPG781 (2024).

Effectiveness

PES *vs.* NMES

No studies directly comparing PES with NMES were identified. Findings from an NMA by Lin et al. (2025)[10] reported that NMES was likely to be more effective in improving swallowing outcomes and QoL than PES in patients with post-stroke dysphagia. In the NMA, pairwise comparison showed that PES performed worse than NMES for both swallowing function (standardised mean difference [SMD], -4.58; 95% CI, -6.68 to -2.48) and QoL (SMD, -3.86; 95% CI, -7.15 to -0.57; Table 3). Similar findings were reported when comparing PES with routine rehabilitation, although the difference in QoL was not statistically significant. Ranking analysis using the Surface Under the Cumulative Ranking (SUCRA) score also showed that NMES had a higher probability of improving swallowing function (77.3% *vs.* 18.2%) and QoL class (79.3% *vs.* 7.7%) than PES (see Table C1 in Appendix C).

Table 3: Results from pairwise comparisons of PES and other relevant interventions

Outcome	Intervention	Comparator	SMD[c] (95% CI)
Swallowing function[a]	PES	NMES	-4.58 (-6.68 to -2.48)
		Routine rehabilitation	-3.71 (-5.76 to -1.67)
		No intervention	0.36 (-0.91 to 0.18)

QoL indicators[b]	PES	NMES	-3.86 (-7.15 to -0.57)
		Routine rehabilitation	-2.77 (-5.84 to 0.29)
		No intervention	-0.35 (-1.78 to 1.07)

[a] Overall swallowing function was assessed using pooled outcomes from multiple scales (i.e. FDS, FOIS, VFSS, DSRS, PAS, DOSS) measuring swallowing ability and the severity of dysphagia.
[b] Quality of life was evaluated with established tools (i.e. BI, SWAL-QOL, ASHS NOMS, CDS, MASA) reflecting the impact of swallowing disorders on daily living and well-being.
[c] A positive value indicated that the intervention performed better than the comparator, and vice versa.

Abbreviations: ASHA NOMS, American Speech-Language-Hearing Association National Outcome Measurement System; BI, Barthel Index; CDA, Clinical Dysphagia Scale; CI, confidence intervals; DOSS, Dysphagia Outcome and Severity Scale; DSRS, Dysphagia Severity Rating Scale; FDS, Functional Dysphagia Scale; FOIS, Functional Oral Intake Scale; MASA, Modified Mann Assessment of Swallowing Ability; NMES, neuromuscular electrical stimulation; PAS, Penetration Aspiration Scale; PES, pharyngeal electrical stimulation; QoL, quality of life; SMD, standardised mean difference; SWAL-QOL, Swallowing Quality of Life; VFSS, Video Fluoroscopic Swallowing Study.

Data adapted from Lin et al. (2025).

PES *vs.* Sham

Based on an SRMA included in NICE IPG781 (2024),[12] PES demonstrated significant pooled overall benefit (SMD, 0.68; 95% CI, 0.22 to 1.14; p=0.04) compared to control treatment (i.e. sham), though NICE noted the difficulty in interpreting this overall benefit (Table 4). Further, this improvement was limited to the early post-treatment period up to two weeks and was not sustained beyond three months (SMD, -0.04; 95% CI, -0.46 to 0.38; p=0.86; Table 4). Moreover, findings from an RCT included in NICE IPG781 (2024) reported no significant differences in changes from baseline in QoL outcomes between the PES and sham groups (Table 5).[12]

Table 4: Summary results of PES on overall effects[a] compared to control treatment

Follow-up period	PES (N)	Control (N)	SMD[b] (95% CI)	p-value
Overall[a]	187	147	0.68 (0.22 to 1.14)	**0.004**
Early (≤2 weeks)	187	147	0.68 (0.22 to 1.14)	**0.004**
Late (>3 months)	47	40	-0.04 (-0.46 to 0.38)	0.86

[a] Overall effect was assessed using outcomes related to swallowing which included swallowing physiology measurement, clinical swallowing function ratings, functional dysphagia symptom scales or health outcomes related to swallowing or pharyngeal functions. For outcome measures that increase with disease severity, the mean values were multiplied by -1.
[b] A positive value indicated that the intervention performed better than the comparator, and vice versa.

Abbreviations: CI, confidence intervals; PES, pharyngeal electrical stimulation; SMD, standardised mean difference

Data adapted from an SRMA included in NICE IPG781 (2024).

Table 5: Impact of PES on Health-related QoL

Outcomes	PES (N)	Sham (N)	MD[a] (95% CI)	p-value
EQ-5D-HUS	87	75	0.13 (0.00 to 0.27)	0.054
EQ-5D VAS			-4.17 (-15.22 to 6.88)	0.46

[a] A positive value indicated that the intervention performed better than the comparator, and vice versa.

Abbreviations: CI, confidence intervals; EQ-5D HUS, EuroQoL 5-dimensions health utility status; EQ-5D VAS, EuroQoL 5-dimensions visual analogue scale;; MD, mean difference; PES, pharyngeal electrical stimulation

Data adapted from one RCT included in NICE IPG781 (2024).

Pooled results for specific dysphagia-related outcomes (including penetration-aspiration scale [PAS], functional oral intake scale [FOIS] and dysphagia severity rating scale [DSRS]) were reported by Liu et al. (2024).[13] Compared to the control group, PES demonstrated significant

improvements in overall swallowing function (SMD, -0.20; 95% CI, -0.38 to -0.03; p=0.02; Table 6). However, when examining individual swallowing outcomes, subgroup analyses revealed no statistically significant improvements for any specific assessments (Table 6; see Table B4 in Appendix B for detailed information on individual swallowing outcomes). In addition, no significant between-group differences were reported for stroke severity and hospital length of stay. These f aligned with findings from NICE IPG781 (2024), which generally showed non-significant improvements for individual swallowing measures.

Notably, some evidence suggests that PES may be beneficial in facilitating decannulation for tracheostomised patients with severe post-stroke dysphagia (RR, 4.69; 95% CI, 2.02 to 10.87; p=0.0003; Table 6).[13] This is corroborated by findings from NICE IPG781 (2024)[12] where, compared to control, PES was associated with a significantly higher decannulation rate within 24 to 72 hours (49% to 75% *vs.* 9% to 20%) among tracheostomised patients.[12] No patients who were decannulated following treatment with PES required recannulation within 30 days or prior to hospital discharge. However, there is a lack of evidence directly comparing PES and NMES on decannulation outcomes.

Table 6: Effect of PES on various outcomes compared to sham

Outcome	PES (N)	Control[a] (N)	SMD (95% CI) or RR (95% CI)	p-value
Decannulation	55	44	4.69 (2.02 to 10.87)[b,c]	**0.0003**
Swallowing function				
Overall	272	242	-0.20 (-0.38 to -0.03)[d]	**0.02**
PAS	107	92	-0.15 (-0.43 to 0.13)[d]	0.30
FOIS	25	25	-0.24 (-0.79 to 0.32)[d]	0.40
DSRS	140	125	-0.24 (-0.48 to 0.00)[d]	0.05
Stroke severity (NIHSS)	148	135	-0.83 (-2.42 to 0.76)[d]	0.31
Length of stay	135	109	-0.19 (-0.44 to 0.07)[d]	0.15

[a] Control group was treated with sham stimulation or routine rehabilitation.
[b] Reported in risk ratio.
[c] A positive value indicated that the intervention performed better than the comparator, and vice versa.
[d] A negative value indicated that the intervention performed better than the comparator, and vice versa.

Abbreviations: CI, confidence intervals; DSRS, Dysphagia Severity Rating Scale; FOIS, Functional Oral Intake Scale; NIHSS, National Institutes of Health Stroke Scale; PAS, Penetration Aspiration Score; RR, risk ratio; PES, pharyngeal electrical stimulation; SMD, standardised mean difference.

Data adapted from Liu et al. (2024).

Cost-effectiveness

No studies on the cost-effectiveness of Phagenyx were identified.

Ongoing trials

There are currently three ongoing studies investigating Phagenyx for post-stroke dysphagia identified from the ScanMedicine database (NIHR Innovation Observatory; Table 7). These include an RCT examining swallowing mechanisms in acute stroke patients (N=84), a phase IV international RCT investigating the effectiveness of PES compared to sham (PhEAST, N=800),

and a US registry study evaluating real-world effectiveness in patients with severe dysphagia (RESTORE-US, N=600), with estimated completion dates ranging from 2025 to 2036.

Table 7: Ongoing clinical trial

Study (Trial ID)	Population & estimated enrolment	Brief description	Estimated study completion date
The Effect of Pharyngeal Electrical Stimulation on Peripheral Biomechanical Aspects of Deglutition (PES) (NCT05666141)[14]	Hospitalised adults (aged between 18 years and 85) with acute stroke and dysphagia N=84 Control: Sham with standard dysphagia treatment	A double-blinded, sequential-assessment RCT aims to clarify which biomechanical aspects of swallowing are altered by PES in stroke patients, ICU patients and healthy volunteers.	September 2025
Pharyngeal Electrical stimulation for Acute Stroke dysphagia Trial (PhEAST) (ISRCTN98886991)[15]	Hospitalised adults (aged 18 years and over) with recent stroke (within 4-31 days) and dysphagia N=800 Control: Sham with standard dysphagia treatment	An international, prospective, randomized, open-label, blinded-endpoint (PROBE) parallel-group, superiority, Phase IV effectiveness trial to assess whether PES is safe and effective at improving post-stroke dysphagia.	September 2027
Phagenyx® Registry Study (RESTORE-US) (NCT06866418)[16]	Patient who requires a nasogastric feeding tube for severe dysphagia and required dysphagia treatment N=600 Control: standard dysphagia care	A retrospective, open-label, matched-control registry study to characterize the effectiveness of PES to improve swallowing in patients with severe post-stroke dysphagia when delivered using the Phagenyx® System in real-world clinical settings in hospitals in the US.	September 2036

Summary

Overall, PES was found to be relatively safe, with some benefits shown for patients with post-stroke dysphagia. Compared to sham, PES demonstrated minimal safety concerns, with some non-serious device-related AEs reported.

Limited evidence suggests PES performs worse than NMES, although with some benefits over sham. An NMA demonstrated that PES resulted in less improvement in both swallowing outcomes and QoL when compared to both NMES and routine rehabilitation. Compared to sham treatment, pooled data showed that PES significantly improved overall swallowing function in the early post-treatment period of up to two weeks only. No significant between-group differences were reported for specific swallowing measures, length of stay, and QoL outcomes. However, in tracheostomised patients with post-stroke dysphagia, PES demonstrated significant improvement in decannulation rates compared to sham (RR, 4.69; 95% CI, 2.02 to 10.87). The cost-effectiveness of PES remains unclear.

The evidence should be interpreted with caution, with no direct comparative studies between PES and NMES identified. The lack of consistent dysphagia severity reporting across studies limits conclusions about the effectiveness of PES in severe cases. Additionally, most studies in NICE IPG781 and the SRMAs were funded by Phagenesis, raising potential bias concerns.

VII. Estimated Costs

No cost information for Phagenyx was identified, but an evidence review by NICE estimated a cost for the base station of approximately £10,000 (S$17,074)[b], with another £1,000 (S$1,707)[b] required per multisession use of the catheter.[17] In the same review, the cost of the NMES machine (VitalStim Plus Electrotherapy System) was £2,394 (S$4,088)[b] with electrodes ranging from £350 (S$598)[b] to £700 (S$1,195)[b] per multisession use.[17] For reference, a local clinician shared that the cost for a 30-minute neurostimulation therapy session ranges from S$100 to S$120, with patients typically receiving around 10-15 sessions per treatment course, depending on their medical condition, participation level, and discharge planning. (Personal communication: Principal Speech Therapist from Tan Tock Seng Hospital, 16 July 2025).

VIII. Implementation Considerations

Given that other stimulation techniques such as NMES are already used locally as adjuncts to conventional therapies, the organisational impact of integrating Phagenyx, as an adjunct to standard care is expected to be minimal. Furthermore, as feeding tubes are routinely placed in patients with severe dysphagia, the dual functionality of Phagenyx may streamline existing procedures and reduce the need for multiple devices.

However, unlike other non-invasive neurostimulation modalities, Phagenyx requires nasal insertion of a catheter into the pharynx, which may cause patient discomfort. To ensure safe and effective treatment, the Phagenyx catheter must be positioned accurately, so the electrodes contact the pharyngeal mucosa correctly. Although the catheter includes markings to guide its placement, additional training for healthcare providers may be necessary to ensure accurate and consistent use of the device.

IX. Concurrent Developments

There are no other similar devices that provide stimulation of the pharynx for the treatment of post-stroke dysphagia in concurrent development.

X. Additional Information

Several international guidelines and HTA agencies recommended the (conditional) use of PES for tracheotomised patients with severe post-stroke dysphagia. Of the four agencies or clinical guidelines recommending the use of PES in this specific subpopulation, NICE, ESO/ESSD and the German Society of Neurology issued the recommendation for use under special conditions including in clinical trial settings, and the need for audit or research (Table 8). The CDA has not issued formal recommendations for routine use, instead highlighting the need for additional evidence.

Table 8: Overseas recommendations and clinical guidelines

Agency/ Clinical guidelines	Country (year)	Recommendation for PES	Details
Canada's Drug Agency (CDA)[11]	Canada (2021)	—	Given that this is a horizon scan report, no recommendation was provided.

[b] Based on the Monetary Authority of Singapore exchange rate as of September 2024 to August 2025: GB£1=S$1.7074. Figures were rounded to the nearest dollar.

European Stroke Organisation (ESO) and European Society for Swallowing Disorders (ESSD)[7]	Europe (2021)	*Use under clinical trial setting	● In patients with post-stroke dysphagia, we recommend that treatment with neurostimulation techniques (rTMS, TES, tDCS and PES) should preferably be conducted within a clinical trial setting. ● In tracheotomised stroke patients with severe dysphagia, we suggest treatment with PES to accelerate decannulation.
German Society of Neurology[18]	Germany (2021)	✓	PES should be used to treat dysphagia in tracheotomised stroke patients with supratentorial lesion. Participation in prospective clinical registries is recommended.
National Clinical Guideline for Stroke[19]	United Kingdom and Ireland (2023)	✓	Patients with tracheostomy and severe dysphagia after stroke may be considered for PES to aid decannulation where the device is available and it can be delivered by a trained independent and safe feeding.
National Institute for Health and Care Excellence (NICE)[12]	United Kingdom (2024)	*Use under special arrangements	For people with neurogenic dysphagia who have a tracheostomy after stroke, Phagenyx neurostimulation system can be used in the NHS while more evidence is generated. It can only be used with special arrangements for clinical governance, consent, and audit or research.
Abbreviations: NHS, National Health Service; PES, pharyngeal electrical stimulation; rTMS, repetitive transcranial magnetic stimulation; tDCS, transcranial direct current stimulation; TES, transcutaneous electrical stimulation			

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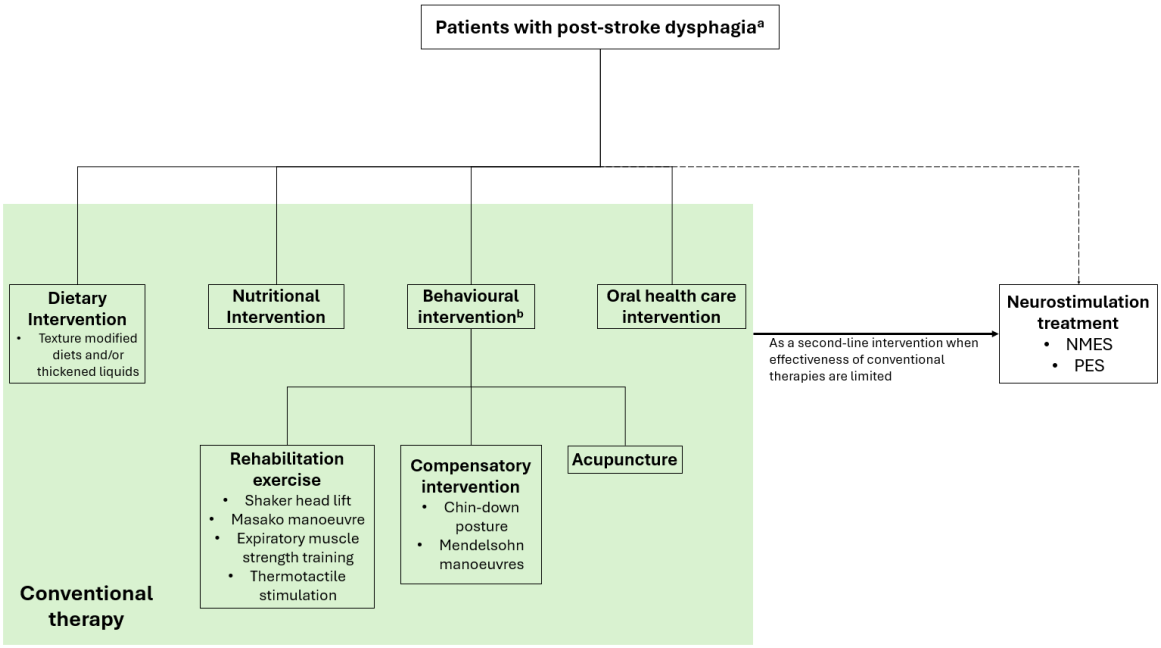
Appendix

Appendix A: Clinical pathways

Table A1: Clinical pathway according to ESO and ESSD Guidance for treatment of post-stroke dysphagia



[a] Confirmed through clinical bedside evaluation and instrumental assessment (videofluoroscopy or fibre-optic endoscopic evaluation of swallowing [FEES]) by a speech and language therapist.
[b] Appropriate behavioural intervention based on a thorough assessment of dysphagia, such as by a speech and language therapist.

Abbreviations: ESO, European Stroke Organisation; ESSD, European Society for Swallowing Disorders; NMES, neuromuscular electrical stimulation; PES, pharyngeal electrical stimulation

Appendix B: Studies included and study design

Table B1: List of included studies

Type of Study	Key evidence base	Supplementary evidence base
NICE Guidance Report	1	—
Published systematic review	2	—

Note:

1. Inclusion criteria
   a. Studies that fulfil the PICO criteria listed in Table 1.
2. Exclusion criteria
   a. Studies only available in abstract form.
   b. Duplicate studies.
   c. Non-human studies.

Table B2: Design and characteristics of included studies

Study		N	Study design	Population	Comparator	Outcome reported
NICE IPG781 (2024)[12]	Cheng et al. (2021)[20]	8 studies[a] N=334 (active treatment: 187)	SRMA	Patients with dysphagia post-stroke	Sham	● Treatment effect (overall, early, late)
	Bath et al. (2016)[21]	N=162 (active treatment: 87)	RCT	Patients with dysphagia post-stroke	Sham	● PAS at 2 weeks ● PAS at 12 weeks ● Swallowing ability (DSRS) ● Dependence and disability (mRS, NIHSS, BI) ● HRQoL ● Nutritional measures
	Dziewas et al. (2018)[22]	N=69 (active treatment: 35)	RCT	Patients with dysphagia and tracheostomy post-stroke	Sham	● Decannulation at 24 to 72 hours after 3 hours of PES ● Treatment effect ● Necessity of recannulations ● Swallowing ability (DSRS, FOIS) at day 2, during follow-up of 30 days or until discharge ● Dependence and disability (mRS, NIHSS) at day 2, during follow-up of 30 days or until discharge ● LOS ● Safety
	Suntrup et al. (2015)[23]	N=30 (active treatment: 20)	RCT	Patients with severe dysphagia and tracheostomy post-stroke	Sham	● Decannulation after 3 days ● Swallowing ability (FOIS) ● Dependence and disability (mRS)

						● LOS in ICU ● LOS in hospital
Liu et al. (2024)[13]		6 studies N=341 (active treatment: 184)	SRMA	Patients with post-stroke dysphagia	Sham	● Swallowing ability (PAS, DSRS, FOIS) ● Decanulation ● LOS in hospital ● Dependence and disability (NIHSS) ● Safety
Lin et al. (2025)[10]		3 studies[a] N=242 (active treatment: 129)	SRMA	Acute or chronic stroke patients with swallowing dysfunction	Routine rehabilitation intervention or no intervention	● Overall swallowing function ● QoL

[a] Studies that assessed safety or clinical effectiveness outcomes of PES in patients with post-stroke dysphagia.
Abbreviations: BI, Barthel Index; DSRS, Dysphagia Severity Rating Scale; FOIS, Functional Oral Intake Scale; HRQoL, health-related quality of life; LOS. length of stay; MA, meta-analysis; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; NR, not reported; PAS, Penetration-aspiration scale; PES, pharyngeal electrical stimulation; QoL, quality of life; RCT, randomised controlled trial; SRMA, systematic review and meta-analysis

Table B3: Primary studies[a] included in the key evidence base *where* PES use in patients with post-stroke dysphagia was assessed

Key evidence base	Study design	Primary studies								Remarks
		Jayasekeran et al. (2010)[24]	Michou et al. (2014)[25]	Suntrup et al. (2015)[23]	Vasant et al. (2016)[26]	Bath et al. (2016)[21]]	Essa et al. (2017)[27]	Dzeiwas et al. (2018)[22]	Cabib et al. (2020)[28]	
NICE IPG781 (2024)[a][12]	HTA	✓	✓	✓	✓	✓	✕	✓	✓	● Most comprehensive coverage of relevant primary studies ● Provided a single pooled overall treatment effect comparing PES and sham
Liu et al. (2024)[13]	SRMA	✓	✕	✓	✓	✓	✓	✓	✕	● Primary studies overlapped with NICE IPG781 ● However, the SRMA conducted pooled analysis for specific swallowing and dysphagia-related outcomes on PES and sham.
Lin et al. (2025)[10]	SRMA	✓	✕	✕	✓	✓	✕	✕	✕	● Primary studies overlapped with NICE IPG781 ● However, the SRMA conducted a NMA to compare pooled outcomes between PES and NMES.

[a] Most studies included in NICE IPG781 (2024) are from a SRMA by Cheng et al. (2021) which forms its key evidence base.

Abbreviations: HTA, health technology assessment; NICE, National Institute for Health and Care Excellence; NMA, network meta-analysis; NMES, neuromuscular electrical stimulation; PES, pharyngeal electrical stimulation; RCT, randomised controlled trial; SRMA, systematic review and meta-analysis

Table B4: Outcome measures

Outcome	Assessment measure	Description
Swallowing ability	PAS	● An 8-point scale that assess the safety of swallowing by endoscopic exam or videofluoroscopy. ● Score ranges from 1 (material does not enter the airway) to 8 (material enters the airway, passes below the vocal folds and no effort is made to eject). ● Higher scores indicate worse swallows and a PAS score of 3 or more is considered an abnormal swallow.
	FOIS	● A 7-point scale that accesses oral intake capacity. ● Score ranges from 1 (no oral intake) to 7 (total oral intake with no restrictions). ● Lower scores indicate more severe dysphagia.
	DSRS	● A scale that estimate of the severity of dysphagia post stroke based on the amount of food and fluid modification people with the condition need as well as the level of supervision required. ● Subscore ranges from 0 (normal and eating independently) to 4 (no oral fluids and feeding). ● Higher scores indicate more severe dysphagia.
Dependence and disability	NIHSS	● A 15-item scale that assesses the level of neurological impairment in people with stroke. ● Subscales include consciousness, language, neglect, visual-field loss, extraocular movement, motor strength, ataxia, dysarthria and sensory loss ● Each subscale being scored on a 3-point to 5-point scale, and a total score of 42. ● Higher scores indicate worse impairment, with scores of more than 25 considered very severe and scores of 15 to 24 considered severe.
Quality of life	EQ-5D	● A score that assesses health-related QoL across 5 domains: mobility, self-care, usual activities, pain and discomfort, and anxiety and depression. ● Higher scores indicate worse QoL.
	EQ-5D VAS	● Vertical line ranges from 0 (the worst health you can imagine) to 100 (the best health you can imagine). ● People mark the line to indicate how their health is that day. ● Higher scores indicate better health.
Abbreviations: BI, Barthel Index; DSRS, Dysphagia Severity Rating Scale; EQ-5D, EuroQoL 5-dimensions; EQ-5D VAS, EuroQoL 5-dimensions visual analogue scale; FOIS, Functional Oral Intake Scale; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; PAS, Penetration-aspiration scale; QoL, quality of life		

Appendix C: List of supplementary tables

Table C1: Probability of improving swallowing function and QOL in stroke patients with different stimulation modalities

Treatment	SUCRA (%)	
	Swallowing function	QoL
NMES	77.3	79.3
PES	18.2	7.7
Routine rehabilitation	40.1	43.4
rTMS	87.3	75.7
tDCS	75.3	78.6

Abbreviations: NMES, neuromuscular electrical stimulation; PES, pharyngeal electrical stimulation; QoL, quality of life; rTMS, repetitive transcranial magnetic stimulation; SUCRA, cumulative lower surface of the ranking curve; tDCS, transcranial direct current stimulation

Data adapted from Lin et al. (2025).