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Editorial

Transcutaneous Auricular Vagus Nerve Stimulation (taVNS): Precise Integration Between Neuroscience and Integrative Medicine

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Abstract

Transcutaneous auricular vagal nerve stimulation (taVNS) is a non-invasive method that regulates the autonomic nervous system via electrical stimulation of the auricular branch of the vagus nerve. Recent literature demonstrates that taVNS can decrease systemic inflammation, attenuate emotional disorders, modulate autonomic functions, and facilitate neural plasticity. This review examines the neurophysiological mechanisms of taVNS, including stimulation paradigms (short- and intensive, prolonged), and clinical findings across various medical disciplines (neurology, psychiatry, cardiology, pulmonology, immunology, gastroenterology) with a focus on trials. The multiple applications presented demonstrate the great potential of taVNS as a new approach in integrative medicine, emphasizing the need for multicenter studies to unify the therapy and consolidate its effectiveness.

Keywords

taVNS; vagus nerve; electrical stimulation; integrative medicine; autonomic modulation

1. Introduction

Integrative medicine aims to integrate traditional practices with contemporary science, offering personalized, safe, and evidence-based interventions. Transcutaneous auricular vagus nerve

stimulation (taVNS) exemplifies this concept by employing controlled electrical stimulation in specific auricular regions, primarily the concha and tragus, which are richly innervated by the auricular branch of the vagus nerve [1].

taVNS is a technique based on modern neuroscience that utilizes precise electrical stimulation to activate the auricular branch of the vagus nerve directly. The use of well-defined parameters, such as frequency, intensity, and duration, enables the standardization of clinical protocols and the development of high-quality clinical trials. Recent studies demonstrate that this approach can modulate autonomic and inflammatory responses, providing therapeutic benefits in conditions such as drug-resistant epilepsy, treatment-resistant depression, anxiety, chronic pain, inflammatory diseases, stroke sequelae, COVID-19, and autonomic dysfunctions [2-6].

2. Neurophysiological Basis

taVNS activates afferent fibers of the auricular branch of the VN, which end in the jugular ganglion and nucleus tractus solitarius (NTS) within the brainstem [7]. The NTS is an autonomic center that controls the emotions, viscera, and intestines. Signals are then sent to central regions, including the locus coeruleus (LC), dorsal raphe nucleus (DR), hypothalamus, amygdala, hippocampus, and prefrontal cortex, from these sites [8, 9].

This neural network accounts for the systemic effects of taVNS. Then, it stimulates the release of norepinephrine and serotonin, which control mood and cognitive functions [10, 11]. Meanwhile, it stimulates the cholinergic anti-inflammatory pathway to suppress pro-inflammatory cytokines, including TNF-α and IL-6, through α7nAChR receptors on the surface of macrophages [12, 13]. This mechanism, referred to as the inflammatory reflex, is of great importance in cases of autoimmune and chronic inflammatory diseases.

Neuroimaging studies demonstrate that taVNS induces cortical desynchronization, a phenomenon associated with plasticity and functional reorganization —both key elements in neurological rehabilitation [14]. Furthermore, it enhances heart rate variability (HRV) as a measure of autonomic equilibrium without significant bradycardia and/or adverse events of severity [15, 16].

The key diseases where taVNS has been recommended with evidence are presented in Table 1 and categorized by medical specialty.

Table 1 Clinical indications of taVNS by medical specialty.

Specialty	Diseases/Clinical Conditions	Treatment Response
Neurology	Drug-resistant epilepsy [17], Stroke – motor rehabilitation [18], Chronic migraine [19], Essential tremor [20], Disorders of consciousness [21], Neuropathic pain [22]	Good response in epilepsy, migraine, and post-stroke rehabilitation. Variable response in disorders of consciousness.
Psychiatry/Neuropsychiatry	Treatment-resistant depression [23], Generalized anxiety disorder [24], PTSD [25], Chronic insomnia [26], Obsessive-compulsive disorder [27],	Good response to depression, anxiety, PTSD, and insomnia. Initial evidence and variable Response to long COVID.

	Mood disorders in long COVID [28]	
Cardiology	Heart failure with reduced ejection fraction [29], Atrial fibrillation [30], Improvement of heart rate variability [31]	Variable results. Consistent improvement in autonomic modulation, but inconclusive clinical outcomes.
Pulmonology	Moderate to severe asthma [32], COPD [33], Improvement of pulmonary function after viral infections [34]	Good response in asthma and post-infection lung function. Limited evidence in COPD.
Infectious Diseases	Acute COVID-19 [3], Long COVID [28], Inflammatory markers in COVID-19 [35]	Good response in reducing inflammation and symptoms in COVID-19 and long COVID. Initial promising results in sepsis.
Immunology/Rheumatology	Rheumatoid arthritis [36], Systemic lupus erythematosus [37], Inflammatory bowel disease [38], Psoriasis [39], Fibromyalgia [40]	Good response in rheumatoid arthritis and inflammatory bowel disease. Preliminary evidence in lupus, psoriasis, and multiple sclerosis.
Gastroenterology	Irritable bowel syndrome [41], Crohn's disease [38], Ulcerative colitis [38], Diabetic gastroparesis [42], Functional dyspepsia [43]	Good response in IBS-C, gastroparesis, and functional dyspepsia. Moderate evidence in Crohn's disease and ulcerative colitis.
Endocrinology/Metabolism	Type 2 diabetes [44], Obesity [45], Metabolic syndrome [46]	Promising initial results in glycemic control and weight management, but still lacking robust evidence.
Otolaryngology	Post-viral olfactory loss [47], Chronic tinnitus [48], Functional vertigo [49]	Good response to olfactory loss and vertigo. Variable response in tinnitus.
Dermatology	Seborrheic dermatitis [50]	Preliminary evidence showing a positive response.
Oncology/Palliative Care	Pain control in cancer patients [51], Fatigue in cancer [52]	Good response to pain and anxiety management; Studies are still in early stages.
Geriatrics/Preventive Medicine	Prevention of cognitive decline in older adults [53], Autonomic regulation of cardiovascular risk prevention [54]	Good response in preventing cognitive decline and improving autonomic balance.

taVNS: Transcutaneous Auricular Vagus Nerve Stimulation; DoC: Disorders of Consciousness; PTSD: Post-Traumatic Stress Disorder; HRV: Heart Rate Variability; COPD: Chronic Obstructive

Pulmonary Disease; COVID-19: Coronavirus Disease 2019; IBS-C: Irritable Bowel Syndrome with Constipation.

3. Application Protocols

Application protocols vary according to clinical condition and therapeutic goals:

- **Short protocol:** 30–60 minutes per session, once a day, for 7 consecutive days. Indicated for acute symptoms, post-COVID recovery, or post-surgical periods [3].
- **Intensive protocol:** Two daily sessions of 30–90 minutes for 7 to 14 days. Indicated for chronic conditions such as IBS-C and severe anxiety [41].
- **Prolonged protocol:** Repeated cycles (14 days of application followed by a 2-week interval). Used for neurological rehabilitation and disorders of consciousness [21].

The technical parameters are summarized in Table 2.

Table 2 Technical parameters of taVNS.

Parameter	Common Values	References
Anatomical site	Auricular concha (cymba or cavum) and tragus	[1]
Stimulation frequency	20–30 Hz (20 Hz for PTSD and insomnia)	[25, 26]
Pulse width	~100 μs	[25]
Intensity	80% of the discomfort threshold	[25]
Session duration	30–60 min (short) or up to 90 min (intensive)	[3, 41]
Application frequency	1 or 2 sessions/day, according to protocol	[3, 41]
Protocol indications	Short: acute symptoms; Intensive: chronic conditions; Prolonged: rehabilitation and DoC	[3, 21, 41]
Safety	Well-tolerated, mild, and transient adverse effects	[16]

taVNS: Transcutaneous Auricular Vagus Nerve Stimulation; Hz: hertz; PTSD: Post-Traumatic Stress Disorder; μs: microsegundos; min: minutos; DoC: Disorders of Consciousness.

4. Discussion

taVNS represents an innovative intervention at the interface of neuroscience and integrative medicine. Its effects span multiple systems, from autonomic regulation to the modulation of mood and inflammation. Robust studies have demonstrated its efficacy in treatment-resistant depression [23], epilepsy [17], and autonomic disorders such as atrial fibrillation [30]. In autoimmune diseases such as rheumatoid arthritis and inflammatory bowel disease, taVNS acts through the cholinergic anti-inflammatory pathway, reducing inflammatory mediators without the side effects of conventional immunosuppressive drugs [36, 38].

During the COVID-19 pandemic, taVNS gained prominence as a complementary strategy for modulating the inflammatory response and promoting functional recovery in patients with long COVID [3, 28]. In neurology, recent advances highlight its role in motor rehabilitation after stroke, especially when combined with intensive physical therapy [18]. In psychiatry, systematic reviews confirm its benefits for depression, anxiety, and sleep disorders [23-26].

Despite these advances, challenges remain. The heterogeneity of technical parameters complicates comparisons between studies. Greater integration of taVNS with other complementary

therapies, such as hypnosis and herbal medicine, is needed to develop combined protocols. No specific publications on this topic were identified in *OBM Integrative and Complementary Medicine*, highlighting an opportunity for the journal to lead scientific production and foster the standardization and dissemination of high-quality evidence.

5. Conclusion

taVNS combines safety, accessibility, and efficacy, making it a promising intervention for a wide range of clinical conditions. Its integration into integrative medicine strengthens a holistic and evidence-based approach to patient care. Strengthening scientific research and standardizing protocols are essential to establish taVNS as a first-line therapeutic tool across various medical specialties.

Author Contributions

The author did all the research work for this study.

Competing Interests

The authors have declared that no competing interests exist.

AI-Assisted Technologies Statement

Artificial intelligence (AI) tools were used solely for basic grammar correction and language refinement in the preparation of this manuscript. Specifically, OpenAI's ChatGPT was employed to improve the readability and linguistic clarity of the English text. All scientific content, data interpretation, and conclusions were developed independently by the author. The authors have thoroughly reviewed and edited the AI-assisted text to ensure its accuracy and accept full responsibility for the content of the manuscript.

References

1. Butt MF, Albusoda A, Farmer AD, Aziz Q. The anatomical basis for transcutaneous auricular vagus nerve stimulation. J Anat. 2020; 236: 588-611.
2. Frangos E, Ellrich J, Komisaruk BR. Non-invasive access to the vagus nerve central projections via electrical stimulation of the external ear: fMRI evidence in humans. Brain Stimul. 2015; 8: 624-636.
3. Seitz T, Bergmayr F, Kitzberger R, Holbik J, Grieb A, Hind J, et al. Randomized controlled study to evaluate the safety and clinical impact of percutaneous auricular vagus nerve stimulation in patients with severe COVID-19. Front Physiol. 2023; 14: 1223347.
4. Redgrave J, Day D, Leung H, Laud PJ, Ali A, Lindert R, et al. Safety and tolerability of transcutaneous vagus nerve stimulation in humans; A systematic review. Brain Stimul. 2018; 11: 1225-1238.
5. Fang J, Rong P, Hong Y, Fan Y, Liu J, Wang H, et al. Transcutaneous vagus nerve stimulation modulates default mode network in major depressive disorder. BiolPsychiatry. 2016; 79: 266-273.

6. Gong J, Yan Z, Zhang J, Dai Y, Tevin Tagu P, Wang Z, et al. Transcutaneous vagus nerve stimulation treatment of epileptic encephalopathy with spike-and-wave activation in sleep: A prospective cohort study. J Child Neurol. 2025. doi:10.1177/08830738251356854.
7. Peuker ET, Filler TJ. The nerve supply of the human auricle. Clin Anat. 2002; 15: 35-37.
8. Berthoud HR, Neuhuber WL. Functional and chemical anatomy of the afferent vagal system. Auton Neurosci. 2000; 85: 1-17.
9. Wang L, Xu Q, Luo M, Xing X, Wang J, Liang Y, et al. Vagus nerve stimulation in various stages of stroke and associated functional impairments: A review. Neuroscience. 2025; 577: 80-113.
10. Manta S, Dong J, Debonnel G, Blier P. Enhancement of the function of rat serotonin and norepinephrine neurons by sustained vagus nerve stimulation. J Psychiatry Neurosci. 2009; 34: 272-280.
11. Tracey KJ. Reflex control of immunity. Nat Rev Immunol. 2009; 9: 418-428.
12. Koopman FA, Chavan SS, Miljko S, Grazio S, Sokolovic S, Schuurman PR, et al. Vagus nerve stimulation inhibits cytokine production and attenuates disease severity in rheumatoid arthritis. Proc Natl Acad Sci USA. 2016; 113: 8284-8289.
13. Bonaz B, Sinniger V, Pellissier S. Vagus nerve stimulation at the interface of brain-gut interactions. Cold Spring Harb Perspect Med. 2019; 9: a034199.
14. Sangare A, Marchi A, Pruvost-Robieux E, Soufflet C, Crepon B, Ramdani C, et al. The effectiveness of vagus nerve stimulation in drug-resistant epilepsy correlates with vagus nerve stimulation-induced electroencephalography desynchronization. Brain Connect. 2020; 10: 566-577.
15. Stavrakis S, Humphrey MB, Scherlag B, Iftikhar O, Parwani P, Abbas M, et al. Low-level vagus nerve stimulation suppresses post-operative atrial fibrillation and inflammation: A randomized study. JACC Clin Electrophysiol. 2017; 3: 929-938.
16. de Moraes TL, Costa FO, Cabral DG, Fernandes DM, Sangaleti CT, Dalboni MA, et al. Brief periods of transcutaneous auricular vagus nerve stimulation improve autonomic balance and alter circulating monocytes and endothelial cells in patients with metabolic syndrome: a pilot study. Bioelectron Med. 2023; 9: 7.
17. Yang H, Shi W, Fan J, Wang X, Song Y, Lian Y, et al. Transcutaneous auricular vagus nerve stimulation (ta-VNS) for treatment of drug-resistant epilepsy: A randomized, double-blind clinical trial. Neurotherapeutics. 2023; 20: 870-880.
18. Chen X, Zhou Z, Chong K, Zhao J, Wu Y, Ren M, et al. Transcutaneous auricular vagus nerve stimulation for long-term post-stroke cognitive impairment: A DTI case report. Front Hum Neurosci. 2024; 18: 1473535.
19. Weng S, Xiao X, Liang S, Xue Y, Yang X, Ji Y. Single-centre, randomised and double-blind clinical trial on the efficacy of transcutaneous auricular vagus nerve stimulation in preventing and treating primary headache in children and adolescents: A study protocol. BMJ Open. 2025; 15: e092692.
20. Marano M, Magee R, Blasi F, Anzini G, Capone F, Ricciuti R, et al. An open-label pilot study of non-invasive cervical vagus nerve stimulation in essential tremor. Brain Stimul. 2024; 17: 1283-1285.
21. Osińska A, Rynkiewicz A, Binder M, Komendziński T, Borowicz A, Leszczyński A. Non-invasive vagus nerve stimulation in treatment of disorders of consciousness–longitudinal case study. Front Neurosci. 2022; 16: 834507.

22. Malley KM, Ruiz AD, Darrow MJ, Danaphongse T, Shiers S, Ahmad FN, et al. Neural mechanisms responsible for vagus nerve stimulation-dependent enhancement of somatosensory recovery. Sci Rep. 2024; 14: 19448.
23. Koenig J, Vöckel J. Transcutaneous auricular vagus nerve stimulation in adolescent treatment resistant depression–A case report. J Pediatr. 2024; 271: 114078.
24. Austelle CW, Cox SS, Connolly DJ, Vogel BB, Peng X, Wills K, et al. Accelerated Transcutaneous Auricular Vagus Nerve Stimulation for Inpatient Depression and Anxiety: The iWAVE Open Label Pilot Trial. Neuromodulation. 2025; 28: 672-681.
25. Bottari SA, Trifilio ER, Rohl B, Wu SS, Miller-Sellers D, Waldorff I, et al. Optimizing transcutaneous vagus nerve stimulation parameters for sleep and autonomic function in veterans with posttraumatic stress disorder with or without mild traumatic brain injury. Sleep. 2025; 48: zsaf152.
26. Zhang S, Zhao Y, Qin Z, Han Y, He J, Zhao B, et al. Transcutaneous auricular vagus nerve stimulation for chronic insomnia disorder: A randomized clinical trial. JAMA Netw Open. 2024; 7: e2451217.
27. Cimpianu CL, Strube W, Falkai P, Palm U, Hasan A. Vagus nerve stimulation in psychiatry: A systematic review of the available evidence. J Neural Transm. 2017; 124: 145-158.
28. Gierthmuehlen M, Gierthmuehlen PC. COVIVA: Effect of transcutaneous auricular vagal nerve stimulation on fatigue-syndrome in patients with Long Covid–A placebo-controlled pilot study protocol. PLoS One. 2025; 20: e0315606.
29. De Ferrari GM, Crijns HJ, Borggrefe M, Milasinovic G, Smid J, Zabel M, et al. Chronic vagus nerve stimulation: A new and promising therapeutic approach for chronic heart failure. Eur Heart J. 2011; 32: 847-855.
30. Jiang Y, Su D, Xiao J, Cheng W, Hou Y, Zhang Y. Low-level auricular vagus nerve stimulation lowers blood pressure and heart rate in paroxysmal atrial fibrillation patients: A self-controlled study. Front Neurosci. 2025; 19: 1525027.
31. Ardell JL, Rajendran PS, Nier HA, KenKnight BH, Armour JA. Central-peripheral neural network interactions evoked by vagus nerve stimulation: Functional consequences on control of cardiac function. Am J Physiol Heart Circ Physiol. 2015; 309: H1740-H1752.
32. Steyn E, Mohamed Z, Husselman C. Non-invasive vagus nerve stimulation for the treatment of acute asthma exacerbations—results from an initial case series. Int J Emerg Med. 2013; 6: 7.
33. Futuro-Neto HA, Pires JG, Gilbey MP, Ramage AG. Evidence for the ability of central 5-HT1A receptors to modulate the vagal bradycardia induced by stimulating the upper airways of anesthetized rabbits with smoke. Brain Res. 1993; 629: 349-354.
34. Flumeri ED, Ducharme FM, St-Pierre J, Niazi F, Shlobin NA, Couillard S, et al. Vagus nerve stimulation as a potential treatment for acute asthmatic bronchoconstriction: A systematic review. Front Physiol. 2025; 16: 1625871.
35. Taha AM, Elrosasy A, Mohamed AS, Mohamed AE, Bani-Salameh A, Siddiq A, et al. Effects of non-invasive vagus nerve stimulation on inflammatory markers in covid-19 patients: A systematic review and meta-analysis of randomized controlled trials. Cureus. 2024; 16: e70613.
36. Marsal S, Corominas H, de Agustín JJ, Pérez-García C, López-Lasanta M, Borrell H, et al. Non-invasive vagus nerve stimulation for rheumatoid arthritis: A proof-of-concept study. Lancet Rheumatol. 2021; 3: e262-e269.

37. Ramkissoon CM, Güemes A, Vehi J. Overview of therapeutic applications of non-invasive vagus nerve stimulation: A motivation for novel treatments for systemic lupus erythematosus. Bioelectron Med. 2021; 7: 8.
38. Veldman F, Hawinkels K, Keszthelyi D. Efficacy of vagus nerve stimulation in gastrointestinal disorders: A systematic review. Gastroenterol Rep. 2025; 13: goaf009.
39. Brock C, Rasmussen SE, Drewes AM, Møller HJ, Brock B, Deleuran B, et al. Vagal nerve stimulation-modulation of the anti-inflammatory response and clinical outcome in psoriatic arthritis or ankylosing spondylitis. Mediat Inflamm. 2021; 2021: 9933532.
40. Lommano MG, Farah S, Bianchi B, Risa AM, Sarzi-Puttini P, Salaffi F, et al. Non-invasive auricular vagus nerve stimulation in fibromyalgia: Impacts on autonomic function, central sensitization and pain catastrophizing. Joint Bone Spine. 2025; 93: 105966.
41. Shi X, Hu Y, Zhang B, Li W, Chen JD, Liu F. Ameliorating effects and mechanisms of transcutaneous auricular vagal nerve stimulation on abdominal pain and constipation. JCI Insight. 2021; 6: e150052.
42. Huang CH, Wu CH, Chan RH, Chen CH, Lin BW, Lin CC. Transcutaneous auricular vagus nerve stimulation accelerates postoperative ileus recovery by enhancing gastric motility complexity: A clinical study. Brain Stimul. 2025; 18: 1091-1093.
43. Yin J. Transcutaneous vagal nerve stimulation for gastrointestinal disorders. J Transl Gastroenterol. 2025; 3: 93-99.
44. Kozorosky EM, Lee CH, Lee JG, Nunez Martinez V, Padayachee LE, Stauss HM. Transcutaneous auricular vagus nerve stimulation augments postprandial inhibition of ghrelin. Physiol Rep. 2022; 10: e15253.
45. Gouveia FV, Silk E, Davidson B, Pople CB, Abrahao A, Hamilton J, et al. A systematic review on neuromodulation therapies for reducing body weight in patients with obesity. Obes Rev. 2021; 22: e13309.
46. Elbanna RH, Elabd SO, Saleh MS, Alghitany SI. Effect of adding noninvasive auricular Vagal nerve stimulation to exercise program on emotional eating and stress responsiveness in patient with metabolic syndrome. Disabil Rehabil. 2025. doi: 10.1080/09638288.2025.2506824.
47. Zheng ZS, Simonian N, Wang J, Rosario ER. Transcutaneous vagus nerve stimulation improves Long COVID symptoms in a female cohort: A pilot study. Front Neurol. 2024; 15: 1393371.
48. Yadav S, Yadav H. Critical appraisal of transcutaneous auricular vagus nerve stimulation for tinnitus in normal hearing subjects: Methodological challenges and future directions. EurArch Oto Rhino Laryngol. 2025; 282: 4379-4380.
49. Beh SC. Nystagmus and vertigo in acute vestibular migraine attacks: Response to non-invasive vagus nerve stimulation. Otol Neurotol. 2021; 42: e233-e236.
50. Nahm WJ, Kim KJ, Namgung E, Falanga V, Chen R, Lee DA, et al. Improvement in facial seborrheic dermatitis following cervical transcutaneous vagal nerve stimulation. JAAD Case Rep. 2025; 61: 72-74.
51. Zuo X, Xu Y, Li S, Jiang J, Wang J, Zhu Y, et al. Efficacy and safety of transcutaneous auricular vagus nerve stimulation plus pregabalin for radiotherapy-related neuropathic pain in patients with head and neck cancer (RELAX): A phase 2 randomised trial. EClinicalMedicine. 2025; 86: 103345.

52. Gierthmuehlen M, Seidel S, Thon N, Seliger C. Transcutaneous auricular vagal nerve stimulation for the treatment of the fatigue syndrome in patients with primary CNS lymphoma–A protocol for a randomized and controlled single center clinical trial. Adv Ther. 2025; 42: 4067-4080.
53. Vargas-Caballero M, Warming H, Walker R, Holmes C, Cruickshank G, Patel B. Vagus nerve stimulation as a potential therapy in early Alzheimer's disease: A review. Front Hum Neurosci. 2022; 16: 866434.
54. Thal SC, Shityakov S, Salvador E, Förster CY. Heart rate variability, microvascular dysfunction, and inflammation: Exploring the potential of taVNS in managing heart failure in type 2 diabetes mellitus. Biomolecules. 2025; 15: 499.