从退行性脑疾病到忧郁症
为现代人的精神健康，提供新的解决方案

neurive
support for new life

相关疾病_抑郁症

精神健康的重要性增大

韩国抑郁症患者人数:70万人/年均增长7%

< 抑郁症患者诊疗趋势>

世界抑郁症药物市场 ： 180亿美元 (2024)

< Global Depression Drugs Market Size and Forecast >

Source : Variant Market Research
单位 : US$ Billion

COVID-19引起的精神健康问题抬头趋势

类型	2020年上半年		增减率	
	门诊费用 (亿韩元)	门诊费用 (亿韩元)	门诊天数 (千天)	门诊费用 (亿韩元)
总计	234,772	82,398	-13.6	-0.3
内科	46,127	14,989	-7.7	0.9
精神科	6,138	3,327	10.4	18.2
外科	5,555	2,945	-6.2	3.9
普通外科	26,854	9,062	-7.4	0.7
麻醉疼痛科	6,887	3,801	-5.9	3.6
妇产科	6,832	5,067	-7.4	20.3
儿科	13,981	2,367	-43.2	-38.3
眼科	16,087	9,178	-9.8	4.2
耳鼻喉科	23,484	5,666	-29.9	-20.5
皮肤科	9,949	2,551	2.5	8.9
泌尿外科	6,073	2,753	-1.5	15.3
全科	50,043	14,812	-11.6	-1.3
其它	16,762	5,876	-8.0	2

抑郁症

中国抑郁症患者情况

Prevalence of depressive disorders and treatment in China: a cross-sectional epidemiological study

Jin Lu*, Xiufeng Xu*, Yueqin Huang, Tao Li, Chao Ma, Guangming Xu, Huifang Yin, Xiangdong Xu, Yanjuan Ma, Limin Wang, Zhengjing Huang, Yongping Yan, Bo Wang, Shuiyuan Xiao, Liang Zhou, Lingjiang Li, Yan Zhang, Hongguang Chen, TingTing Zhang, Jie Yan, Hua Ding, Yaqin Yu, Changgui Kou, Zonglin Shen, Linling Jiang, Zhizhong Wang, Xian Sun, Yifeng Xu, Yanling He, Wanjun Guo, Lijun Jiang, Shengyan Li, Wen Pan, Yue Wu, Guohua Li, Fujun Jia, Jianfei Shi, Zhongxia Shen, Ning Zhang

中国抑郁症患者有三千万，但咨询人数只有三百万，仅9%的咨询率

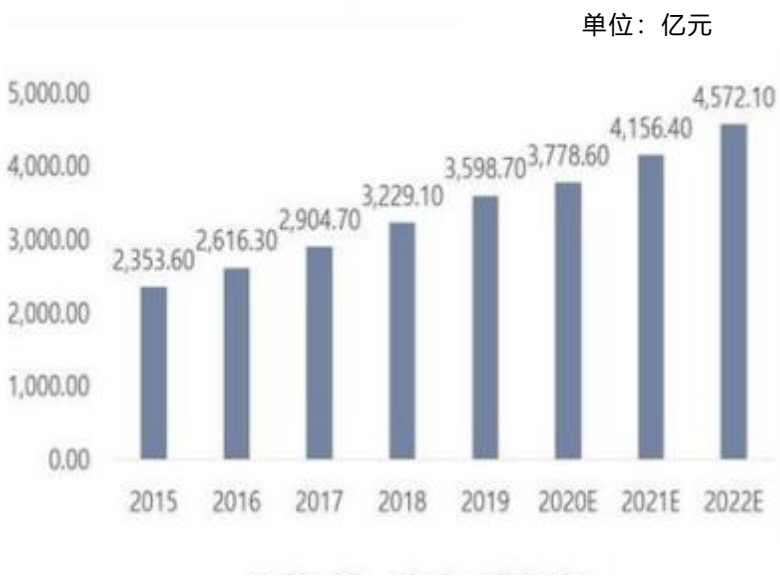
中国人口的16.5%经历各种的心理和精神问题。中国全国人口大约为14.5亿，其中2.4亿人口经历大大小小的精神困扰。

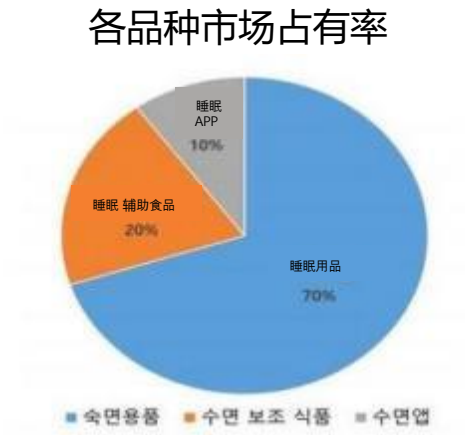
据《2006年中国全国残疾人调查》统计，中国的残疾人占全国人口的6.34%，约830万名，残疾人中患有精神疾病的人数占残疾人数的7.4%，约61万名。

根据调查，中国的抑郁症患者数为2940万名。大部分抑郁症患者未能接受正确的治疗。抑郁症患者咨询率为9.5%，治疗率也只达到6.8%。

失眠症

中国睡眠市场规模增加





相关疾病-老年痴呆/认知障碍

老龄化加速需要制定对老年痴呆的医学和社会对策

老龄化社会，向痴呆症宣战的中国…“65岁老人要每年进行体检”

应对老龄化中国政府开始进行老年痴呆防治。地方政府为65岁以上人群每年进行一次认知功能初筛。
17日，香港SCMP引用中国卫健委向地方卫健委下发的通知说到， 中国政府正着手推进老年痴呆患者防治3年计划。

卫健委谈到，老年痴呆防治的目标是提高公众对老年痴呆的认识、改善识别患者的能力、加强陪护教育等。有条件的地区应结合实际为辖区内65岁及以上常住居民每年提供1次认知功能初筛，提早发现痴呆高风险人群和疑似痴呆人群，指导其可以及时到有关机构就诊。

卫健委将指导有条件的地区，结合实际对记忆门诊工作人员和看护人员进行专项培训， 社区服务中心为老年痴呆患者提供认知激活、运动康复、生活照料、情绪管理等照护。

中国的痴呆患病率高于世界平均水平。去年3月， 据“普通精神医学”中刊登的“中国阿尔茨海默报告”中显示，中国每10万名中就有788.3名患有此病。这比世界平均（每10万名中682.5名）更高。中国60岁以上的痴呆患者有1500万名，其中阿兹海默患者为983万名。

中国关注痴呆问题的原因在于老龄化。世界卫生组织预计到2040年为止，中国60岁以上人口占全国人口的28%。这是比2020年（18.7%）增加十个百分点的数据。截止到去年，中国65岁以上人口是2.978亿占全国人口的14.9%。

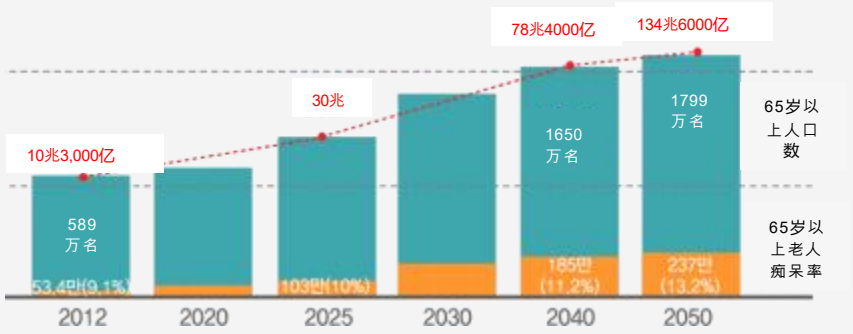
SCMP谈到痴呆是中国五大死亡原因之一，但中国社会对痴呆的理解程度低。

相关疾病_痴呆症/认知功能障碍

老龄化加速需要制定针对痴呆症的医学/社会对策

痴呆症患者人数及管理费用

< 国内痴呆症患者人数:80万人/年均增长10%>



治疗痴呆症的药物市场规模

✓乙酰胆碱分解酶抑制剂（ACEI）种类及处方液
✓全球10.8万亿韩元，国内2000亿韩元市场

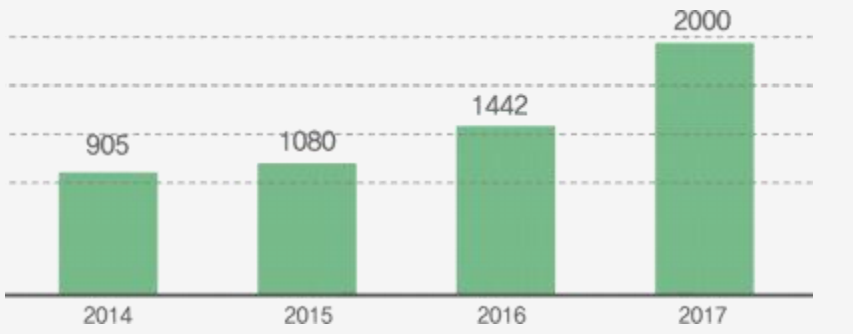
(单位:亿)

成分名	2013年	2014年	2015年	2016年	市场占有率
多奈哌齐	859	1123	1309	1472	78.2%
盐酸美金刚	96	109	149	174	9.2%
胆碱酯酶抑制剂	172	200	183	140	7.4%
加兰他敏	89	92	96	96	5.1%
合计	1252	1525	1737	1182	100%

脑功能改善剂国内市场

< 甘磷酸胆碱成分标准>

(单位:亿)



资料:医药品调查机构IMS数据

世界痴呆症相关市场规模

✓全球960兆韩元市场

(单位：US$ Billion)

Source：Variant Market Research

治疗退行性脑疾病的新的突破口

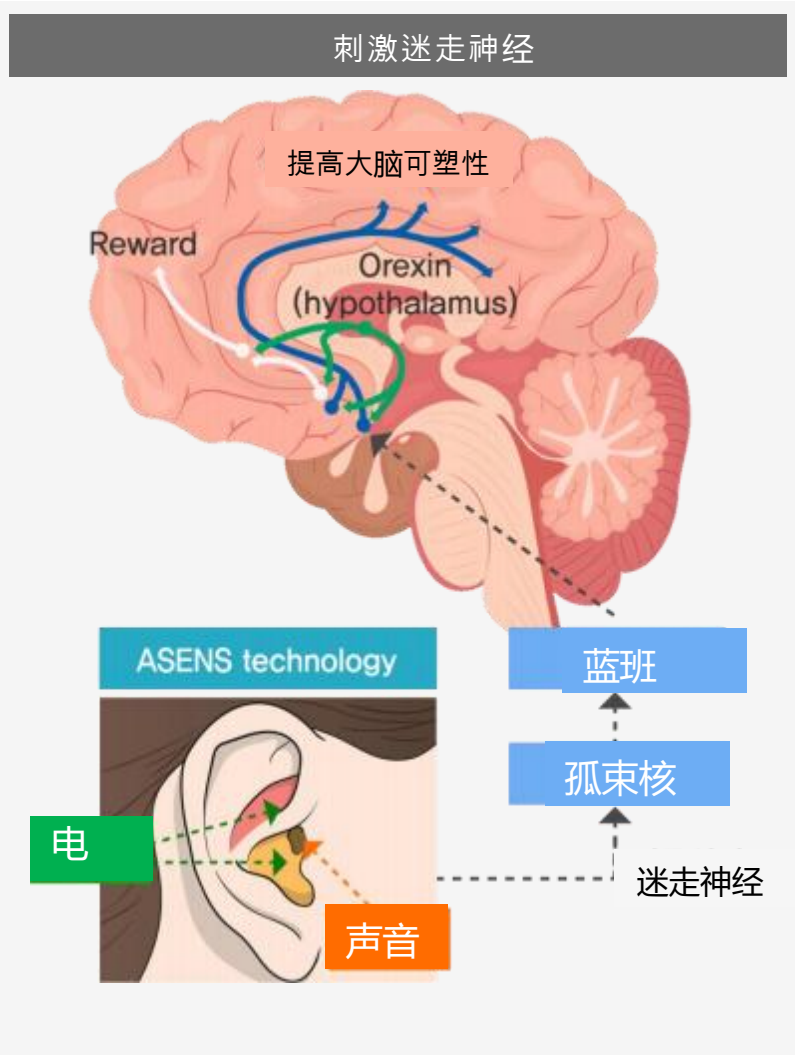
ASENS技术

ASENS 技术: 用声音和电刺激迷走神经激活大脑的技术

技术性

唯一能刺激大脑深部的技术_感情/情绪的调节

刺激迷走神经技术相关的国内唯一电子药/数码治疗剂企业



耳鸣

忧郁症

失眠症

痴呆

认知功能障碍

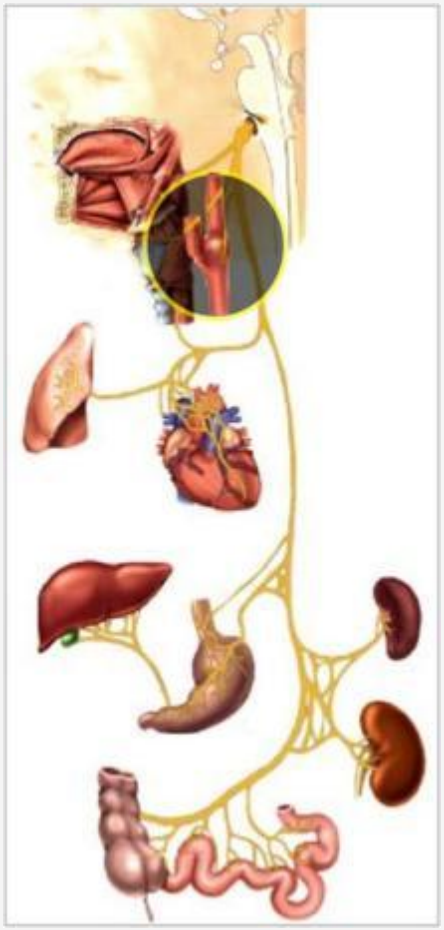
肥胖

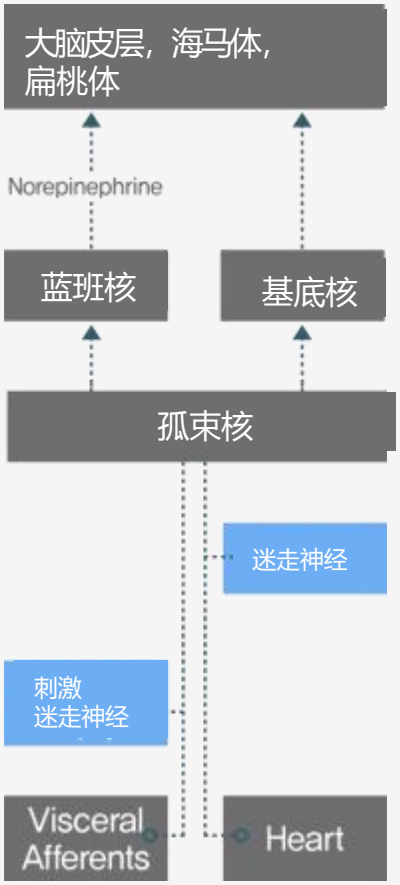
慢性疼痛

癫痫

刺激迷走神经

刺激迷走神经是被很多人验证过的技术



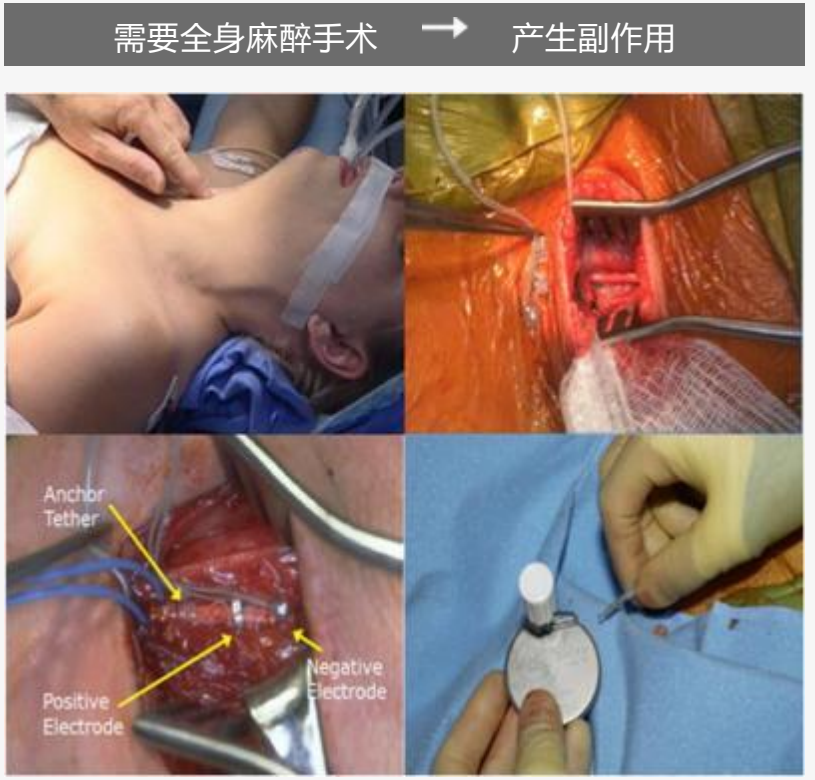


1. Roosevelt RW, et al. Brain Res 2006;1119(1):124-32. 2. Hassert DL, et al. Behavioral Neuroscience 2004;118(1):79-88. 3. Woodbury DM and Woodbury JW. Epilepsia 1990;31(Suppl.2):S7-S19. 4. Hammond BM, et al. Brain Research 1992;583:300-3 5. Ben-Menachem E, et al. Epilepsy Res 1995;20:221-7. 6. Marrosu F, et al. Epilepsy Res 2003;55:59-70 7. Krahl S, et al. Epilepsia. 1998;39:709-714. 8. Henry TR, et al. Epilepsia. 2004;45(9):1064-1070.9 Wang Het al., J Neurosci. 2009;in press. 10. Koo B. J Clin Neurophysiol. 2001;18:434-441. 11. Vonck K, et al. Seizure 2008;17(8):699-706

技术性

侵入性迷走神经刺激装置_抑郁症/癫痫症相关技术，获得国内外许可

市场规模年均5000亿韩元，年均增长12.5%



副作用:硬件故障:2.7%感染:3.5%沙哑的声音，吞咽困难，死亡:5.4%

技术性

非侵入性神经刺激装置（海外） 产品

不能刺激迷走神经部位，治疗效果有限

制造商	electroCore	cerbomed	parasym	NEUVANA	IHS
产品名	gamma Core™, gammaCore Sapphire™	NEMOS®，VITOS®	The Parasym™	Xen®	NSS-2 Bridge
产品图像					
适应症	偏头痛·头痛	脑栓塞·耳鸣	耳鸣	睡眠，压力，冥想	麻药类戒断症状缓解
特征	电O, 声音X 颈部皮肤刺激	电O, 声音X	电O, 声音X	电O, 声音X 颈部皮肤刺激	电O, 声音X
价格	$598每月	NEMOS® €2,436.00 VITOS® €973.82	£599 (仅供研究用销售)	电O, 声音O App	$1,195
FDA	申报 O (DEN150048, K191830)	X	申报/批准免除对象	X	申报 O (DEN170018)
CE	$598每月	NEMOS 许可 O	许可 O	$598每月	不可确认

技术性

Soricle的差别性和优秀性

VS

侵袭性

非侵入性的

声音+电能提高治疗效果

两侧外迷走神经的非侵入性刺激

用个人医疗器械增加便利性

确保临床有效性资料

开发管道

1 电子药

- **Soricle(医疗器械)**

-通过电/声音刺激迷走神经（Vagus Nerve），通过大脑塑性(Brain Plasticity)及大脑活性化以改善耳鸣症状为目的开发

2 消费者家电

- **Healaon (健康机器)**

- 以刺激迷走神经(Vagus Nerve)、通过激活副交感减少压力、提高集中力/竞技力等为目的开发的产品

3 数码治疗剂 (Digital Therapeutics)

- **SoriCLEAR (软件医疗器械)**

- 用于认知行为治疗、李明载训练治疗等，通过改善认知(Cognitive)要素改善耳鸣症状

Soricle事业现状

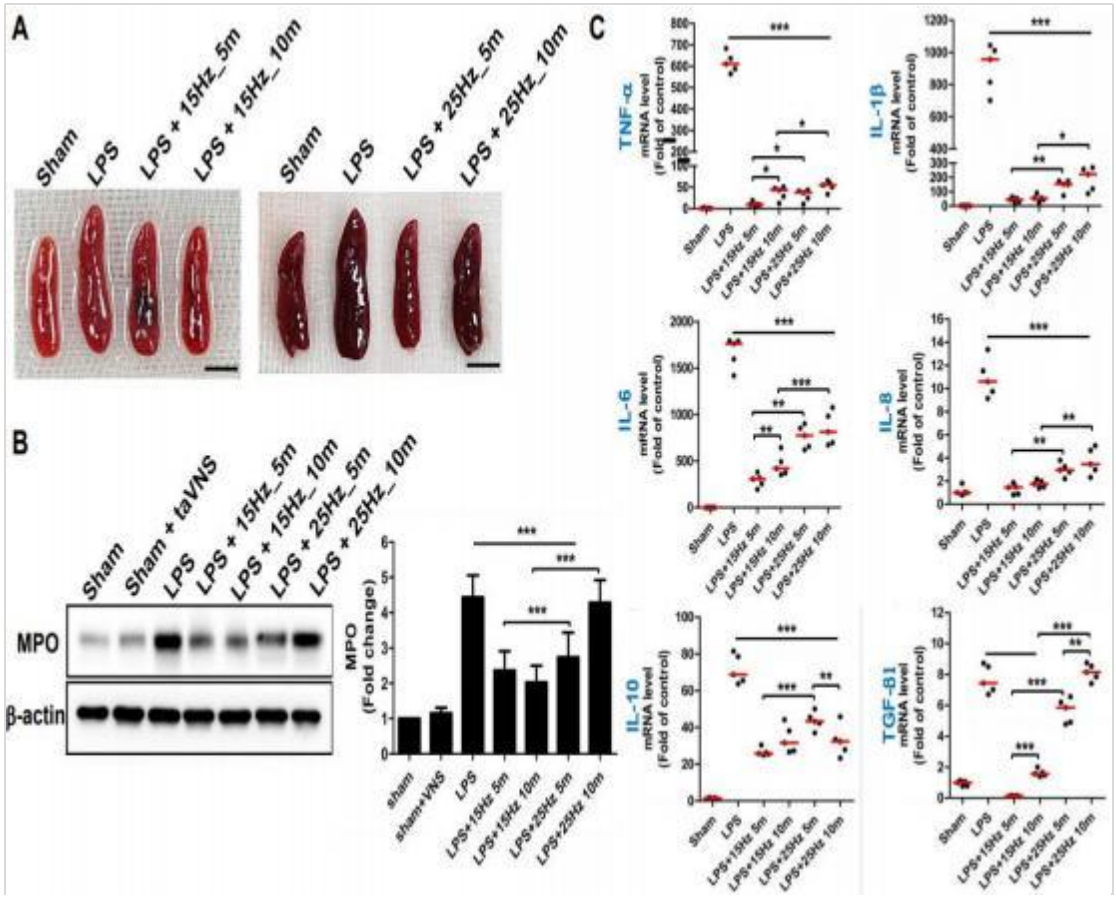
个人医疗器械 → 不收费也可以创造收益

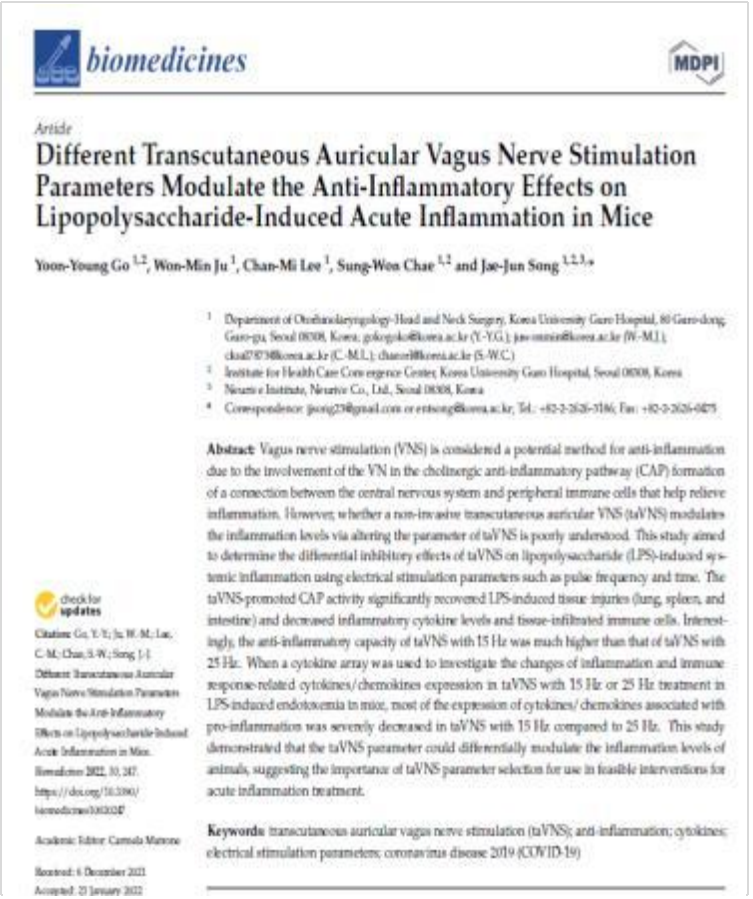
效能•效果	通过声音和电，刺激外耳迷走神经(VNS)， 可实现大脑可塑性及大脑活性化 ，最终达到 =治疗退行性脑疾病的目的
使用方法	• 每天30分钟，每周5天， 施行4周* 
事业方向及上市时间	• 量产试剂 • 国内许可用临床试验正在进行中（耳鸣）

技术性

VNS和全身炎症

- ✓ 刺激迷走神经治疗全身炎症
- ✓ 对运动后全身炎症及恢复也会产生影响





biomedicines

MDPI

Article

Different Transcutaneous Auricular Vagus Nerve Stimulation Parameters Modulate the Anti-Inflammatory Effects on Lipopolysaccharide-Induced Acute Inflammation in Mice

Yoon-Young Go [1,2], Won-Min Ju [1], Chan-Mi Lee [1], Sung-Won Chae [1,2] and Jae-Jun Song [1,2,3,*]

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[2] Institute for Health Care Convergence Center, Korea University Guro Hospital, Seoul 08308, Korea

[3] Neuravi Institute, Neuravi Co., Ltd., Seoul 08308, Korea

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Abstract: Vagus nerve stimulation (VNS) is considered a potential method for anti-inflammation due to the involvement of the VN in the cholinergic anti-inflammatory pathway (CAP) formation of a connection between the central nervous system and peripheral immune cells that help relieve inflammation. However, whether a non-invasive transcutaneous auricular VNS (taVNS) modulates the inflammation levels via altering the parameter of taVNS is poorly understood. This study aimed to determine the differential inhibitory effects of taVNS on lipopolysaccharide (LPS)-induced systemic inflammation using electrical stimulation parameters such as pulse frequency and time. The taVNS-promoted CAP activity significantly recovered LPS-induced tissue injuries (lung, spleen, and intestine) and decreased inflammatory cytokine levels and tissue-infiltrated immune cells. Interestingly, the anti-inflammatory capacity of taVNS with 15 Hz was much higher than that of taVNS with 25 Hz. When a cytokine array was used to investigate the changes of inflammation and immune response-related cytokines/chemokines expression in taVNS with 15 Hz or 25 Hz treatment in LPS-induced endotoxemia in mice, most of the expression of cytokines/chemokines associated with pro-inflammation was severely decreased in taVNS with 15 Hz compared to 25 Hz. This study demonstrated that the taVNS parameter could differentially modulate the inflammation levels of animals, suggesting the importance of taVNS parameter selection for use in feasible interventions for acute inflammation treatment.

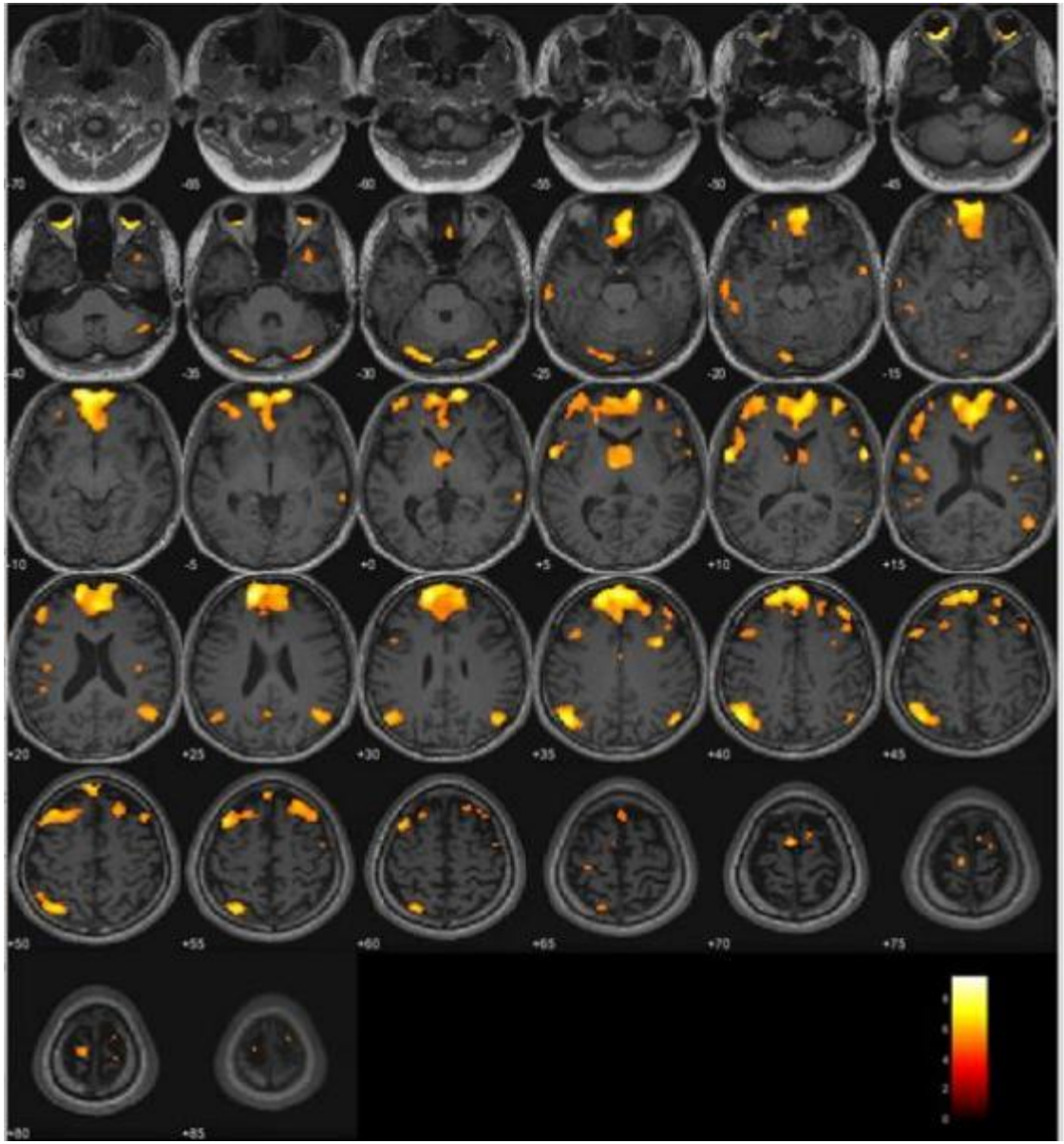
Keywords: transcutaneous auricular vagus nerve stimulation (taVNS); anti-inflammation; cytokines; electrical stimulation parameters; coronavirus disease 2019 (COVID-19)

技术性

FMRI研究

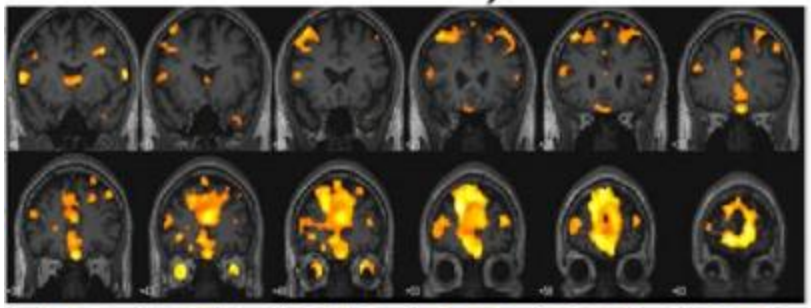
- ✓ 活性化 部位
  - 边缘系
  - 前前额叶

  - 鉴定/情绪/认知担当
  - 与忧郁症/失眠症/不安症/耳鸣/痴呆等有关

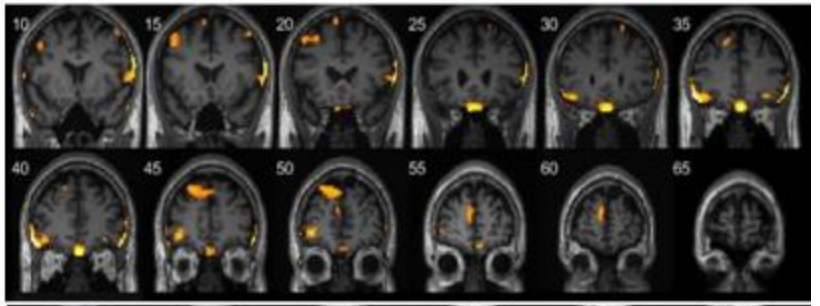


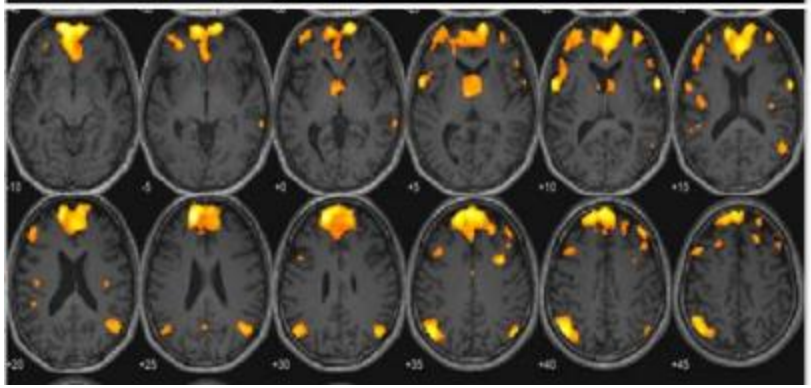
应用性

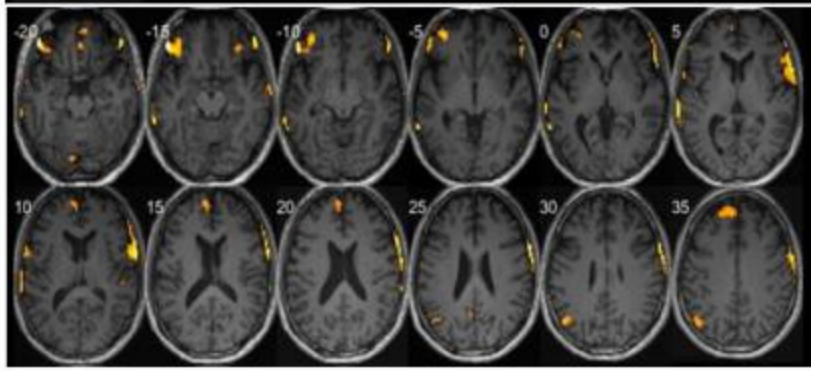
同类竞争产品比较



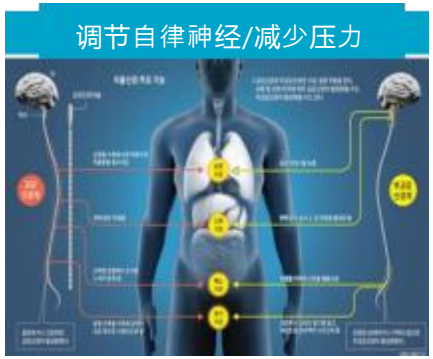
VS







healaon事业现状

效能•效果	• 以通过声音和电力刺激迷走神经(VNS)、通过激活副交感减少压力、提高集中力、提高体育竞技能力等，以改善生活质量为目的开发的健康机器
使用方法	  
产品开发后台	• 副交感神经的神经介质为乙酰胆碱荷尔蒙， 有助于睡眠、伤口治疗、改善消化功能，能够使身体得到适当休息。
事业方向及上市时间	• 获得KC认证(2022年5月) • B2G/2022年7月   

healaon 电器

消除压力，强化集中力，呵护精神健康

心理保健用非医疗用消费者家用电器

痴呆症安心中心	保健所/ 老人福利馆	国家创伤中心	体育政策科学院
			
销售网点建设	老人福利设施:8万多个	浦项地震创伤中心 进行中	吉世基博士团队正在进行共同研究

问卷调查，实验时长

实验时长：一个月

10月 17日

问卷调查
实验组，对比组

11月 30日

第二次问卷调查
实验组，对比组

12月 28日

第三次问卷调查
实验组，对比组

CSAI-2/ PSS/抑郁检测用纸

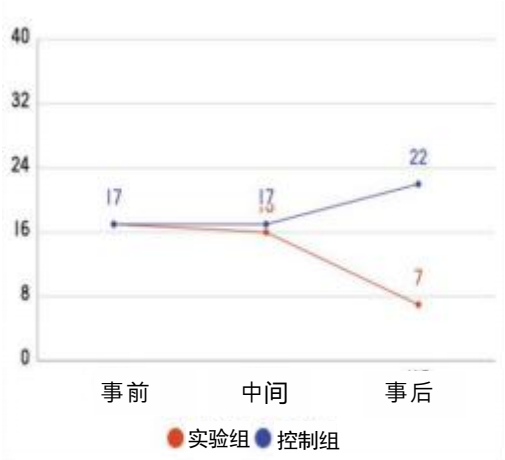
临床负责人：韩国仁川大学 体育科学研究所
韩国体育政策科学院 共同参与

结果1_压力和抑郁变化

事前　　中间　　事后

一般压力变化

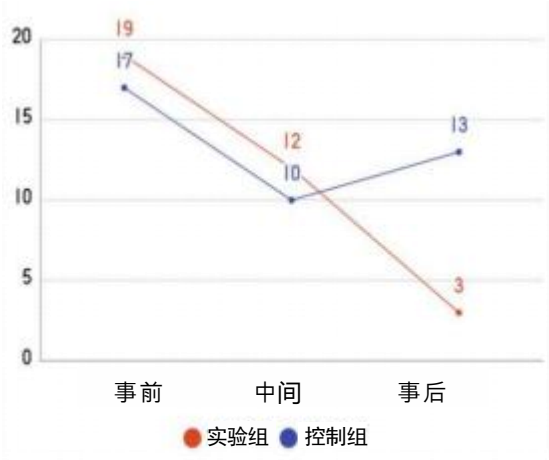
66% 改善



p < 0.003

抑郁变化 - 1

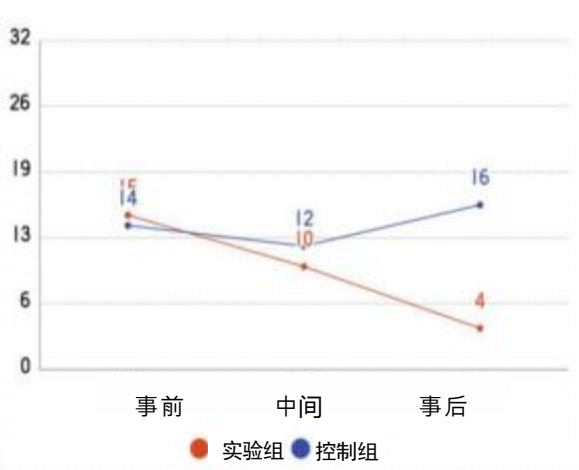
76% 改善



p < 0.001

抑郁变化 - 2

74% 改善



p < 0.001

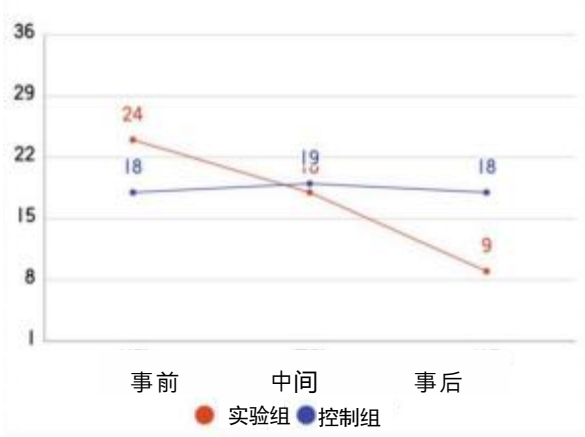
CSAI-2/ PSS/抑郁检测用纸

临床负责人：韩国仁川大学 体育科学研究所
韩国体育政策科学院 共同参与

结果2_不安情绪和自信感变化

认知不安变化

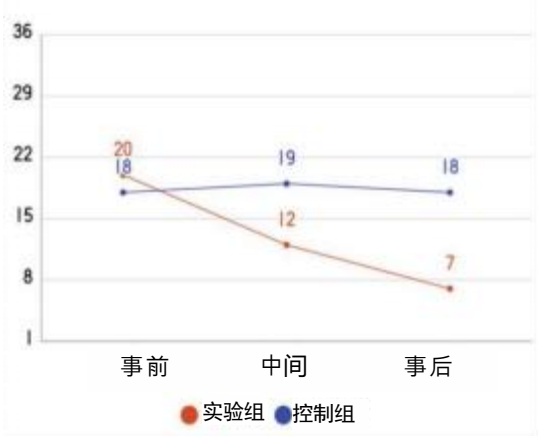
63% 改善



$p < 0.5$

身体不安变化

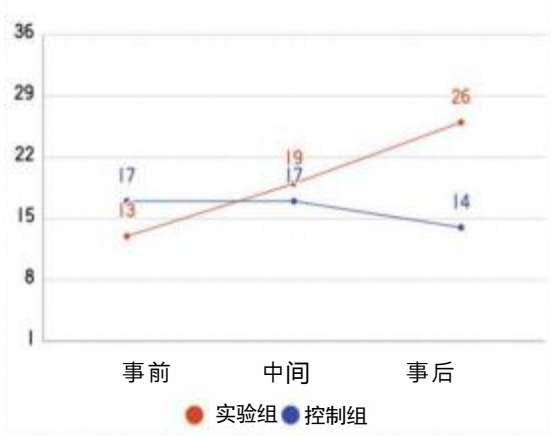
65% 改善



$p < 0.005$

自信感变化

143% 增加



$p < 0.05$

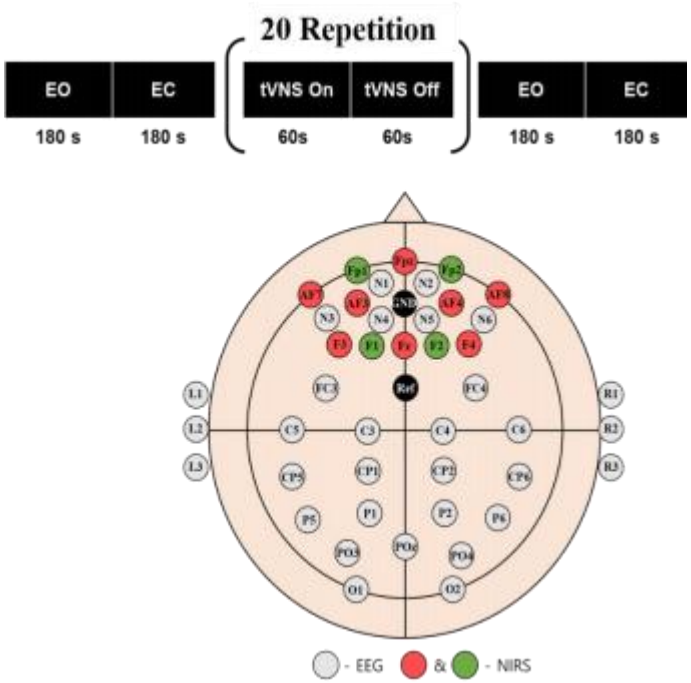
CSAI-2/ PSS/抑郁检测用纸

临床负责人：韩国仁川大学 体育科学研究所
韩国体育政策科学院 共同参与

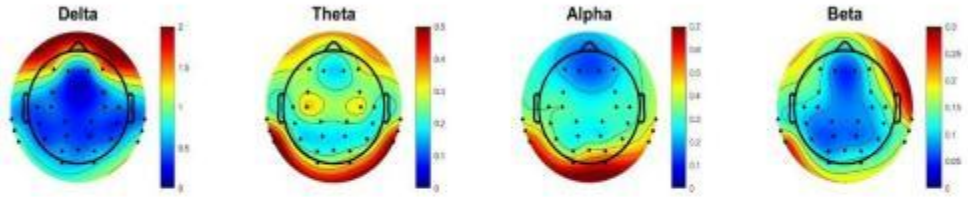
脑电波研究

进行Soricle VNS治疗后的EEG变化

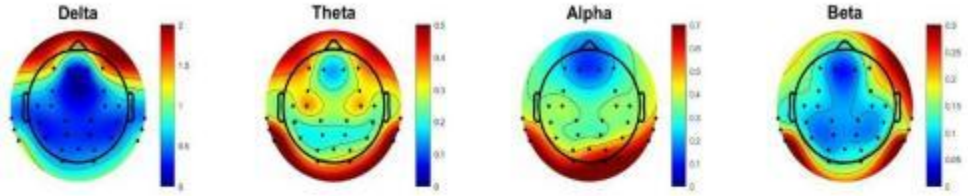
- ✓ 阿尔法波
  - 给药期间，松弛度、认知、压力缓解均有所改善



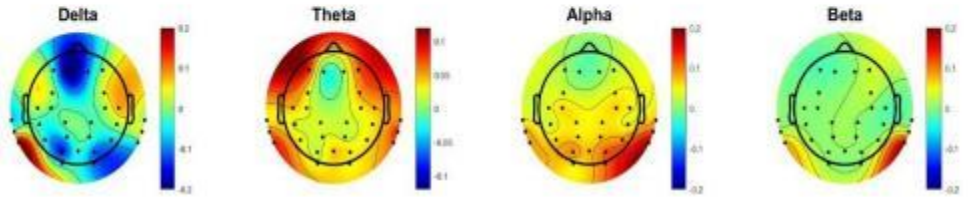
治疗前



治疗后



变化



声音清澈_治疗耳鸣用的数码治疗剂

SoriCLEAR

医院就诊

问诊/咨询/
检查/处方

根据耳鸣
程度
分流患者

针对性认知行动治疗（认知再构成）

治疗视频

功能类型
情感类型
认知类型

针对性治疗内容视频

+

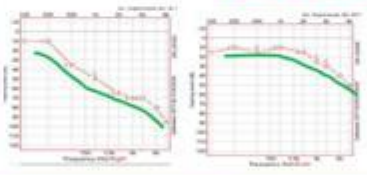
思考记录本

记录在思考记录本上

实时矫正

听力/耳鸣
测试分析

生成符合患者病情的音频



耳鸣
评价

治疗
结束

处方　治疗开始　阶段评估　阶段评估　最终评价

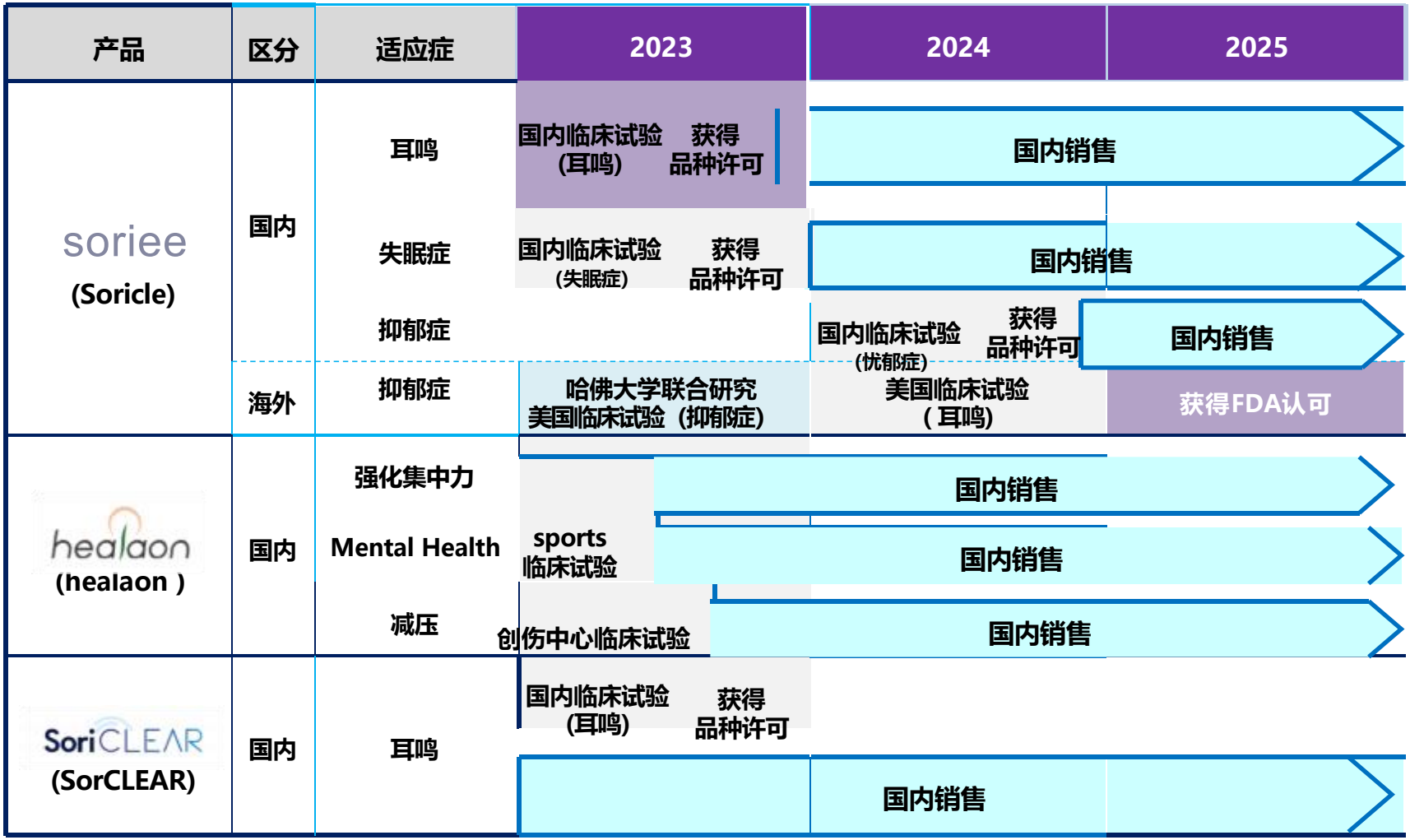
6周/30板块

医院使用平板

+

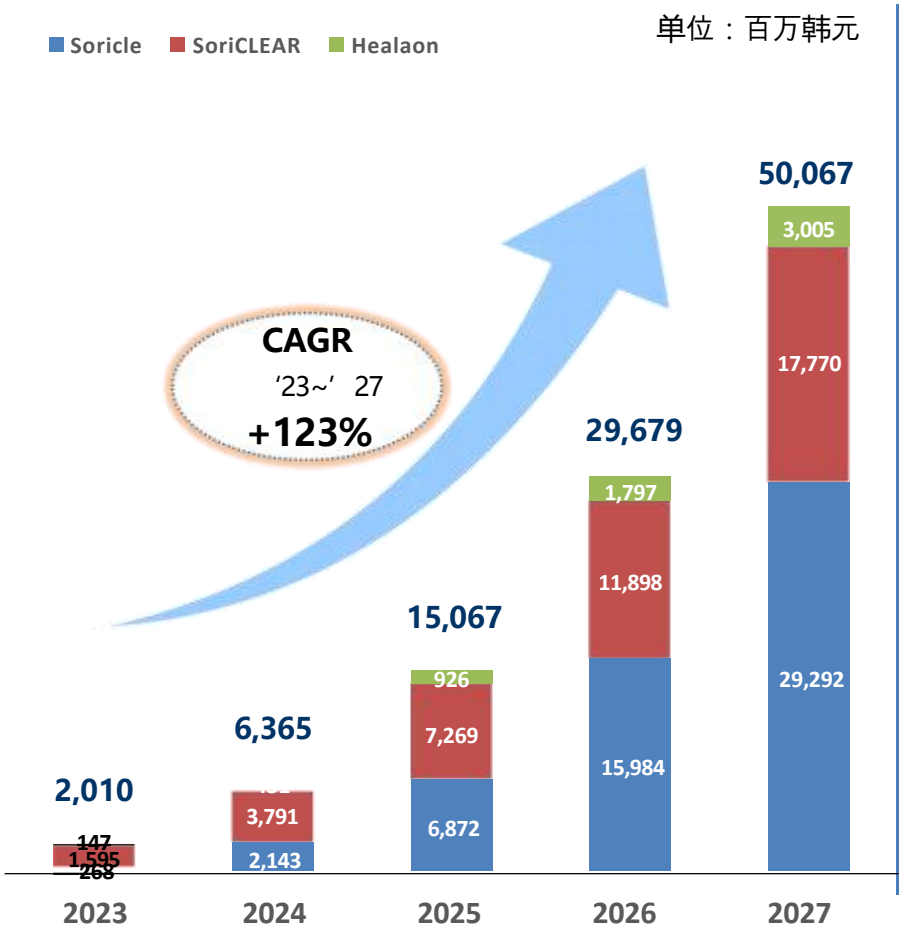
在智能手机进行自测&定期就诊

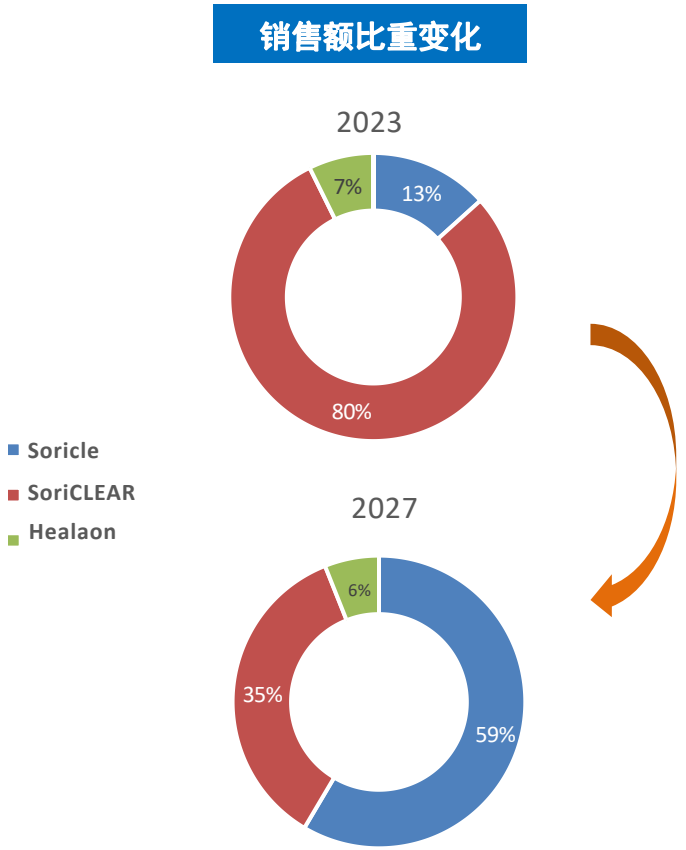
事业计划


产品
区分
适应症
2023
2024
2025
soriee
(Soricle)
国内
耳鸣
国内临床试验
(耳鸣)
获得
品种许可
国内销售
失眠症
国内临床试验
(失眠症)
获得
品种许可
国内销售
抑郁症
国内临床试验
(忧郁症)
获得
品种许可
国内销售
海外
抑郁症
哈佛大学联合研究
美国临床试验（抑郁症）
美国临床试验
（耳鸣）
获得FDA认可
healaon
(healaon)
国内
强化集中力
国内销售
Mental Health
sports
临床试验
国内销售
减压
创伤中心临床试验
国内销售
SoriCLEAR
(SorCLEAR)
国内
耳鸣
国内临床试验
(耳鸣)
获得
品种许可
国内销售

销售计划_3个产品管道

- ✓ 从耳鸣治疗器械SoriCLEAR （电子药）和Soricle （数码治疗剂）上市的时间（2023年4Q）开始， 销售额将会急速上升





创业团队的专业性

低成本高效率结构/较低烧钱率/开发时间3年

公司名称	(株) Neurive (Neurive Co, Ltd)
代表理事	宋在俊
成立日	2018.4.20
总社	金海市酒村面所望街88,205号 (医疗实用化中心)
资本金	1.3亿元
大股东股份	宋在俊(68.0%), 2017 Magna Instar基金(8.2%), SLINEXT Innovation基金(6.0%)
沿革	2018.4 设立法人 2020.3 风险企业认证 2020.3 选定技术保证基金的U-TECH Valley项目 2020.5 种子公司招商引资 (Magna Investment) 2020.6 被选定TIPS项目 2020.6 被选定为初创模范事业 2020.5 Pre-A招商引资 (Magna Investment , SL Investment) 2020.6 本社搬迁 2020. 1 Follow on 投资 (Magna Investment) 2022. 12 选定为原材料、零部件、装备开发项目 2022.12系列A招商引资 (新韩风险投资、 BigBang Angels、庆南风险投资、 F1 Partners股份公司) 2022.12 规模升级, 选定为技术开发项目

KC 认证

GMP 认证

创业团队的专业性

学会保险理事_进入新技术医疗制度圈

CEO 宋在俊
高丽大学医学院学士
高丽大学医学院硕/博士
现高丽大学九老医院耳鼻喉科科长

作为耳鼻喉科专家，拥有大量研究开发经验

现有研发无法解决的未满足的医疗需求

研究业绩

University of Michigan 交换教授
SCI论文:100多篇　教科书著述：4本
完成多项医疗器械国家课题
正在进行各部门的医疗器械开发事业

医疗器械相关经历

食品医药品安全处医疗器械专门委员

大韩耳鼻喉科学会 保险委员

大韩理科学会 保险理事

大韩平衡医学会 保险理事

健康保险审查评价院 诊疗审查评价委员会 非常勤评价委员

健康保险审查评价院 医疗行为专门评价委员

韩国保健医疗研究院 外科界医疗专门委员会

海外网络_哈佛医学院

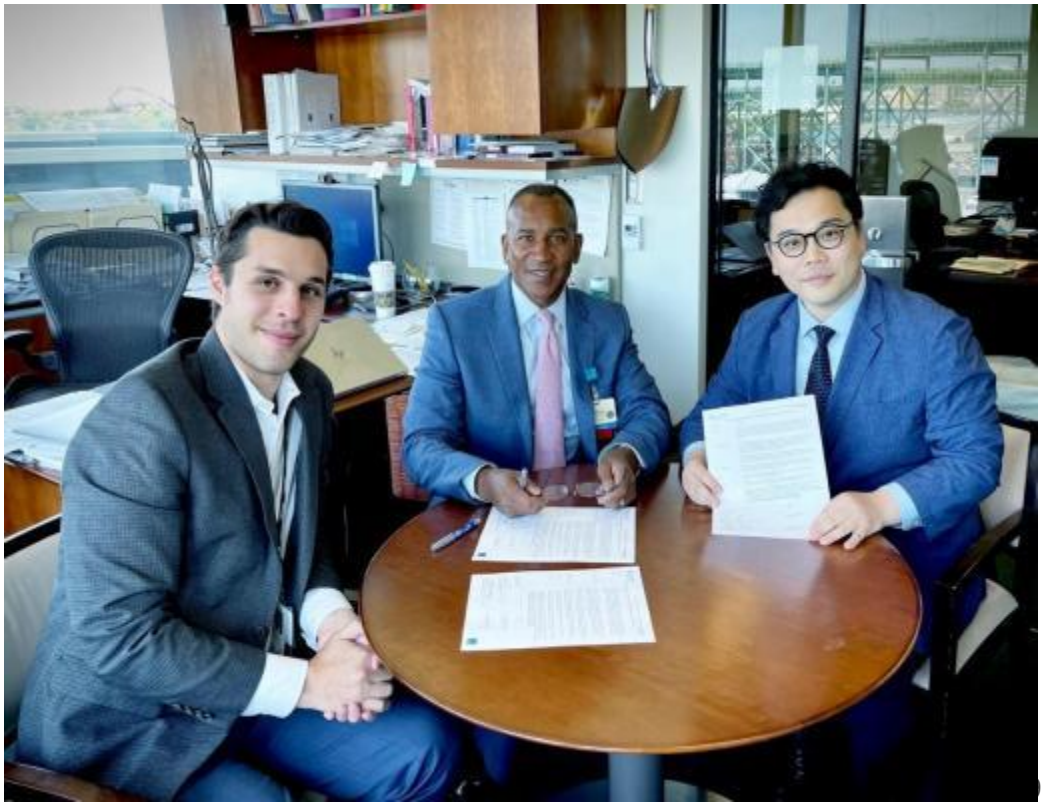
- ✓ Spaulding 医院内设立研究所
  - 暂用名： Spaulding Neurive神经调节中心
  - 共同研究及论文撰写
- ✓ FDA认证临床试验(2023)


SPAULDING

GIN Agreement between Neurive Co., Ltd. and Spaulding Rehabilitation Hospital Corporation

May 25 2022

5/25/2022



经济性

海外网络_哈佛医学院

Review Article

ASNR

Neurorehabilitation and Neural Repair

Sage

Understanding the Neuroplastic Effects of Auricular Vagus Nerve Stimulation in Animal Models of Stroke: A Systematic Review and Meta-Analysis

Paulo S. de Melo, MS[1,2,*], João Parente, MS[1,2,*], Ingrid Rebello-Sanchez, MS[2,3], Anna Marduy, MS[2,4], Anna Carolyna Gianlorenco, PhD[2,5], Chi Kyung Kim, PhD[6], Hyuk Choi, PhD[7,8], Jae-Jun Song, PhD[8,9], and Felipe Fregni, PhD[1]

Abstract

Background. Transauricular vagus nerve stimulation (taVNS) is being studied as a feasible intervention for stroke, but the mechanisms by which this non-invasive technique acts in the cortex are still broadly unknown. *Objectives.* This study aimed to systematically review the current pre-clinical evidence in the auricular vagus nerve stimulation (aVNS) neuroplastic effects in stroke. *Methods.* We searched, in December of 2022, in Medline, Cochrane, Embase, and Lilacs databases. The authors executed the extraction of the data on Excel. The risk of bias was evaluated by adapted Cochrane Collaboration's tool for animal studies (SYRCLE's RoB tool). *Results.* A total of 8 studies published between 2015 and 2022 were included in this review, including 391 animal models. In general, aVNS demonstrated a reduction in neurological deficits (SMD = −1.97, 95% CI −2.57 to −1.36, I^2 = 44%), in time to perform the adhesive removal test (SMD = −2.26, 95% CI −4.45 to −0.08, I^2 = 81%), and infarct size (SMD = −1.51, 95% CI −2.42 to −0.60, I^2 = 58%). Regarding the neuroplasticity markers, aVNS showed to increase microcapillary density, CD31 proliferation, and BDNF protein levels and RNA expression. *Conclusions.* The studies analyzed show a trend of results that demonstrate a significant effect of the auricular vagal nerve stimulation in stroke animal models. Although the aggregated results show high heterogeneity and high risk of bias. More studies are needed to create solid conclusions.

Keywords

stroke, auricular vagal nerve stimulation, animal models, meta-analysis, systematic review

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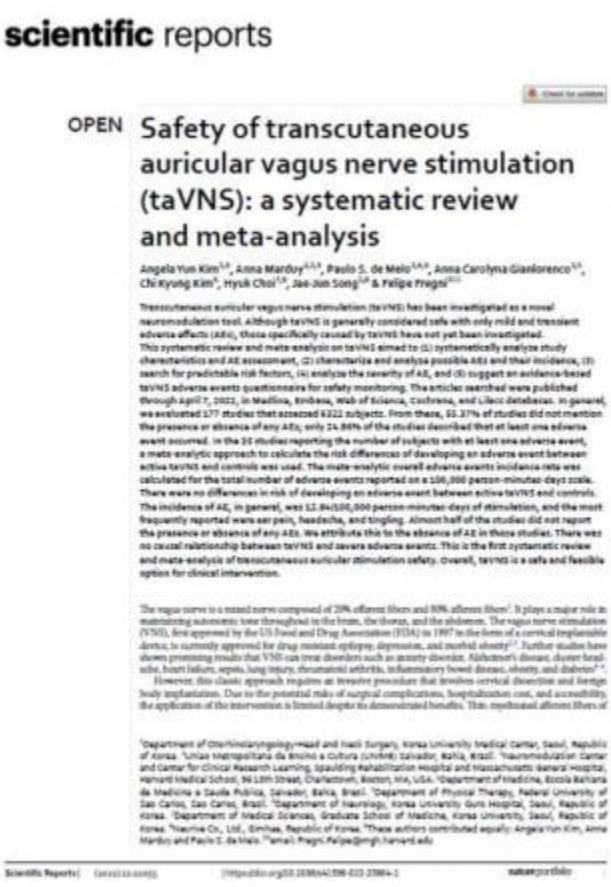
[3]Universidade Federal da Bahia, Salvador, Bahia, Brazil
[4]União Metropolitana de Ensino e Cultura (UNIME) Salvador, Bahia, Brazil
[5]Department of Physical Therapy, Federal University of São Carlos, São Carlos, Brazil
[6]Department of Neurology, Korea University Guro Hospital, Seoul, Republic of Korea
[7]Department of Medical Sciences, Graduate School of Medicine, Korea University, Seoul, Republic of Korea
[8]Neurive Co., Ltd., Gimhae, Republic of Korea
[9]Department of Otorhinolaryngology-Head and Neck Surgery, Korea University Medical Center, Seoul, Republic of Korea

*These authors contributed equally to this work.

Supplementary material for this article is available on the *Neurorehabilitation & Neural Repair* website along with the online version of this article.

Corresponding Author:
Felipe Fregni, Neuromodulation Center and Center for Clinical Research Learning, Spaulding Rehabilitation Hospital and Massachusetts General Hospital, Harvard Medical School, 1575 Cambridge Street, Cambridge, MA 02138, USA.
Email: FregniFelipe@mgh.harvard.edu



scientific reports

OPEN

Safety of transcutaneous auricular vagus nerve stimulation (taVNS): a systematic review and meta-analysis

Angela Yun Kim[1,2], Anna Marduy[1,2,3], Paulo S. de Melo[1,2,4], Anna Carolyna Gianlorenco[1,2], Chi Kyung Kim[5], Hyuk Choi[7,8], Jae-Jun Song[7,8] & Felipe Fregni[1,2]✉

Transcutaneous auricular vagus nerve stimulation (taVNS) is been investigated as a novel neuromodulation tool. Although taVNS is generally considered safe with only mild and transient adverse effects (AEs), those specifically caused by taVNS have not yet been investigated. This systematic review and meta-analysis on taVNS aimed to (1) systematically analyze study characteristics and AE assessment, (2) characterize and analyze possible AEs and their incidence, (3) search for predictable risk factors, (4) analyze the severity of AE, and (5) suggest an evidence-based taVNS adverse events questionnaire for safety monitoring. The articles' searched were published through April 7, 2022, in Medline, Embase, Web of Science, Cochrane, and Lilacs databases. In general, we evaluated 177 studies that accessed 6322 subjects. From these, 65.37% of studies did not mention the presence or absence of any AEs; only 24.86% of the studies described that at least one adverse event occurred. In the 35 studies reporting the number of subjects with at least one adverse event, a meta-analytic approach to calculate the risk differences of developing an adverse event between active taVNS and controls was used. The meta-analytic overall adverse events incidence rate was calculated for the total number of adverse events reported on a 100,000 person-minutes-days scale. There were no differences in risk of developing an adverse event between active taVNS and controls. The incidence of AE, in general, was 12.84/100,000 person-minutes-days of stimulation, and the most frequently reported were ear pain, headache, and tingling. Almost half of the studies did not report the presence or absence of any AEs. We attribute this to the absence of AE in those studies. There was no causal relationship between taVNS and severe adverse events. This is the first systematic review and meta-analysis of transcutaneous auricular stimulation safety. Overall, taVNS is a safe and feasible option for clinical intervention.

The vagus nerve is a mixed nerve composed of 20% efferent fibers and 80% afferent fibers[1]. It plays a major role in maintaining autonomic tone throughout the brain, the thorax, and the abdomen. The vagus nerve stimulation (VNS), first approved by the US Food and Drug Association (FDA) in 1997 in the form of a cervical implantable device, is currently approved for drug resistant epilepsy, depression, and morbid obesity[2,3]. Further studies have shown promising results that VNS can treat disorders such as anxiety disorder, Alzheimer's disease, cluster headache, heart failure, sepsis, lung injury, rheumatoid arthritis, inflammatory bowel disease, obesity, and diabetes[4–7].

However, this classic approach requires an invasive procedure that involves cervical dissection and foreign body implantation. Due to the potential risks of surgical complications, hospitalization cost, and accessibility, the application of the intervention is limited despite its demonstrated benefits. Thin, myelinated afferent fibers of

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biomedicines

MDPI

Systematic Review

Electroencephalographic Patterns in taVNS: A Systematic Review

Anna Carolyna L. Gianlorenco[1,2,3], Paulo S. de Melo[1,2,4], Anna Marduy[1,2], Angela Yun Kim[5], Chi Kyung Kim[5], Hyuk Choi[7,8], Jae-Jun Song[7,8] and Felipe Fregni[1,2]

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[5] Department of Otorhinolaryngology-Head and Neck Surgery, Korea University Medical Center, Seoul 08308, Korea
[6] Department of Neurology, Korea University Guro Hospital, Seoul 08308, Korea
[7] Department of Medical Sciences, Graduate School of Medicine, Korea University, Seoul 08308, Korea
[8] Neurive Co., Ltd., Gimhae 08308, Korea
* Correspondence: fregni.felipe@mgh.harvard.edu
† These authors contributed equally to this work.

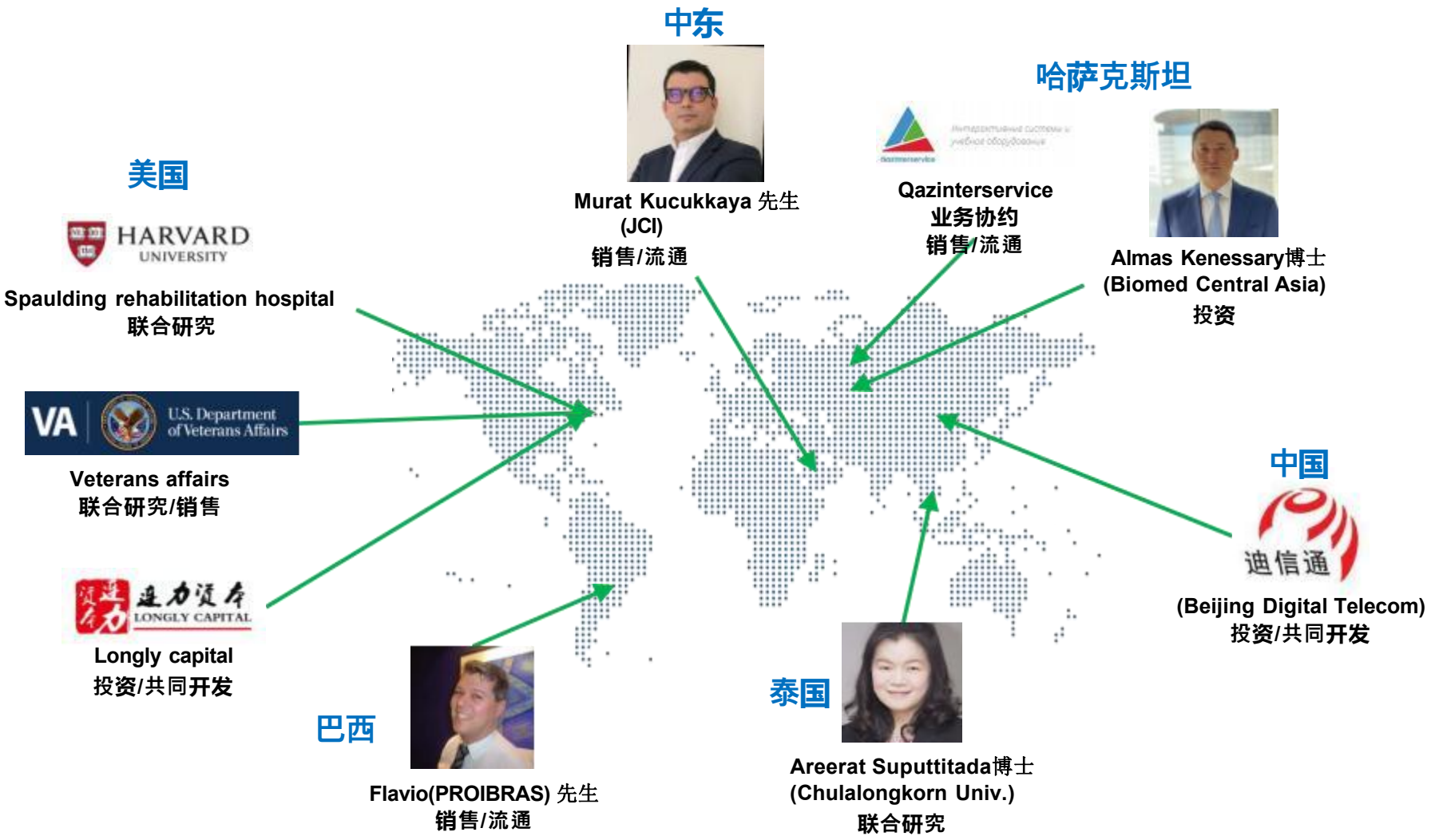
Abstract: Transcutaneous auricular vagus nerve stimulation (taVNS) is a newer delivery system using a non-invasive stimulation device placed at the ear. taVNS research is focused on clinical trials showing potential therapeutic benefits, however the neurophysiological effects of this stimulation on brain activity are still unclear. We propose a systematic review that aims to describe the effects of taVNS on EEG measures and identify taVNS parameters that can potentially lead to consistent EEG-mediated biomarkers for this therapy. A systematic literature review was carried out following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and the Cochrane handbook for systematic reviews. Clinical trials examining EEG parameters were considered, including absolute and relative power, coherence, degree of symmetry, evoked potentials, and peak frequency of all bands. According to our criteria, 18 studies (from 122 articles) were included. Our findings show a general trend towards increased EEG power spectrum activity in lower frequencies, and changes on early components of the ERP related to inhibitory tasks. This review suggests that quantitative electroencephalography can be used to assess the effects of taVNS on brain activity, however more studies are needed to systematically establish the specific effects and metrics that would reflect the non-invasive stimulation through the auricular branch of the vagus nerve.

Keywords: transcutaneous vagus nerve stimulation; taVNS; brain signals; EEG

1. Introduction

Due to its long path extending from its origin from the brainstem through the face and thorax down to the abdomen, the vagus nerve is also described as the "wandering nerve" [1]. The vagus nerve plays a widespread role maintaining autonomic tone among brain structures and peripheral organs. Traditionally, vagus nerve stimulation techniques have been developed to treat epilepsy and were first approved by the FDA in 1997 as an implantable treatment device [2]. Implantable vagus nerve stimulation is FDA-approved for therapeutic use in drug-resistant epilepsy and depression, and recent studies have shown promising results in treating various disorders such as cluster headache, heart failure, Alzheimer's disease, anxiety disorder, obesity, sepsis, lung injury, rheumatoid arthritis, and diabetes [3,4]. However, this classical approach requires an invasive surgical

Global business




neurive
support for new life