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Reshaping Clinical Dialogue: Integrating an AI-Based EEG Tool into Depression Care

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Abstract

Depression remains underdiagnosed in many Asian populations, largely due to stigma, limited illness insight, and reliance on subjective self-report instruments. The Stress electroencephalography (EEG) Assessment (SEA) SystemTM is an AI-driven EEG tool approved by the Taiwan regulatory authority. It generates an objective, user-friendly index from just 90 seconds of resting-state EEG data to assist in the diagnosis of major depressive disorder (MDD). This article presents three clinical cases illustrating how SEA can enhance diagnostic clarity, facilitate patients and family understanding, and uncover otherwise unrecognized depressive symptoms. In each case, the availability of objective neurophysiological data to support clearer clinical communication, improve treatment adherence, or inform critical diagnostic and therapeutic decisions. Unlike conventional EEG systems, SEA is intuitive, rapid, and operable by non-specialists, making it feasible for integration into primary care, geriatric medicine, and wellness or preventive settings. By framing depression as a biological and measurable brain condition, SEA may help reduce stigma, promote early help-seeking, and reshape clinical dialogue between patients, families, and healthcare providers. Integrating this technology into psychiatric practice holds promise for strengthening shared decision-making and optimizing care pathway. Further research is warranted to evaluate its long-term clinical effectiveness and impact on patient outcomes.

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Reshaping Clinical Dialogue: Integrating an AI-Based EEG Tool into Depression Care

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Abstract
Depression remains underdiagnosed in many Asian populations, largely due to stigma, limited illness insight, and reliance on subjective self-report instruments. The Stress electroencephalography (EEG) Assessment (SEA) System™ is an AI-driven EEG tool approved by the Taiwan regulatory authority. It generates an objective, user-friendly index from just 90 seconds of resting-state EEG data to assist in the diagnosis of major depressive disorder (MDD). This article presents three clinical cases illustrating how SEA can enhance diagnostic clarity, facilitate patients and family understanding, and uncover otherwise unrecognized depressive symptoms. In each case, the availability of objective neurophysiological data to support clearer clinical communication, improve treatment adherence, or inform critical diagnostic and therapeutic decisions. Unlike conventional EEG systems, SEA is intuitive, rapid, and operable by non-specialists, making it feasible for integration into primary care, geriatric medicine, and wellness or preventive settings. By framing depression as a biological and measurable brain condition, SEA may help reduce stigma, promote early help-seeking, and reshape clinical dialogue between patients, families, and healthcare providers. Integrating this technology into psychiatric practice holds promise for strengthening shared decision-making and optimizing care pathway. Further research is warranted to evaluate its long-term clinical effectiveness and impact on patient outcomes.

Keywords:
Major Depressive Disorder; Electroencephalography; Biomarkers; Psychophysiology; Artificial Intelligence; Mental Health

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Background

Depression affects more than 300 million people worldwide. Although numerous evidence-based treatments are available, a substantial proportion of individuals delay or avoid seeking professional help, resulting in significant personal, familial, and economic burdens. This treatment gap highlights the urgent need for enhanced mental health advocacy and service improvements, particularly in Asia contexts.

In the United States, over 60% of individuals with depression seek medical or professional help. In contrast, the corresponding figure is only around 30% in Taiwan and Japan [1-3]. This striking disparity underscores the persistent challenges of low illness insight and pervasive mental health stigma in many Asian populations [4]. Even when patients are brought to clinical settings under family pressure, some may question the validity of the diagnosis, underreport symptoms, or demonstrate poor adherence to treatment, thereby undermining clinical effectiveness. Furthermore, traditional rating scales are susceptible to inaccuracies among individuals with limited insight or

intentional symptom minimization, posing additional challenges for accurate diagnosis and appropriate intervention.

Depression is traditionally diagnosed using clinical criteria based on current symptoms and history, a process that relies heavily on subjective interpretation. Standard tools, whether clinician- or self-administered, offer reasonable accuracy depending on threshold scores and help identify high-risk individuals for further diagnostic evaluation. While indispensable, these traditional approaches are vulnerable to underreporting, cultural stigma, and subjective variability in interpretation [5]. This has led to growing recognition of the need for objective physiological biomarkers to complement psychiatric assessment. EEG represents a particularly promising modality due to its portability, non-invasiveness, and relatively low cost compared with other interpretable data. Advances in digital signal processing now allow EEG to generate cleaner and more interpretable data, offering a potentially more direct reflection of depression-related neurophysiological changes than self-report measures [6,7,8]. Moreover, incorporating physiological assessments can help reframe depression as a tangible biological condition, thereby reducing stigma and shifting perceptions away from personal weakness or lack of will power [9,10].

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The SEA System

The SEA System is a Taiwan Food and Drug Administration (TFDA)-approved, AI-based software as a medical device (SaMD) designed to assist in the diagnostic assessment of MDD. The system records 90 seconds of resting-state EEG data using a standardized montage, after which the signals undergo preprocessing, including artifact removal and spectral decomposition. A numerical index ranging from 1 to 10 is generated to represent the probability of depression, and the entire assessment can be completed within approximately 15-20 minutes.

A machine learning classification model was trained using EEG spectral power and nonlinear dynamic features derived from a large multicenter prospective clinical study that recruited more than 400 subjects in Taiwan.[11] The model outputs a single continuous SEA Index, representing the probability of depressive pathology. A predefined cut-off value, determined through receiver operating characteristic (ROC) analysis in a development cohort, is applied to classify individuals as "positive" (≥ 7) or "negative" (< 7) for depression risk. The SEA Index demonstrated a sensitivity of 88%, specificity of 80%, and an overall classification accuracy of approximately 84%, indicating robust discriminative validity in differentiating individuals with MDD from healthy controls.[11]

Unlike quantitative EEG (qEEG) systems that generate multiple normative comparison maps requiring specialized expert for interpretation, the SEA Index offers an intuitive, single-value output. It can be readily used by psychiatrists regardless of prior EEG training, as well as by other healthcare professionals. In clinical settings, SEA has been observed to facilitate communication and bridge the gap between patients' subjective experiences and clinicians' interpretations. The following three real-world cases illustrate its clinical utility.

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Case 1 – Resolving Family Disagreement

A female college student presented with severe depressive symptoms, reflected by a Patient Health Questionnaire-9 (PHQ-9) score of 20. However, her parents initially dismissed her condition as mere "overthinking." As family tensions increased, they agreed to undergo an SEA assessment, which yielded a SEA index score of 9, indicating a high risk of depression and aligning with psychiatrist's clinical evaluation. By integrating and discussing both the clinical interview findings and the objective SEA results, the parents came to accept the diagnosis. This facilitated the timely initiation of combined pharmacotherapy and psychotherapy. With strengthened family support, the patient experienced significant clinical improvement withing three months.

Case 2 – Physiological Evidence Supporting MDD Diagnosis

A female associate professor in her early 50s, who described herself as a perfectionist, presented with emotional difficulties characterized by depressive symptoms, anxiety, and psychological distress. Despite these complaints, she expressed skepticism about the diagnosis and requested additional objective evidence Routine brain imaging, qEEG assessment, and blood tests all yielded normal results. Subsequently, SEA testing was performed, producing a SEA index score of 8, indicating a high likelihood of MDD. By integrating the physiological findings from SEA with the clinical diagnostic interview, the patient gained greater confidence in the diagnosis and actively participated in discussions regarding appropriate treatment options.

Case 3 – Uncovering Hidden Symptoms

A 50-year-old male patient receiving long-term antidepressant treatment consistently reported" feeling okay" during follow-up visits. However, SEA assessment revealed a high depression score 9, suggesting significant residual symptoms that were not captured through self-report. This finding prompted a medication adjustment. Three months later, his SEA score had decreased to 2, and he described" feeling much lighter". This case illustrates SEA's value in uncovering unspoken or underreported distress and in objectively monitoring treatment response over time.

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Discussion of Clinical Utility

The three cases presented highlight the multifaceted clinical utility of applying a machine learning-based EEG framework for the diagnosis and management of MDD. Specifically, they illustrate its value across three key dimensions: (1) addressing family dynamics, (2) enhancing patient acknowledgment and acceptance of diagnosis, and (3) supporting ongoing treatment monitoring. Importantly, the SEA index is not intended to replace clinical judgment, but rather to complement it by providing an objective physiological measure that can facilitate dialogue between patients, families, and clinicians. By grounding clinical discussion in tangible data, AI-based EEG assessment empowers shared decision-making, which in turn can strengthen therapeutic alliances and improve treatment [12].

Future Applications and Outlook

The potential applications of an accessible AI-EEG index extend well beyond specialized psychiatric settings. Its objective, rapid, and user-friendly characteristics make it suitable for integration into a variety of clinical and non-clinical environments, enabling earlier detection and greater patient engagement.

In general medical practice, SEA could support early detection when used by general practitioners and non-psychiatric specialists—such as those in family medicine, sleep medicine, pain management, endocrinology and metabolism, and gastroenterology—by providing a quantitative, physiologically grounded metric to guide appropriate psychiatric referrals.

In non-medical settings, such as corporate wellness programs and health screening centers, the simplicity of SEA makes it a promising tool for raising mental health awareness, identifying individuals at risk, and encouraging timely help-seeking behaviors.

Bridging the Gap in Early Detection and Stigma Reduction

In many Asian Societies, including Taiwan, Japan, and South Korea, stigma remains a substantial barrier to mental health care. By reframing depression through objective physiological assessment, SEA can enhance patient insight, foster acceptance of psychiatric diagnoses, and reduce stigma associated with seeking treatment. Broader implementation of SEA across hospital specialties and preventive health services, rather than limiting its use to psychiatric departments, could bridge the gap between early detection and clinical intervention, ultimately promoting timely diagnosis and treatment.

Enhancing Diagnostic Clarity in Specialized Contexts

The assessment tool may also have important applications in geriatric medicine. By providing objective neurophysiological data, it can assist clinicians in differentiating depression-related cognitive impairment (often referred to as *pseudodementia*) from neurodegenerative dementia. Because depressive symptoms can mimic cognitive decline in older adults, careful attention to such objective indicators is warranted [13].

In addition, the objective nature of the SEA index is valuable in more complex clinical contexts, such as cases involving suspected malingering or excessive reliance on antidepressant medication. Current clinical assessment relies heavily on subjective symptom reports, which may not accurately represent underlying pathophysiology. Biomarker-based tools could aid in identifying patients who may not benefit from prolonged pharmacotherapy.[14] For clinicians evaluating individuals who may be overly dependent on pharmacological treatment, the SEA Index provides an evidence-based reference to complement subjective reports and inform clinical decision-making. Similarly, in cases where patients intentionally feign or exaggerate symptoms, the tool serves as a useful adjunct to clinical interviews, offering a more robust and objective foundation for diagnostic assessment.

Clinical Integration and Complementary Role of AI–EEG

We encourage clinicians to actively consider integrating AI-EEG tools into clinical workflows, not as substitutes for expert judgment, but as complementary supports to enhance diagnostic and therapeutic decision-making. The core value of these tools lies in their ability to bridge biological markers, clinical symptomatology, and patients' subjective experiences, thereby fostering a more holistic understanding of depression. By providing objective, data-driven insight, AI-EEG assessments can empower clinicians with additional information to guide clinical decisions and enrich the therapeutic dialogue between patients and healthcare providers.

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The authors declare no other competing interests.

Abbreviations
AI Artificial Intelligence
EEG Electroencephalography
MDD Major depressive disorder
SEA Stress EEG Assessment (SEA) System™, an AI-driven EEG system developed by HippoScreen Neurotech Corporation

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