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Wearable Electrochemical Biosensor for Real-Time Cortisol Monitoring in Major Depressive Disorder: Correlation with Hypothalamic-Pituitary-Adrenal Axis Dynamics

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Abstract

Dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis in major depressive disorder (MDD) is typically assessed via intermittent serum or salivary cortisol measurements. We developed a microneedle-based electrochemical biosensor for continuous interstitial cortisol monitoring over 72-hour periods. In a cohort of 80 MDD patients and 40 healthy controls, real-time cortisol profiling revealed ultradian rhythmic disruption and enhanced stress-reactivity peaks predictive of treatment resistance to selective serotonin reuptake inhibitors (SSRIs). Machine learning classification of cortisol dynamics achieved 87% accuracy in distinguishing MDD subtypes. This ambulatory monitoring platform enables objective, longitudinal assessment of HPA axis function and treatment response.

Keywords: wearable biosensor, cortisol monitoring, major depressive disorder, HPA axis, microneedle technology, precision psychiatry