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Decoding the Spectrogram Rainbow

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Invented almost a century ago, electroencephalography (EEG) has evolved over time into a trusted technique widely used around the world.[1] In the current digital age, computerized techniques have replaced simple pen and paper plots of voltage against time with sophisticated quantitative measures of EEG activity. These transformations can collapse long stretches of data into manageable summaries for more efficient EEG review.[2] Compact summaries of the EEG allow one to observe trends in the EEG otherwise not possible with conventional 10-second page-by-page analysis; hence, quantitative EEG (QEEG) measures are often called "trends."[3]

In recent years, a multitude of QEEG measures have become widely available. These developments have led to misconceptions of QEEG that range from a kneejerk dismissal of the unknown to naïve overestimations of utility. Despite the proliferation and growing complexity of available QEEG measures, the most standard one, spectral estimation, is based on a classical mathematical method invented in the 1820s,[4] the Fourier Transform. As typically applied, this technique decomposes a short (2–4 second long) time-based segment of an EEG signal into a frequency-based signal or spectrum. Applying this transformation repeatedly to consecutive EEG segments and plotting the spectra as a function of time produces the spectrogram. The spectrogram is often plotted using colors to represent spectral power. Hence, the spectrogram is sometimes called a "color spectral array" or "color density spectral array."[5] To the uninitiated, spectrograms may seem intimidating. However, embedded within this polychromatic madness is a treasure trove of useful clinical information.

In this special topical issue of the Journal of Clinical Neurophysiology, we aim to decode the spectrogram rainbow. First, we review the basics of QEEG with a strong focus on spectrograms in an easily digestible, need-to-know, nononsense guide for clinicians. Then, we review evidence-based indications for the clinical application of QEEG spectrograms in 2020. At present, the best evidence lies in using QEEG for seizure detection and monitoring for ischemia in the adult, pediatric, and subarachnoid hemorrhage settings, respectively. Armed with information from the reviews in this special topical issue, we hope that the reader will come away with a firm grasp of QEEG spectrogram basics and understand

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how to best deploy (and not deploy) the present-day capabilities of QEEG spectrograms in clinical practice to improve delivery of patient care.

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