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The Unlikely Revolutionary: You, The Statistician — From ECT Confusion To AI Revolution: Discover How Statisticians Transformed Messy Medical Data into Life-Saving Insights

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Extended Abstract

"Are you in charge of ECT?" This question, posed by my psychiatrist colleagues when I joined a medical college with a newly minted PhD in Electrical and Computer Engineering and a never-heard-of position title of Assistant Professor of Electrical Engineering in Psychiatry in the late 1990s, encapsulates the gulf between 'traditional' medicine and the coming data science revolution. Electroconvulsive therapy (ECT) was their sole reference point for electricity in psychiatry then. This humorous misunderstanding foreshadowed a 25-year journey that would fundamentally transform how we see, understand, and heal the human brain, from megabyte-sized images to terabyte-scale datasets.

This keynote explores three pivotal transformations in biomedical data science: High-Quality Data Acquisition, Advanced Analytics with Statistical Rigor, and Asking Focused, Right Questions.

First, the digital revolution, which converted analog brain images on film into quantifiable imaging data. The challenge extended far beyond simple digitization. We had to optimize data acquisition techniques (to enhance signal and reduce noise), manage the explosive growth of fMRI data (gigabytes of brain activity recordings per participant) and develop automated processing and analysis software pipelines with rigorous quality control (to reduce anatomical variability and enable group comparisons), for the entire imaging data life cycle.

Lesson One: A study, a field, and the science are only as good as their data.

Second, the analytic revolution, which eventually demanded that every analytical methodology known to humans, from advanced statistical modeling and machine learning methods to graph theory-based network analysis, must play a role in deciphering the most complex system on Earth—the human brain—with statistical rigor. Here, the challenge wasn't just analyzing brain images, but a whole array of new analytical advancements: from transforming noisy signals into reliable data by modeling physiological rhythms and other structured sources of variation, to building "statistical conscience" into medical imaging, ensuring that beautiful brain visualizations represented robust, reproducible science rather than "expensive screensavers."

Lesson Two: Don't ignore what you don't understand—model it.

The third transformation explores the philosophy that the best algorithm is worthless if it answers the wrong question. Through concrete applications—from developing patents that transform laboratory inventions into clinical tools, to pioneering studies on detecting consciousness in non-communicative patients with severe brain injuries—this transformation demonstrates how statisticians must help define the questions, not just analyze the results, and how statistical thinking can operationalize profound clinical questions. As AI promises to transform healthcare, statistical expertise becomes more, not less, critical. Every neural network is a sophisticated regression model, and every AI diagnostic tool requires statistical validation.

Lesson Three: The right question is worth a thousand algorithms.

Let us be reminded that statisticians serve as translators between the language of nature and the imperatives of healing. From teaching computers to detect tumors to giving voice to comatose patients, statisticians don't just crunch numbers—we reveal the truth hidden in data. Twenty-five years after that ECT joke, the revolution is complete: statisticians now electrify not just psychiatry but all of medicine with the power of rigorous quantitative thinking. As we stand at the intersection of statistics and AI, the next 25 years promise even more profound transformations. The unlikely revolutionary—you, the statistician—will continue to be the guardian of truth in an age of algorithmic abundance.

References

[1] H. Pan, *et al.*, New and emerging imaging techniques for mapping brain circuitry. *Brain Research Review*, vol. 67, no. 1-2, pp. 226-251, 2011.

[2] H. Pan, *et al.*, U.S. Patents 9 773 308, 10 761 173, 11 612 322, 11 630 176, 2017-2023.