

AI and ML Transform Clinical Trials Using Real-World Evidence to Improve Design, Analysis, Outcomes

Sejong Bae¹, Chenguang Wang², Tuan Le³, Karan P. Singh³, AI Bartolucci⁴

¹ Department of Biostatistics, Data Science, and Epidemiology, School of Public Health, Georgia Cancer Center, Augusta University

² Regeneron

³ Department of Epidemiology and Biostatistics, School of Medicine, The University of Texas at Tyler Health Science Center

⁴ Department of Biostatistics, School of Public Health, University of Alabama at Birmingham

Abstract: The integration of Artificial Intelligence (AI) and Machine Learning (ML) into clinical trials is a solution to the limitations of traditional randomized controlled trials (RCTs). These limitations include limited generalizability, high costs, and extended timelines.¹ AI/ML particularly when leveraged for Real-World Evidence (RWE), is revolutionizing the landscape of clinical research.² RWE-integrated trials, which use data from electronic health records, claims databases, patient registries, and wearable devices, evaluate interventions in broader, more diverse populations, and more realistic environments.² AI/ML technologies enable the extraction, harmonization, and analysis of complex, high-dimensional data at scale, facilitating more precise patient phenotyping, adaptive trial design, and real-time safety monitoring, advancing clinical insight and accelerating evidence-based decision-making.^{1,2} This presentation explores the practical applications of AI/ML in enhancing various phases of RWE-integrated trials. From cohort selection and natural language processing of unstructured clinical notes to predictive modeling for outcomes and bias mitigation, and improving the quality, accessibility, and utility of RWE. AI/ML plays a pivotal role in clinical trials.^{3,4} We also address regulatory perspectives, challenges with data quality, interpretability, and the ethical implications of algorithm-driven decision-making in clinical research.⁴ Through case studies and emerging applications, it is demonstrated how these technologies are not only augmenting human capabilities but also creating a more efficient, inclusive, and evidence-rich ecosystem for drug development and comparative effectiveness research.

Keywords: Artificial Intelligence (AI); Machine Learning; Real-World Evidence (RWE); clinical trial.

REFERENCES

1. Harvard Medical School. AI in Clinical Research: Opportunities, Limitations, and What Comes Next. Published 2023. Accessed August 7, 2025. <https://learn.hms.harvard.edu/insights/all-insights/ai-clinical-research-opportunities-limitations-and-what-comes-next>
2. Maxs Clinical Sciences. Use of AI/ML for Improving the Quality of RWD. Accessed August 7, 2025. www.maxiscclinical.com
3. Tai CA, Tannier X. Clinical trial cohort selection using Large Language Models on n2c2 Challenges. Published online January 19, 2025. Accessed August 7, 2025. <https://arxiv.org/pdf/2501.11114v1>
4. Parexel Access Consulting. AI in RWE: Key drivers for accelerating clinical development and patient access. Published online 2024. <https://www.ispor.org/docs/default-source/intl2024/221parexel.pdf>