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Personalized Psychiatry and Neurology

Letter

Gene and Cell Technologies for Personalized Medicine

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Dear colleagues!

Personalized psychiatry and neurology are approaching a point where "precision" is no longer defined only by clinical scales, neuroimaging patterns, or iterative pharmacotherapy. The accelerating development of gene and cell technologies is making it realistic to connect an individual patient's molecular etiology with a measurable cellular phenotype and a rational therapeutic strategy. This shift is most evident in rare monogenic disorders, but it is increasingly relevant to broader neuropsychiatric practice as multi-omics, advanced analytics, and clinical-grade biomarker frameworks become more accessible.

Several technological trajectories are converging in a way that is particularly important for disorders of the nervous system. In vivo gene transfer, primarily based on adeno-associated viral vectors, is evolving through improved capsid engineering, better tissue targeting, and more predictable expression control. Ex vivo gene therapy using autologous hematopoietic stem cells has demonstrated the value of durable, system-wide correction with clinically meaningful neurological impact, especially for conditions where microglia turnover, lysosomal function, or long-term enzyme delivery shape the disease course. In parallel, programmable nucleic acid medicines are expanding the therapeutic palette, enabling dose-adjustable modulation of gene expression and splicing, which is an attractive feature for the central nervous system where titration and long-term safety monitoring are critical.

The field has already accumulated convincing examples of clinical implementation that illustrate what "personalized" can mean in practice. Approved gene and gene-modulating therapies have changed outcomes in severe pediatric neurological diseases, demonstrating that timely molecular diagnosis and early intervention can alter trajectories that were previously considered inevitable. AAV-based therapy for spinal muscular atrophy, gene therapy for aromatic L-amino acid decarboxylase deficiency, and ex vivo lentiviral approaches for inherited leukodystrophies provide concrete clinical precedents where a defined genetic diagnosis leads to a targeted intervention and a structured follow-up model. These successes also clarify the operational requirements for broad adoption: reliable patient stratification, immunological monitoring, validated endpoints, robust manufacturing and quality systems, and long-term registries that capture real-world outcomes.

Cell technologies are developing along complementary lines. Regenerative strategies based on pluripotent stem cell–derived neural lineages are moving steadily through clinical development, supported by progress in differentiation fidelity, safety control, and transplantation protocols. At the same time, "cell-based biologics" such as extracellular

vesicles are being explored as a pragmatic bridge between complex living products and scalable therapeutics, although their clinical translation will depend on standardized potency assays and rigorous trials. Immunoengineering is also reshaping neurology: approaches inspired by engineered immune cell therapies, while established in oncology, are increasingly influencing neuroimmunology through more precise modulation of pathogenic immune compartments. For psychiatry, the near-term pathway is likely to be strongest at the intersection with neurology, including neurodevelopmental disorders and syndromic forms where molecular causality is clear and actionable mechanisms can be linked to defined circuit and behavioral phenotypes.

Looking ahead, foresight reports and technology roadmaps on the future of healthcare and biotechnology tend to converge on a few priorities that are directly relevant to personalized psychiatry and neurology. One is the "platform" logic of therapeutics, where delivery systems and manufacturing pipelines become reusable foundations that shorten the path from target to clinic. Another is the integration of multi-modal biomarkers, including single-cell and spatial omics, neuroimaging, electrophysiology, and digital phenotyping, into trial designs that support smaller, biologically stratified cohorts with higher signal-to-noise. A third is the maturation of non-viral delivery and next-generation editing modalities, including base and epigenetic editing concepts, which may eventually broaden the range of tractable targets while reducing the burden of irreversible risk. Across all of these directions, artificial intelligence is becoming a practical tool for integrating heterogeneous patient data into clinically interpretable models and for improving reproducibility, which has historically limited translation in neuropsychiatry.

Importantly, gene and cell technologies bring new responsibilities along with new opportunities. Long-term safety, durability, and immune effects require systematic monitoring; cost and access demand realistic implementation models; and clinical decision-making must remain evidence-driven, especially when expectations rise faster than randomized data. In this context, a journal focused on personalization in psychiatry and neurology plays a unique role: it can connect mechanistic neuroscience with clinical workflows, highlight standards for biomarker-driven trials, and provide a forum where translational advances are evaluated not only for novelty, but also for practical deployability.

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