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Conventional and precision medicine: opposites or complementary ends?

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An Editorial on the Frontiers in Science Lead Article
Precision cardiovascular medicine: shifting the innovation paradigm

Key points

- The evolution of omics, RNA therapeutics, and artificial intelligence (AI) tools in research and clinical practice is shifting the focus from conventional medicine to precision medicine—promising deeper insights into disease mechanisms, diagnosis, prognosis, and personalized therapy.
- Population-based and precision strategies represent complementary layers of the same system of cardiovascular medicine, rather than opposites: the former provides the essential, scalable framework for reducing the overall disease burden, while the latter can refine care for those who need it most.
- The strength of future cardiovascular medicine will lie in balancing these two dimensions to address the global challenges posed by cardiovascular disease.

One of us (VF) was recently preparing a presentation for the upcoming United Nations Assembly in New York on the global challenges posed by cardiovascular disease (CVD), a topic that we have all been reflecting on together. A critical concern is that approximately 80% of fatal and non-fatal cardiovascular events occur in low- and middle-income countries (LMICs), where access to effective treatments and long-term adherence remain limited (1). More than two decades ago, the concept of a cardiovascular polypill—or fixed drug combination (FDC)—was introduced as a simple, cost-effective, and scalable strategy, and it has now been endorsed by the World Health Organization (WHO) as an essential

approach (1). While we were contemplating the appeal of such a straightforward population-wide solution, we were invited to write an editorial commenting on the lead article by Aikawa et al. on precison cardiovascular medicine, which at first glance seems to advocate an opposite strategy: a movement toward highly invidividualzed, technology-driven care (2). However, while these two approaches can appear to stand at opposing ends of the spectrum, both seek to reduce the global CVD burden and their relationship may be more complementary than contradictory.

In the midst of evolving strategies for personalized medicine in the United States (3), the European Union has launched the *Individualized Care from Early Risk of CVD* (iCARE4CVD) project. This initiative marks an important step forward in personalized cardiovascular care, integrating cutting-edge omics technologies and artificial intelligence (AI) across 36 leading institutions and drawing on data from 1 million individuals (4). As outlined in its introduction, contemporary management of CVD is typically guided by large, randomized trials on lipid-lowering drugs, antihypertensive agents, heart failure treatments, and so on. While these approaches are effective for many patients, they do not capture the complex interplay of the biological, environmental, and lifestyle factors that make each individual unique. The project anticipates delivering "a suite of validated tools and protocols to improve cardiovascular care and outcomes and cut healthcare costs … moving towards more personalized and preventative models, with an impact on public health in Europe and globally."

From a population health perspective, conventional or global medicine and precision or personalized medicine can appear contradictory. Moreover, population-based approaches are no panacea, and even a simple intervention such as the polypill—with an estimated potential to prevent up to 29 million deaths and 51 million cardiovascular events worldwide—still faces enormous barriers to global implementation, despite WHO endorsement (5). At the same time, over the past 3 years, thousands of publications and conferences have advocated for "precision" or "personalized" medicine as a way to improve outcomes and reduce healthcare costs. In this context, population-based strategies can seem like a one-size-fits-all approach, treating individuals as statistical averages. Yet these broad-stroke interventions provide the essential framework for reducing overall disease burden, within which more precise, individualized measures can then be identified and applied. Seen in this light, the two approaches are not in conflict: they represent opposite ends of a continuum, each with strengths and limitations potentially complementary in practice.

Turning to the foundations of precision medicine, Aikawa and colleagues highlight the "evolving revolution" of omics, advanced cell systems, programmable RNA therapeutics, and AI (2). Their review identifies new opportunities and challenges for medicine in general and cardiovascular medicine in particular. They emphasize the heterogeneity of CVD, which arises from the interplay of genetic factors and environmental exposures. As they rightly note, there is no single entity called heart disease but rather multiple conditions that affect the heart and the vasculature in different ways. To address this complexity, they propose that precision medicine—drawing heavily on omics and AI—offers the way forward. Harnessing big data, from molecular analysis to clinical information, and powered by advanced computational methods, these approaches can help identify key biomarkers and biological processes. In this sense, we have moved beyond the stage of simply acknowledging that "things are complicated" toward developing tools capable of making sense of that complexity.

While it is inarguable that big data has been—and will continue to be—transformative, it is not without limitations. Tools such as Cell Chat, for example, allow us to infer how cells communicate within tissue environments. Yet omics remains one instrument in a vast scientific toolbox and should be seen as an addition rather than a replacement for the time-tested methods that have produced Nobel prize-winning and medicine-defining discoveries over the past century. Mechanistic studies in molecular biology, biochemistry, immunology, and neuroscience continue to be essential, often forming the bedrock of major advances. Likewise, omics cannot displace the classical understanding of organ- and system-level pathophysiology. As Aikawa et al. emphasize, CVD is inherently complex (2). Indeed, most diseases involve multiple physiological systems—the immune and nervous systems among them—that influence one another with far-reaching consequences. In this sense, the enduring insights of classical science remain indispensable for framing disease at the systemic level. At the same time, the evolving precision technologies—omics, programmable RNA therapeutics, and AI—are advancing along an encouraging path toward assisting drug development and treatment selection, including for rare diseases (3, 6).

What, then, of AI at the clinical level? Recent scientific statements from the National Academy of Medicine and the American Heart Association have begun to address this question (3, 7). Thus far, only a limited number of AI tools have demonstrated sufficient impact on cardiovascular and stroke care to warrant broad adoption. One promising area is image interpretation, where expertise takes years to develop and specialists are often overburdened with tasks such as processing, segmentation, quantification, and even interpretation. AI applications can ease this workload and are therefore attracting growing interest. Similarly, the application of AI to electrocardiography (ECG) has already transformed practice by automating the interpretation of the exploding number of ECGs and, in some cases, identifying occult disease entities not readily recognized even by experts. However, such findings urgently require sensitive, specific, and rigorous validation, implementation, and adoption. Early pilot studies suggest that embedding AI models directly into electronic health record (EHR) systems may improve disease detection, stratify patients into more treatable subtypes, and identify novel clinical workflows. Yet raw EHR data, drawn from disparate information systems, require careful linkage and preparation by individuals familiar with local practice patterns. Even so, preliminary evidence indicates that AI may help streamline documentation, coding, virtual health assistance, and disease surveillance—offering tangible benefits to physicians by reducing the administrative burden and to patients by shortening delays in care.

An outstanding example of integrating precision technologies in both basic research and clinical practice comes from the

neurological sciences: the Global Neurodegeneration Proteomic Consortium (GNPC). This initiative has assembled one of the world's largest harmonized proteomic datasets, comprising approximately 250 million unique protein measurements from multiple international platforms. The dataset spans four major neurodegenerative disorders—Alzheimer's disease, Parkinson's disease, frontotemporal dementia, and amyotrophic lateral sclerosis—and is accessible to GNPC members. By addressing these conditions simultaneously, the consortium demonstrates the power of omics and AI to enable international collaboration, data sharing, and open science, thereby accelerating discovery in neurodegeneration research (8).

In conclusion, Aikawa and colleagues emphasize the ways in which the continued evolution of omics and AI tools in both research and clinical practice is shifting the focus from conventional medicine to precision medicine, promising deeper insights into disease mechanisms, diagnosis, prognosis, and personalized recommendations. Yet significant challenges lie ahead for such individualized approaches. Most importantly, these advances must not distract attention from the global burden of CVD and the critically low levels of access and adherence to proven, conventional treatments that exist, especially in LMICs. Nor can they replace the clinician's skill, experience, and capacity for empathy in the doctor–patient relationship—qualities that remain central to medical training (9). Rather than opposing forces, broad population-based strategies and individualized precision tools should be viewed as complementary aspects of the same system: the scalable, one-size-fits-all foundation reduces global disease burden, while precision approaches refine care for those who need it most. The strength of future cardiovascular medicine will lie in balancing these two dimensions.

Statements

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Generative AI statement

The authors declared that no generative AI was used in the creation of this manuscript.

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