BLOCKCHAIN IN HEALTHCARE TODAY
PLATFORM APPROACHES IN HEALTHCARE

CONFERENCE PRESENTATION

Opportunities and Risks of Technology Convergence in Precision Health

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Abstract

This ConV2X Decentralized Health 2026 executive roundtable explores how technology convergence impacts precision health outcomes. The dialogue focuses on the main technologies supporting precision health, the latest scientific developments, technology advancements, opportunities, and risks. It is moderated by BHTY journal editor Prof. Dr. Vasiliu-Feltes. Participants emphasize the latest scientific developments, opportunities, and risks associated with precision health, enabled by converging advanced technologies.

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Executive Roundtable

Dr. Carlos D. Bustamante

Carlos D. Bustamante discussed lessons learned from the Galatea Bio team's work to build inclusive and representative precision health ecosystems that work globally. A key message from the presentation was that human genetic diversity can accelerate biomedical discovery and ensure that science advances ethically, with participant autonomy, privacy, and data stewardship at the center. High-quality genomic datasets were identified as critical foundational infrastructure to realize the promise of precision health.

The future of precision health, Dr. Bustamante said, will depend less on the amount of data we collect and, in the future, more on the quality, diversity, annotation, and longitudinal data of our genomic and clinical datasets, which will be needed to deliver on the promise of precision health for everyone.

There needs to be greater focus on developing genomics biobanks for the Americas to accurately capture and reflect the diversity of people from North, Central, and South America; this will facilitate biomarker discovery, more effective diagnostics, better therapeutic targeting, and the external validity of artificial intelligence (AI)-enabled precision health models.

Dr. Bustamante offered a glimpse into how the U.S. and the rest of the world are thinking about the governance of precision health data. The U.S. has the benefit of being extremely innovative, competitive, and dynamic, with multiple stakeholders involved from academia and healthcare as well as the private sector. Other nations are taking a national approach to building their precision health systems and population-scale biobanking initiatives. He offered an optimistic view of precision health for everyone at scale: the next generation of genomics-enabled healthcare will ensure precision health equity, make sure we don't leave anyone behind, and deliver on the promise of personalized prevention, diagnostics, and therapeutics to the global population.

Dr. Evelyne Bischof

The next speaker, Dr. Bischof, spoke about her work in precision health and longevity medicine. Advances in genomics and multiomics, combined with data-driven precision health and clinical decision support, will change healthcare as we know it. Precision medicine will move beyond treating disease to a future focused on preventive care, early detection, and interventions that optimize and sustain health span and physiological resilience throughout the course of human life. Building on her organization's experience with genomics-enabled precision health, the team is advancing precision health technologies like molecular diagnostics, biomarker analysis, and individualized risk and treatment recommendations for increasingly personalized prevention and therapeutics. Looking to the future, the next generation of genomics will combine genomics with multiomics and the broader context of clinical records, lifestyle, and environment to better understand what drives health and disease and the trajectories of individuals along those paths.

She pointed out that AI is being rapidly integrated into healthcare, with new risks being considered. Overuse of AI by clinicians and patients will need to be carefully managed. There is tremendous potential for AI to support clinical reasoning, evidence gathering, and clinical decision-making. How reliance on AI may lead clinicians to develop reduced cognitive skills in clinical judgment and critical thinking (automation bias). Patient access to and adoption of AI may lead to overuse and misinterpretation of health data, unrealistic expectations of AI capabilities, and inappropriate interventions. Beyond the challenges of AI, privacy protection, cyber-ethics risks, and patient trust will become a foundation for scalable precision health ecosystems.

Stephen J. Dennis

Mr. Dennis is working on Softhread's AI-enabled blockchain infrastructure. In the future, blockchain will be important as a technology layer as well as infrastructure that can enable the trust and interoperability required in precision health ecosystems powered by AI. Today we think of blockchain as a technology that provides security and traceability of crypto assets. In the future, however, permissioned blockchain architectures, identity management, confidential computing, smart contracts, and crypto provenance will become critical infrastructure to enable precision health research at scale and support trusted data interoperability and exchange across healthcare environments.

Mr. Dennis underscored the growing need to consider the new cybersecurity risks and threats that the complex AI portfolio can introduce, as multi-agent systems and AI-enabled autonomous decision-making are incorporated into healthcare and precision health systems. Blockchain-based zero-trust architectures and other related technologies will be key enablers for verifying identities, establishing audit trails, ensuring algorithm provenance, and managing consent over time across these systems. Softhread's platform will help enable these use cases by securely exchanging data, implementing federated architectures, supporting the audit and provenance of all records, and enabling precision health analytics within regulated health systems.

Session Highlights

Precision Health at Scale for All: Dr. Carlos D. Bustamante

Insight: The power of human genetic diversity to solve acute problems in biomedicine, while respecting the integrity of the research enterprise and the autonomy and privacy of research participants.

Precision Health for Longevity. Dr. Evelyne Bischof

Insight: Clinicians' and patients' increased dependence on AI is a risk for precision health.

Building Trusted, Auditable, and Secure Precision Health Ecosystems

Stephen J. Dennis, MSEE, MBA

Insight

The role of blockchain in ensuring data privacy, data integrity, data provenance, and quantum-resilience for precision health ecosystems.

A review of relevant publications reveals that precision health is changing in ways that would have been unimaginable just a few short years ago, as it is being enabled by high-dimensional biological data, advanced data computation methods, AI, distributed data infrastructures and, more recently, quantum technologies.

New research published today shows that precision health is no longer restricted to the study of genomes but is instead a more integrated multimodal discipline that uses a combination of genomic and other sources of data, including molecular, clinical, imaging, environmental, behavioral, and real-world evidence, to enable predictive, preventive, personalized, and participatory medicine.

Genomics continues to play an important role in the field of precision health. Cardoso et al.[1] describe how genomics is an essential part of modern biomedicine and can be used to determine who is at risk for disease, to guide pharmacogenomic treatment, to inform clinical decision-making, and to deliver molecular diagnostics and therapies with precision to individuals across a range of clinical areas.

As the cost of genomic sequencing falls and becomes more readily available to patients and researchers alike, the data is beginning to transition from being generated primarily for research to the clinical environment and eventually to the broader population. In addition to these developments, Reardon et al.[2] show how combining machine learning (ML) with genomics can transform precision oncology by identifying new biomarkers, by discovering new molecular sub-types of cancers, by predicting how a tumor will respond to potential treatment, and by helping to personalize a patient's treatment based on all these factors.

In this regard, AI is not a replacement for clinical judgment, but rather it is a tool to add to the arsenal `available to clinicians, helping to enable the extraction of information from genomic data to make clinical decisions of this nature.

With greater availability of data in diverse domains, the field is becoming increasingly multi-omics, meaning that genomic data, for example, is not being used alone to describe biological states or to guide clinical treatment, but rather transcriptomics, proteomics, metabolomics, epigenomics, microbiomics, radiomics, digital biomarkers, and other modalities are being combined to provide a more complete understanding of a given patient's biology.

To cite one example, Sharma et al.[3] uses precision nephrology to show how spatial metabolomics, when combined with other forms of omics, can significantly advance our understanding of kidney disease and improve its treatment outcomes. Complementing this finding, Baião et al.[4] discuss the technical aspects of multiomics, from how to combine data to computational algorithms that have evolved over the years from simple statistical analyses to deep learning and, more recently, deep generative approaches to deal with increasingly complex and nonlinear biological data. Together, the articles discussed thus far point towards a future in which more scalable and comprehensive computational and other infrastructures that can

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enable a more complete understanding of a given patient are required to support precision health.

Similarly, AI is evolving. In the past, human-in-the-loop learning models were in vogue, but the next step is for these models to evolve into autonomous, agentic AI. For example,e-dou et al.[5] describes bioinformatic systems, which are agentic in nature, in that they can automate literature searches and synthesis, hypothesis generation, experimental design, and scientific discovery, with an emphasis placed on reproducibility and rigor. In a similar manner, Gentile et al.[6] demonstrate how agentic AI systems, such as transcriptomics, may be used autonomously yet with human oversight of any final, important decision points. Expanding upon this, Branda et al.[7] propose multiagent scientific ecosystems, in which several different AI agents work together to help scientists perform the various stages of research, including data gathering, analysis and interpretation, simulation, validation, and knowledge generation.

The work described above points toward a shift in the field of precision health from using AI and other tools to aid clinical decision-making toward a more collaborative model between humans and AI agents. All of this might allow for the acceleration of biomedical discovery, while also raising concerns about how AI models may be governed, validated, and accounted for, as well as the various potential bioethical concerns that such technology may bring forth.

Summary

The evolution of precision health is being aided by the decentralization of healthcare more broadly. Cicin and Cicin[8] show how mobile health can be used to facilitate clinical trials for cancers by providing more comprehensive and continuous information from patients who participate in the clinical trial. They might be able to do so in a decentralized manner, as opposed to in-person visits, and provide different endpoints, thus achieving a higher degree of patient enrollment and engagement. These decentralized clinical models have the potential to expand access to clinical trials and also may allow the capture of additional real-world evidence, which might be more useful than standard clinical studies as national biobanks, genomic and population-scale data, biobanks, digital pathology repositories, imaging centers, and wearable devices become more readily available and as the need for the secure and privacy-preserving exchange of these data across institutional boundaries increases.

Thus, blockchain technologies have been identified as an important enabler of trusted and precision health ecosystems. For example, Wang et al.[9] reviewed blockchain-enabled federated learning in healthcare systematically and concluded that "blockchain can be leveraged to build an environment that facilitates trust, data integrity, coordination, and auditability among distributed ML players; and that can be a means of cybersecurity, data governance, and regulation for such an environment." Additionally, Chafik et al.[10] demonstrated that "blockchain improves the way we manage and control clinical data by providing immutable records, transparent governance, improved interoperability, and compliance with regulations." More generally, Liu and Hu[11] argue that "the combination of blockchain and AI constitutes an ideal platform for the digital healthcare transformation in the future that provides trusted data infrastructure and intelligent support of decisions at the same time."

Integration of blockchain technology with federated learning is another important and rapidly evolving area of precision health research. Shahsavari et al.[12] suggested "new architectures in healthcare based on a distributed ML framework, which can simultaneously support the preservation of patient privacy, cybersecurity, regulatory compliance, collaboration, and data availability." Federated learning makes it possible for ML algorithms to be trained and deployed using a combination of decentralized datasets. Thus, eliminating the need to move personal health data and providing significant privacy benefits to healthcare consumers, as well as greater access to data and patient populations. Complementarily, Myrzashova et al.[13] demonstrated that "blockchain-enabled federated learning can provide trust, transparency, resiliency, and data provenance in Internet of Medical Things ecosystems and lay a strong foundation to design the future healthcare ecosystem."

Emerging and future quantum technologies may represent another significant development in support of precision health in the future. For example, Nassir et al.[14] suggest that "quantum computing is becoming a reality and is considered a game-changing technology that can support and accelerate different precision medicine applications like genome sequence analysis, biomarker discovery and molecular modeling, and drug development (optimization, molecular simulation, and modeling) and biological simulations, where classical computer architecture is not enough." Further, Sung and Cheong[15] suggest a theoretical "quantum-mechanical framework for redox biology and disease and the possibility that quantum biology could be used to explain or treat disease," and, as such, it will be interesting to monitor the future of this theoretical framework in precision health research and practice. Similarly, Baldini et al.[16] describe future "potential roles of advanced biophotonics for molecular characterization, diagnostics, and precision medicine." Thus, these technologies, in aggregate with AI, blockchain and other emerging technologies, will likely be the technologies of the future upon which precision health research and systems will be implemented.

Additionally, quantum technologies are expected to accelerate pharmaceutical research by enhancing the speed and efficacy of molecular simulations in the development of therapeutics. Gomase et al.[17] suggest that "quantum computing is a promising technology that will accelerate drug discovery and will enhance drug design capabilities through improved molecular simulation, virtual drug screening, molecular optimization, and simulation of complex biochemical interactions. " Likewise, Khan et al.[18] describe how "the integration of AI and quantum computing to drive a shift from traditional drug discovery techniques toward hybrid quantum ML models" could accelerate precision drug design by providing a new "quantum computing framework that offers significant speedups over classical methods for chemical space exploration" and may ultimately replace AI in this context as technology advances.

These and other future innovations will likely lead to future precision health systems that integrate multimodal biological data, AI for trusted and secure analysis, autonomous agents for discovery, blockchain for secure data management, federated learning for decentralized analytics, and quantum computing. Of course, the application of emerging and frontier technologies will introduce a range of scientific, technical, regulatory, ethical, cybersecurity, governance, and other critical challenges, including privacy, transparency, accountability, explainability, trust, validation, interoperability, portability, workforce skills, quantum security, and other significant issues to be addressed in advancing precision health. Thus, leveraging the benefits of these innovations will require not only advances in science and engineering but also in harmonized governance and standards, cybersecurity, international alignment, and multidisciplinary collaboration. Future work will need to continue in this multidisciplinary direction.

Key Learnings

Distinguished leaders from the research, clinical, and healthcare technology innovation communities gathered for the Executive Roundtable titled "Opportunities and Risks of Technology Convergence in Delivering Precision Health Outcomes." The purpose of this gathering was to examine one of the most significant developments in modern medicine. Panelists discussed how precision health is evolving from its roots in genomics to the use of a variety of technologies, with a focus on the convergence of AI, blockchain, quantum, and other advanced infrastructures. In the past, blockchain was used to provide a trusted digital foundation for precision health. This has included immutable provenance, secure interoperability, patient sovereignty, and auditability. This has been the foundation of the increasingly distributed healthcare ecosystem.

The primary topic of discussion was the role of technology convergence in future precision health applications and the idea that a technology or technology stack is unlikely to drive the evolution. What would drive this is how these complementary technologies work together across the biomedical value chain. Genomics and omics technologies will underpin disease prevention, diagnostics, and therapeutics, but this will only have an impact if those data can be processed in a meaningful and useful way. AI can understand various datasets and work across modalities, and blockchain technologies can build trust in where those data come from and who they're consented for, allowing trusted data exchange among different institutions. There is now the potential to bring all these technologies together to improve precision in stratifying risks and delivering more effective and timely interventions and more personalized care.

Panelists also described how AI, and increasingly agentic and autonomous AI technologies, are rapidly being integrated into precision health ecosystems. Artificial intelligence can understand and process various datasets. It can accelerate biomarker discovery, support clinical decision-making, accelerate translational research, and do so with a level of precision and at a scale previously unattainable. At the same time, however, as healthcare providers and payers become increasingly reliant upon AI-driven intelligence to inform their decision-making, blockchain will be needed to ensure the integrity, provenance, reproducibility, and trustworthiness of those outputs throughout their lifecycle.

Blockchain can also help to unlock some of the global challenges that have made precision health less viable at scale until now. For example, distributed ledger technologies provide for secure interoperability, trusted data exchange, dynamic consent management, and decentralized identity. They also create verifiable, cryptographic proof of the provenance of data and metadata, without relying on any one institution to serve as a centralized custodian of highly sensitive genomic data. This has implications for precision health applications that include research collaborations, genomics studies, and precision health populations, particularly those that span multiple organizations and jurisdictions.

The use of quantum computing and quantum simulations was described as having the potential to revolutionize precision health by accelerating genomic analysis, molecular modeling, systems biology, drug discovery, and computational precision medicine. This session concluded with a discussion of how the convergence of quantum computing, AI, and blockchain may create the next generation of technology. A trusted infrastructure that enables quantum-enabled analytics to operate on verifiable, immutable, provenance-preserved genomic data and data, where the blockchain will play a vital role, not only as a trust layer that provides the foundation for future hybrid classical/quantum ecosystems but also as the infrastructure for quantum-level cryptography integrity, data lineage, and the creation of auditable computing workflows.

In addition, the Executive Roundtable participants discussed the opportunities and risks of using emerging and developing technologies. Panelists discussed several of the most pressing issues, including privacy, security, explainability, interoperability, regulatory issues, workforce training and readiness, and digital trust.

Blockchain-based architectures have the potential to provide a robust security framework in the future, including the ability to ensure the system is immutable, tamper-resistant, and resistant to malicious hacking. Blockchain could ensure that information is cryptographically protected, access to those systems is granular and tightly controlled, and there is clear governance and transparency as part of the system. These are all the characteristics needed to support a zero-trust system within the healthcare and precision health context.

Consensus

Speakers agreed that the primary challenge of precision health is not technological innovation but the ability to harness and orchestrate new technologies in a more responsible way to meet the demands of a highly regulated precision health ecosystem. Advanced technologies supporting precision health are becoming ubiquitous, highly interconnected, and more autonomous; however, the governance around those systems is lagging and will need to be harmonized. This includes principles like ethics by design, security by design, or the ability to perform dynamic auditing. Provenance using blockchain-based architectures, AI-enabled transparency, genomic data stewardship, and quantum computing technologies and resilience will all need to be present within future healthcare systems and, specifically, precision health systems.

The panel also concurred that while omics, AI, wearables, biosensors, bioimplants, blockchain, quantum, and other advanced technologies will collectively power the next generation of precision health, digital trust will remain the decisive

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factor determining societal adoption and scalable implementation. By combining scientific rigor, clinical insight, technological innovation, and trusted digital infrastructure, precision health has the potential to deliver safer, more equitable, and personalized outcomes for patients and populations worldwide.

Future Directions

The panel moderator then shared a few ideas regarding future possibilities for progress in the field of precision health. "The future of precision health will not depend solely on the advancement of omics, AI, blockchain, quantum, or other advanced technologies. It will also depend on a trusted digital infrastructure that would support the responsible scaling of precision health," stated Prof. Dr. Vasiliu-Feltes.

Furthermore, the professor highlighted that as healthcare systems transition into more autonomous and decentralized architectures, blockchain-enabled cyber-ethics and quantum resilience will shift from being desirable aspirations to key design requirements in system engineering. Saying that blockchain would be a viable engineering solution for cyber-ethics-by-design. This could be accomplished through immutable provenance ledgers, cryptographic attestations, decentralized identity management, dynamic consent orchestration, and smart contract enforcement, in which core values such as transparency, accountability, autonomy, auditability, data minimization, and fairness will be hard-coded into the underlying system architecture instead of being applied to the architecture through policy mechanisms. Blockchain could therefore become an executable trust infrastructure, continuously verifying the ethical compliance of the whole data lifecycle. Additionally, she noted that the potential of blockchain and digital twinning for auditing and performance improvement will likely become essential to all complex precision health ecosystems that manage a high volume of multimodal data.

Another important feature needed in creating a trusted precision health ecosystem is ensuring quantum resilience. Dr. xxx also emphasized the fact that genomic data carry very long cryptographic lifetimes, with the possibility to contain valuable information for years or even generations in the future. For that reason, today's systems must be crypto-agile and urgently migrate to post-quantum cryptography. Blockchain architectures coupled with post-quantum cryptographic algorithms, hybrid trust architectures, and quantum-resilient identity systems may offer a secure digital foundation for future precision health.

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Contributions

Each author contributed their opinions to the roundtable discussion.

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