

Biomedical Innovation Frameworks for Future Healthcare Development

Prof. Shana Kelley

Professor, University of Toronto, Canada

Abstract

Biomedical innovation is increasingly influencing the development of future healthcare systems by integrating advances in biomedical engineering, biotechnology, artificial intelligence, medical devices, digital health, computational biology, and personalized medicine. Rapid developments in biomedical technologies are creating new opportunities for disease prevention, diagnosis, treatment, rehabilitation, and continuous health monitoring. This study examines biomedical innovation frameworks for future healthcare development through a conceptual and literature-based research design.

The study focuses on major innovation domains, including biomedical devices, artificial intelligence, precision medicine, tissue engineering, regenerative medicine, digital biomarkers, biosensors, wearable technologies, computational healthcare, and advanced diagnostic systems. Biomedical innovation frameworks can facilitate the translation of scientific discoveries into practical healthcare solutions by connecting research, technology development, clinical validation, regulatory assessment, and healthcare implementation.

AI-supported biomedical systems can analyze complex clinical and biological information, while advanced biosensors and wearable devices can support continuous monitoring. Regenerative medicine and tissue-engineering approaches may contribute to the development of advanced therapeutic solutions. However, biomedical innovation also involves challenges related to research translation, patient safety, regulatory requirements, ethical considerations, data privacy, cybersecurity, interoperability, cost, accessibility, and clinical adoption. The study emphasizes the importance of multidisciplinary collaboration among biomedical engineers, clinicians, researchers, technology developers, policymakers, and healthcare organizations.

A successful future biomedical innovation framework should combine scientific advancement with clinical relevance, ethical governance, patient-centered design, and sustainable implementation. The study concludes that integrated biomedical innovation can strengthen future healthcare development when supported by rigorous validation, responsible governance, interdisciplinary collaboration, and equitable access.

Keywords: Biomedical Innovation, Healthcare Development, Biomedical Engineering, Biotechnology, Artificial Intelligence, Precision Medicine, Medical Devices, Regenerative Medicine, Biosensors, Future Healthcare.

1. Introduction

Biomedical innovation has become a central component of modern healthcare development because advances in engineering, biotechnology, computational science, and medical research are continuously expanding the capabilities of prevention, diagnosis, treatment, and rehabilitation. Conventional healthcare systems increasingly interact with technologies such as intelligent medical devices, biosensors, wearable systems, advanced imaging, computational analytics, and personalized therapeutic approaches. These developments create opportunities to improve healthcare quality while supporting more precise and individualized approaches to patient management.

The convergence of biomedical engineering and digital technologies has accelerated the development of intelligent healthcare solutions. Artificial intelligence can support medical image analysis, disease prediction, biological-data interpretation, and clinical decision support. Advanced biosensors can detect physiological or biochemical changes, while wearable technologies can facilitate continuous health monitoring. These innovations provide opportunities for shifting healthcare from episodic intervention toward more proactive, preventive, and personalized models.

Biomedical innovation also extends beyond digital technologies. Tissue engineering, regenerative medicine, biomaterials, medical robotics, implantable devices, and advanced drug-delivery systems represent important areas of biomedical development. These technologies seek to address complex healthcare problems through engineering and biological approaches. However, the successful translation of biomedical discoveries into clinical practice requires extensive testing, validation, regulatory assessment, manufacturing capabilities, and integration with healthcare environments.

The development of biomedical innovation involves significant ethical, technical, economic, and organizational considerations. Patient safety, informed consent, data protection, algorithmic fairness, device reliability, regulatory compliance, and accessibility must be addressed throughout the innovation lifecycle. Technologies that demonstrate promising laboratory performance may face substantial challenges when implemented in diverse clinical environments. Therefore, biomedical innovation requires a systematic framework that connects scientific discovery with clinical requirements and real-world healthcare implementation.

Future healthcare development is likely to depend on multidisciplinary innovation involving biomedical engineers, clinicians, biologists, computer scientists, researchers, healthcare organizations, policymakers, and patients. An effective innovation framework should encourage technological advancement while maintaining patient-centeredness, safety, sustainability, and ethical responsibility. This study examines biomedical innovation frameworks for future healthcare development, focusing on emerging technologies, healthcare applications, innovation processes, implementation challenges, and future research directions.

2. Objectives of the Study

2.1 Primary Objective

The primary objective of this study is to examine biomedical innovation frameworks for future healthcare development and analyze how biomedical engineering, biotechnology, artificial intelligence, advanced medical devices, biosensors, regenerative medicine, precision medicine, and digital

technologies can contribute to improved healthcare diagnosis, treatment, monitoring, prevention, and patient-centered services.

The study also aims to identify the technological, clinical, regulatory, ethical, and organizational factors necessary for translating biomedical innovations into sustainable healthcare applications. Particular attention is given to safety, validation, interoperability, data governance, affordability, accessibility, multidisciplinary collaboration, and clinical integration. The study seeks to establish a structured conceptual perspective on future biomedical innovation.

2.2 Examination of Emerging Biomedical Technologies

The first objective is to examine emerging biomedical technologies, including intelligent medical devices, biosensors, wearable systems, artificial intelligence, biomedical imaging, tissue engineering, regenerative medicine, biomaterials, and precision healthcare technologies.

The objective further evaluates the potential contribution of these technologies to disease diagnosis, health monitoring, personalized treatment, rehabilitation, and preventive healthcare. Emphasis is placed on technological convergence and the increasing interaction between biological sciences, engineering, computational methods, and digital healthcare systems.

2.3 Assessment of Biomedical Innovation Implementation

The second objective is to assess the factors influencing the translation of biomedical innovations from research and development environments into practical healthcare applications.

The objective also examines barriers involving clinical validation, regulatory approval, patient safety, ethical governance, data privacy, cybersecurity, cost, infrastructure, interoperability, and professional acceptance. Identifying these factors can support the development of responsible and sustainable biomedical innovation frameworks for future healthcare systems.

3. Review of Literature

3.1 Biomedical Engineering and Healthcare Innovation

Biomedical engineering integrates engineering principles with biological and medical sciences to develop technologies that address healthcare challenges. Devices, diagnostic systems, biomaterials, implants, imaging technologies, and rehabilitation systems represent major areas of biomedical engineering innovation.

Langer and Vacanti (1993) established important foundations for tissue engineering, demonstrating the potential of engineering approaches for developing biological substitutes. Ratner and Zhang (2020) further highlighted the importance of biomaterials and biomedical engineering in modern healthcare development. These areas demonstrate how multidisciplinary research can translate scientific principles into practical healthcare technologies.

3.2 Artificial Intelligence and Biomedical Innovation

Artificial intelligence has expanded the analytical capabilities of biomedical systems. AI can support medical imaging, disease prediction, biological-data analysis, drug discovery, and clinical decision support. Rajkomar, Dean, and Kohane (2019) emphasized the growing role of machine learning in

medicine, while Yu, Beam, and Kohane (2018) described AI as an important component of emerging healthcare transformation.

AI-enabled biomedical innovation requires careful attention to data quality, model validation, explainability, bias, and clinical applicability. Computational performance alone cannot establish clinical usefulness. Effective innovation requires collaboration between technology developers and healthcare professionals.

3.3 Regenerative Medicine and Precision Healthcare

Regenerative medicine combines biological science, tissue engineering, biomaterials, and cellular approaches to develop potential solutions for tissue damage and disease. Tissue engineering has created opportunities for developing engineered biological structures, while precision medicine emphasizes the use of individual biological and clinical information to guide healthcare decisions.

Collins and Varmus (2015) discussed the potential of precision medicine to transform healthcare through more individualized approaches. Regenerative and personalized technologies remain developing fields and require extensive clinical validation. Their future contribution will depend on scientific advancement, regulatory frameworks, manufacturing capacity, ethical considerations, and equitable access.

4. Research Methodology

4.1 Research Design

This study adopts a conceptual and literature-based research design to examine biomedical innovation frameworks for future healthcare development. The research focuses on biomedical engineering, artificial intelligence, biosensors, wearable technologies, medical devices, precision medicine, regenerative medicine, tissue engineering, and digital biomedical systems.

A descriptive and analytical approach is used to organize existing academic knowledge into major innovation themes. The study does not introduce fabricated laboratory experiments, patient datasets, clinical measurements, or experimental outcomes. Instead, it synthesizes existing scholarly perspectives to identify technological opportunities, healthcare applications, implementation requirements, and challenges associated with future biomedical innovation.

4.2 Literature Collection and Organization

The literature was conceptually organized around major biomedical innovation areas, including biomedical devices, diagnostic technologies, biosensors, artificial intelligence, precision medicine, tissue engineering, regenerative medicine, digital biomarkers, wearable systems, and computational healthcare.

The reviewed literature was categorized according to technological function, healthcare application, innovation stage, clinical relevance, and implementation requirement. Particular attention was given to the relationship between scientific discovery and healthcare application. This organization supported a structured assessment of how emerging biomedical technologies may contribute to future healthcare development.

4.3 Analytical Framework

The biomedical innovation framework evaluates future healthcare technologies through the following dimensions:

- **Scientific Discovery:** Identification of biological, medical, or engineering knowledge that can address healthcare challenges.
- **Technology Development:** Conversion of scientific findings into biomedical devices, systems, materials, algorithms, or therapeutic technologies.
- **Prototype Development:** Creation and technical evaluation of biomedical solutions.
- **Preclinical Validation:** Assessment of safety, functionality, biological compatibility, and performance.
- **Clinical Validation:** Evaluation of healthcare effectiveness and clinical relevance.
- **Regulatory Assessment:** Compliance with relevant safety, quality, and regulatory requirements.
- **Healthcare Integration:** Incorporation into clinical workflows and healthcare infrastructure.
- **Patient-Centered Implementation:** Consideration of patient preferences, accessibility, safety, usability, and outcomes.
- **Continuous Innovation:** Monitoring performance and improving technologies according to emerging evidence and healthcare requirements.

4.4 Data Analysis Approach

A thematic analytical approach was used to synthesize literature on biomedical innovation and future healthcare development. The analysis identified recurring themes related to emerging technologies, healthcare applications, innovation pathways, clinical translation, and implementation barriers.

The identified themes were organized into scientific, technological, clinical, regulatory, ethical, economic, and organizational dimensions. Comparative interpretation was used to examine how different biomedical innovations contribute to diagnosis, treatment, monitoring, prevention, and personalized healthcare. Particular attention was given to safety, validation, interoperability, sustainability, accessibility, and multidisciplinary collaboration.

5. Analysis

5.1 Major Biomedical Innovation Domains

Biomedical innovation encompasses diverse technologies that address different healthcare requirements. Artificial intelligence supports computational analysis, biosensors facilitate physiological and biochemical monitoring, and advanced medical devices provide diagnostic or therapeutic capabilities.

Tissue engineering and regenerative medicine explore biological approaches for restoring damaged tissues, while precision medicine uses individual characteristics to support personalized healthcare. This section summarizes major biomedical innovation domains and their potential healthcare contributions.

Table 1: Major Biomedical Innovation Domains and Healthcare Applications

Innovation Domain	Core Technology	Potential Healthcare Application
Artificial Intelligence	Machine Learning and Deep Learning	Diagnosis and prediction
Biosensors	Biochemical and Physiological Sensing	Health monitoring
Wearable Technologies	Connected Sensors	Continuous monitoring
Medical Imaging	Advanced Computational Imaging	Disease detection
Precision Medicine	Individualized Biological Data	Personalized treatment
Tissue Engineering	Biomaterials and Cell-Based Approaches	Tissue regeneration
Regenerative Medicine	Cellular and Biological Technologies	Restoration of damaged tissue
Medical Robotics	Robotic Engineering	Surgical and rehabilitation support
Digital Biomarkers	Computational Health Indicators	Disease monitoring
Smart Medical Devices	Embedded Intelligence	Diagnosis and treatment support

Interpretation: demonstrates the broad scope of biomedical innovation and its potential contribution to future healthcare. AI can support diagnosis and prediction, while biosensors and wearable systems facilitate continuous monitoring. Advanced imaging technologies can improve detection and analysis of medical abnormalities.

Precision medicine supports individualized healthcare strategies, whereas tissue engineering and regenerative medicine explore biological restoration. Medical robotics can assist surgical and rehabilitation activities, while digital biomarkers provide computational indicators of health conditions.

5.2 Biomedical Innovation Across the Healthcare Lifecycle

Biomedical innovation can contribute throughout the healthcare lifecycle, beginning with prevention and screening and extending through diagnosis, treatment, rehabilitation, and long-term monitoring. AI-enabled predictive systems can identify potential risks, while advanced diagnostics can support earlier

disease identification. Intelligent devices and remote monitoring systems can assist treatment management and follow-up. presents biomedical innovation applications across different healthcare stages.

Table 2: Biomedical Innovation Applications Across Healthcare Stages

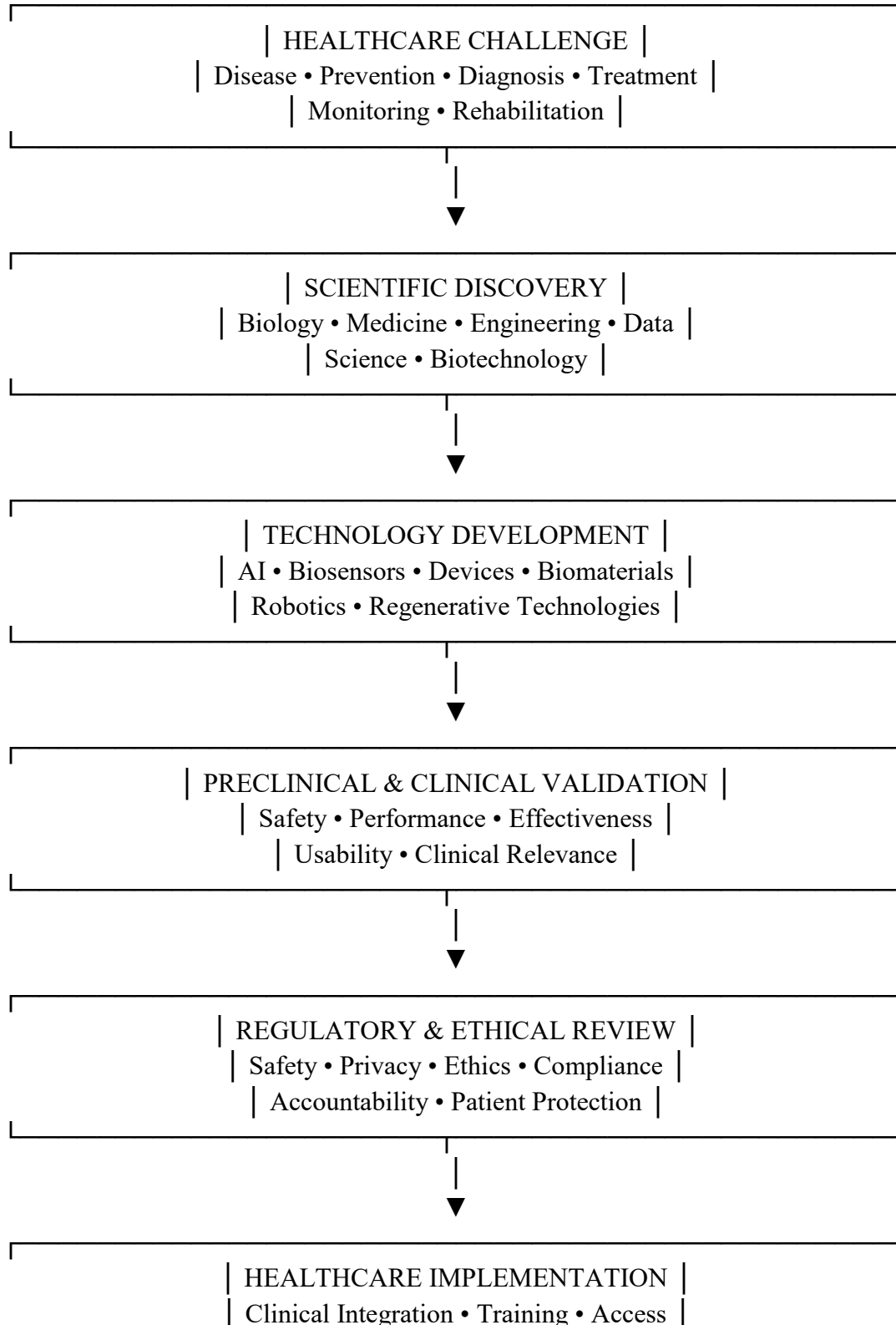
Healthcare Stage	Biomedical Innovation	Potential Contribution
Prevention	Digital Health and Wearables	Health-risk awareness
Screening	AI and Biosensors	Early identification
Diagnosis	Medical Imaging and AI	Diagnostic support
Treatment	Smart Medical Devices	Targeted intervention
Drug Development	Computational Biology	Therapeutic discovery
Rehabilitation	Medical Robotics	Functional recovery
Monitoring	Wearables and Remote Sensors	Continuous observation
Personalized Care	Precision Medicine	Individualized management
Regeneration	Tissue Engineering	Tissue restoration
Long-Term Care	Intelligent Platforms	Continuous care support

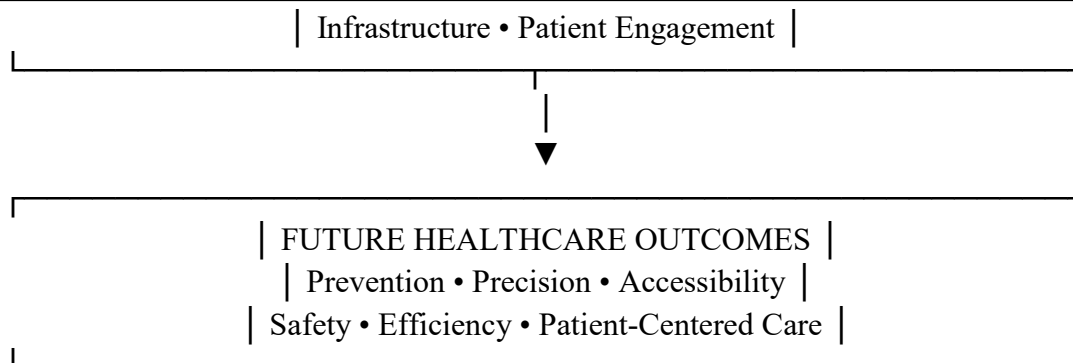
Interpretation: indicates that biomedical innovation can support nearly every stage of healthcare delivery. Digital health technologies and wearable systems can contribute to prevention and health awareness, while AI and biosensors can strengthen screening. Medical imaging and intelligent analytics can support diagnosis, and smart medical devices can facilitate targeted treatment. Computational biology can accelerate aspects of therapeutic discovery.

Robotics can assist rehabilitation, while wearable and remote sensors support continuous monitoring. Precision medicine enables individualized management, and regenerative technologies offer possibilities for tissue restoration. Integrated biomedical innovation can therefore contribute to a more continuous and personalized healthcare lifecycle.

5.3 Biomedical Innovation Development Framework

Figure 1: Framework for Future Biomedical Innovation and Healthcare Development





Interpretation: The framework illustrates biomedical innovation as a continuous pathway connecting healthcare challenges with scientific discovery, technology development, validation, governance, and clinical implementation. Biomedical technologies should undergo technical, preclinical, and clinical evaluation before broader healthcare adoption.

Regulatory and ethical review provides additional safeguards related to safety, privacy, accountability, and patient protection. Implementation requires appropriate infrastructure, professional training, and patient engagement. The final objective is to translate biomedical innovation into meaningful healthcare outcomes involving improved prevention, precision, accessibility, safety, efficiency, and patient-centered care. Continuous feedback can support further technological refinement.

6. Discussion

6.1 Convergence of Biomedical Engineering and Digital Intelligence

The future of biomedical innovation is increasingly characterized by convergence between biomedical engineering and digital intelligence. AI, embedded computing, advanced sensors, and connected medical devices can transform conventional biomedical technologies into intelligent systems. Such convergence can enable real-time data analysis, predictive monitoring, automated pattern recognition, and personalized healthcare support.

The integration of computational and biomedical technologies also creates opportunities for more adaptive healthcare systems. Intelligent devices can potentially respond to changing physiological information, while AI can analyze complex biological datasets. Nevertheless, technological complexity should not be pursued independently of clinical requirements. Successful innovation requires evidence demonstrating safety, reliability, usability, and meaningful clinical value.

6.2 Personalized and Regenerative Healthcare

Precision medicine and regenerative medicine represent two important directions for future biomedical development. Precision approaches seek to use individual biological, genetic, environmental, and clinical characteristics to support more targeted healthcare decisions. Regenerative approaches aim to restore or replace damaged tissues through combinations of cells, biomaterials, and engineering techniques.

These fields may significantly influence future treatment models, but substantial scientific and translational challenges remain. Personalized systems require reliable biological and clinical information, while regenerative technologies require careful assessment of biological safety, long-term

outcomes, manufacturing processes, and regulatory requirements. Continued multidisciplinary research is essential for translating promising innovations into clinically appropriate applications.

6.3 Translation, Regulation, and Patient-Centered Innovation

Biomedical innovation must successfully move from laboratory research to clinical implementation before its healthcare value can be fully realized. Translational challenges can arise from differences between experimental environments and real-world clinical settings. Regulatory requirements, manufacturing consistency, safety evaluation, clinical evidence, and healthcare workflow integration can influence whether an innovation becomes practically useful.

Patient-centered innovation should therefore remain central to biomedical development. Technologies should be evaluated according to patient safety, usability, accessibility, affordability, and meaningful outcomes. Researchers and developers should collaborate with healthcare professionals and patients during the innovation process. This approach can reduce the gap between technological capability and practical healthcare needs while promoting responsible adoption.

7. Challenges

7.1 Clinical Validation and Translational Barriers

Biomedical technologies often require extensive validation before they can be implemented in routine healthcare. Promising laboratory results may not necessarily translate into equivalent clinical performance because real-world patients, healthcare environments, and operating conditions are highly variable.

Clinical validation should assess safety, reliability, effectiveness, usability, and long-term performance. Developers must also consider manufacturing consistency and compatibility with healthcare workflows. Collaboration among researchers, clinicians, engineers, and regulatory experts can improve translation.

Longitudinal evidence is particularly important for technologies involving implants, regenerative medicine, intelligent devices, and continuously learning systems. Strong translational frameworks can reduce the gap between scientific discovery and practical clinical adoption.

7.2 Regulatory and Ethical Complexity

Biomedical innovation operates within complex regulatory and ethical environments because technologies can directly affect patient safety and health outcomes. Medical devices, biological products, AI-enabled systems, implants, and regenerative technologies may require different forms of assessment and oversight.

Ethical issues may involve informed consent, privacy, data ownership, algorithmic bias, patient autonomy, and equitable access. Developers should incorporate ethical and regulatory considerations throughout the innovation lifecycle rather than addressing them only before commercialization.

Transparent documentation, appropriate testing, risk assessment, and accountability mechanisms can strengthen responsible biomedical innovation and protect patients.

7.3 Cost and Accessibility

Advanced biomedical technologies may involve substantial research, manufacturing, infrastructure, maintenance, and training costs. Expensive technologies may initially be available only to well-resourced healthcare institutions or populations, potentially increasing disparities in access.

Future innovation should therefore consider affordability and scalability alongside technical performance. Modular technologies, efficient manufacturing, shared infrastructure, and appropriate public-private collaboration may help reduce implementation barriers.

Policymakers and healthcare organizations should evaluate the broader socioeconomic implications of biomedical innovation. Equitable access should remain an important objective so that technological progress contributes to broader healthcare improvement rather than creating additional inequalities.

7.4 Data Security and Interoperability

Modern biomedical technologies increasingly generate and exchange large volumes of health and biological information. Connected medical devices, AI systems, wearable technologies, and digital biomarkers may operate across multiple platforms. Fragmented data structures can limit interoperability, while cybersecurity vulnerabilities may expose sensitive information.

Secure data architectures, appropriate authentication, encryption, access controls, and standardized information exchange mechanisms are necessary. Biomedical systems should be designed with security and interoperability from the beginning. Continuous monitoring is also required to identify technical failures, unauthorized access, and data-quality problems. Effective information governance can support both innovation and patient protection.

8. Future Research

Future research should focus on integrated biomedical innovation platforms combining AI, advanced biosensors, wearable technologies, medical imaging, computational biology, and intelligent medical devices. Such systems could support continuous and personalized healthcare by integrating multiple sources of biological and clinical information. Research should examine how multimodal biomedical information can be combined without compromising data quality, privacy, interoperability, or patient autonomy.

Further research should investigate precision medicine, regenerative medicine, tissue engineering, digital biomarkers, medical robotics, intelligent implants, advanced biomaterials, and AI-enabled biomedical diagnostics. Special attention should be given to the clinical translation of emerging technologies. Research should establish reliable evaluation methods for safety, effectiveness, usability, long-term performance, and patient outcomes. Multidisciplinary research teams can strengthen connections between laboratory science, engineering development, and clinical implementation.

Future empirical research should evaluate biomedical innovations across diverse healthcare settings and patient populations. Studies should examine cost-effectiveness, accessibility, clinical workflow integration, professional acceptance, patient experience, and health outcomes. Longitudinal studies are particularly important for technologies whose benefits or risks emerge over extended periods.

Research should also examine regulatory models capable of responding to rapidly evolving biomedical technologies while maintaining patient safety and ethical accountability.

9. Conclusion

Biomedical innovation provides a foundation for future healthcare development by integrating engineering, biotechnology, artificial intelligence, computational science, and medical research. Emerging technologies such as intelligent medical devices, biosensors, wearable systems, advanced imaging, precision medicine, tissue engineering, regenerative medicine, medical robotics, and digital biomarkers can contribute to prevention, diagnosis, treatment, monitoring, and rehabilitation.

The analysis demonstrates that biomedical innovation can influence multiple stages of the healthcare lifecycle. AI can support predictive analysis and diagnostic interpretation, biosensors can enable health monitoring, precision medicine can facilitate individualized care, and regenerative technologies can provide new possibilities for tissue restoration. The convergence of these technologies may support a transition toward more proactive, personalized, and data-informed healthcare systems.

However, technological advancement must be accompanied by rigorous clinical validation, regulatory compliance, ethical governance, cybersecurity, interoperability, affordability, and accessibility. Biomedical innovations that perform effectively in controlled research environments may encounter significant barriers during clinical implementation. Therefore, translational research and multidisciplinary collaboration are essential for converting scientific discoveries into practical healthcare solutions.

Overall, effective biomedical innovation frameworks should connect scientific discovery, engineering development, validation, regulatory assessment, clinical implementation, and continuous improvement. Patient safety and patient-centered outcomes should remain central throughout this process. Future biomedical healthcare systems will benefit from innovations that are not only technically advanced but also clinically meaningful, ethically responsible, economically sustainable, and accessible to diverse populations.

References

1. Topol, E. J. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nature Medicine*, 25, 44–56. <https://doi.org/10.1038/s41591-018-0300-7>
2. Dzau, V. J., Balatbat, C. A., & Alexander, M. (2016). Translational research and implementation science: A bridge to improve health. *The Lancet*, 387(10024), 1449–1455.
3. Woolf, S. H. (2008). The meaning of translational research and why it matters. *JAMA*, 299(2), 211–213. <https://doi.org/10.1001/jama.2007.26>
4. Zerhouni, E. A. (2005). Translational and clinical science—Time for a new vision. *New England Journal of Medicine*, 353(15), 1621–1623. <https://doi.org/10.1056/NEJMs053723>
5. Marjanovic, S. (2020). Innovating for improved healthcare: Sociotechnical and innovation systems perspectives and lessons from the NHS. *Science and Public Policy*, 47(2), 283–297. <https://doi.org/10.1093/scipol/scaa005>

6. Wang, X., Zhang, S., Liu, Y., Du, J., & Huang, H. (2021). How pharmaceutical innovation evolves: The path from science to technological development to marketable drugs. *Technological Forecasting and Social Change*, 167, 120698. <https://doi.org/10.1016/j.techfore.2021.120698>
7. Esdaille, C. J., Washington, K. S., & Laurencin, C. T. (2021). Regenerative engineering: A review of recent advances and future directions. *Regenerative Medicine*, 16(5), 495–512. <https://doi.org/10.2217/rme-2021-0016>
8. Elisseeff, J., Badylak, S. F., & Boeke, J. D. (2021). Immune and genome engineering as the future of transplantable tissue. *New England Journal of Medicine*, 385(26), 2451–2462. <https://doi.org/10.1056/NEJMra1913421>
9. Waters, S. L., Schumacher, L. J., & El Haj, A. J. (2021). Regenerative medicine meets mathematical modelling: Developing symbiotic relationships. *npj Regenerative Medicine*, 6, 24. <https://doi.org/10.1038/s41536-021-00134-2>
10. Chang, S. E., & Chen, Y. C. (2020). Blockchain in health care innovation: Literature review and case study from a business ecosystem perspective. *Journal of Medical Internet Research*, 22(8), e19480. <https://doi.org/10.2196/19480>
11. Ashrafian, H., Patel, V. M., Varatharajan, L., et al. (2020). Are disruptive innovations recognised in the healthcare literature? A systematic review. *BMJ Innovations*, 7(1), 208–216. <https://doi.org/10.1136/bmjinnov-2020-000424>
12. Stephanie, L., & Sharma, R. S. (2020). Digital health eco-systems: An epochal review of practice-oriented research. *International Journal of Information Management*, 53, 102032. <https://doi.org/10.1016/j.ijinfomgt.2019.10.017>
13. Maroto-Martínez, M., et al. (2020). Innovation ecosystems in health: Countries and theoretical models. *F1000Research*, 11, 1458.
14. World Health Organization, World Intellectual Property Organization, & World Trade Organization. (2020). *Promoting access to medical technologies and innovation: Intersections between public health, intellectual property and trade* (2nd ed.). World Health Organization.
15. Lander, E. S. (2016). The Heroes of CRISPR. *Cell*, 164(1–2), 18–28. <https://doi.org/10.1016/j.cell.2015.12.041>
16. Fitzgerald, G. A. (2019). Cardiovascular innovation: From bench to bedside. *Circulation Research*, 124(2), 177–180.
17. Dincer, C., Bruch, R., Costa-Rama, E., Fernández-Abedul, M. T., Merkoçi, A., Manz, A., Urban, G. A., & Güder, F. (2019). Disposable sensors in diagnostics, food, and environmental monitoring. *Advanced Materials*, 31(30), 1806739. <https://doi.org/10.1002/adma.201806739>
18. Murphy, S. V., & Atala, A. (2014). 3D bioprinting of tissues and organs. *Nature Biotechnology*, 32, 773–785. <https://doi.org/10.1038/nbt.2958>
19. Langer, R., & Vacanti, J. P. (1993). Tissue engineering. *Science*, 260(5110), 920–926. <https://doi.org/10.1126/science.8493529>
20. Porter, M. E., & Teisberg, E. O. (2006). *Redefining health care: Creating value-based competition on results*. Harvard Business School Press.