DOI https://doi.org/10.30525/978-9934-26-446-7-17

MODERN TRENDS OF SCIENTIFIC RESEARCH IN IMPROVING HEALTHCARE

СУЧАСНІ ТЕНДЕНЦІЇ НАУКОВИХ ДОСЛІДЖЕНЬ У ВДОСКОНАЛЕННІ ОХОРОНИ ЗДОРОВ'Я

Kolesnikov E. B.
Doctor of Medical Sciences, Professor,
Professor at the Department of General and Emergency Surgery

Kryzhevskiy V. V.
Doctor of Medical Sciences, Professor,
Head of the Department of General and Emergency Surgery
Shupyk National University of Healthcare of Ukraine
Kyiv, Ukraine

Scientific research in medicine is constantly evolving due to technological advances, a better understanding of biological systems, and the growing need for more effective treatments and health care strategies. Some of the most prominent current trends in medical research include: precision medicine, immunotherapy for malignant diseases, the latest gene editing technologies, regenerative medicine using stem cells, real-time health monitoring with the possibility of early disease detection, telemedicine and artificial intelligence.

Moving beyond a one-size-fits-all approach, precision medicine tailors' treatment plans to individual patients based on genetic, biomarker, and phenotypic data. This approach aims to optimize medical care to each person's unique disease pathogenesis and lifestyle. President Obama has launched the Precision Medicine Initiative (PMI) – a bold new research effort to revolutionize how we improve health and treat disease. The PMI is collective work of the society to enable a new era of medicine through research, technology, and policies that empower patients, researchers, and providers to work together toward development of individualized care. Precision medicine is the intersection between people, their environment, changes in their markers of health and illness and social and behavioral factors. Precision medicine looks at factors that make up individuals and populations and how these factors change and interact over time. Examples of precision medicine, also called personalized medicine, include using targeted therapies to treat specific types of cancer cells, such as HER2-positive breast cancer cells, or using tumor marker testing to help diagnose cancer. Precision medicine has been put to best use in the COVID-19

pandemic through use of various biomarkers such as IL-6 and c-reactive protein in assessing severity of disease, for development of various therapies and also to judge efficacy of vaccines.

The Precision Medicine Initiative is a long-term research endeavor, involving the National Institutes of Health (NIH) and multiple other research centers, which aims to understand how a person's genetics, environment, and lifestyle can help determine the best approach to prevent or treat disease. The Precision Medicine Initiative has both short-term and long-term goals. The short-term goals involve expanding precision medicine in the area of cancer research. Researchers at the National Cancer Institute (NCI) hope to use an increased knowledge of the genetics and biology of cancer to find new, more effective treatments for various forms of this disease. The long-term goals of the Precision Medicine Initiative focus on bringing precision medicine to all areas of health and healthcare on a large scale. To this end, the NIH has launched a study, known as the All of Us Research Program, which involves a group (cohort) of at least 1 million volunteers from around the United States. Participants are providing genetic data, biological samples, and other information about their health. To encourage open data sharing, participants can access their health information, as well as research that uses their data, during the study. Researchers can use these data to study a large range of diseases, with the goals of better predicting disease risk, understanding how diseases occur, and finding improved diagnosis and treatment strategies [1, 2, p. 2].

Another modern trend of scientific research is immunotherapy. Particularly in the field of oncology, immunotherapy has emerged as a powerful method for treating cancer. It involves harnessing the body's immune system to fight cancer cells, with significant research focusing on checkpoint inhibitors, CAR-T cell therapies, and cancer vaccines. Multiple myeloma (MM) remains largely incurable, indicating a need for new treatment approaches. Chimeric antigen receptor (CAR) T cell therapy works by mechanisms distinct from those of other MM therapies and involves the modification of patient or donor T cells to target specific cell-surface antigens. B cell maturation antigen (BCMA) is expressed only on plasma cells, a small subset of B cells and MM cells, which makes it a suitable target antigen for such therapies [3, p. 2]. Purpose Therapies with novel mechanisms of action are needed for multiple myeloma (MM). T cells can be genetically modified to express chimeric antigen receptors (CARs), which are artificial proteins that target T cells to antigens [4, p. 3].

Gene-editing technologies have revolutionized genetic research by allowing scientists to edit parts of the genome by removing, adding, or altering sections of the DNA sequence. CRISPR (clustered regularly interspaced short palindromic repeats) and other gene-editing technologies are modern trends of scientific research in improving healthcare in the

country. This is critical not only for potential cures for genetic disorders but also for wider applications in treating infectious diseases, improving crop resistance, and more. Genome editing using clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR-associated protein 9 (Cas9) predominantly induces non-homologous end joining, which generates random insertions or deletions, whereas homology-directed repair, which generates precise recombination products, is useful for wider applications. Targeted nucleases have provided researchers with the ability to manipulate virtually any genomic sequence, enabling the facile creation of isogenic cell lines and animal models for the study of human disease, and promoting exciting new possibilities for human gene therapy In particular, the ease with which CRISPR-Cas9 and TALENs can be configured to recognize new genomic sequences has driven a revolution in genome editing that has accelerated scientific breakthroughs and discoveries in disciplines as diverse as synthetic biology, human gene therapy, disease modeling, drug discovery, neuroscience, and the agricultural sciences [5, p. 3].

Artificial Intelligence (AI) in healthcare is increasingly being applied to diagnose diseases more accurately, develop drugs faster, customize patient treatments, and predict patient outcomes. AI is also being used extensively in processing and analyzing the vast amounts of data generated by biomedical research. The impact of AI is observed in detecting clinical conditions in medical imaging and diagnostic services, controlling the outbreak of coronavirus disease 2019 with early diagnosis, providing virtual patient care using AI-powered tools, managing electronic health records, augmenting patient engagement and compliance with the treatment plan, reducing the administrative workload of healthcare professionals, discovering new drugs and vaccines, spotting medical prescription errors, extensive data storage and analysis, and technology-assisted rehabilitation [6, p. 4].

The field of Regenerative Medicine includes stem cell research and organ regeneration. Organ and tissue loss through disease and injury motivate the development of therapies that can regenerate tissues and decrease reliance on transplantations. Regenerative medicine, an interdisciplinary field that applies engineering and life science principles to promote regeneration, can potentially restore diseased and injured tissues and whole organs. Since the inception of the field several decades ago, a number of regenerative medicine therapies, including those designed for wound healing and orthopedics applications, have received Food and Drug Administration (FDA) approval and are now commercially available. Scientists are working on methods to generate tissues and organs in the lab, which can be used to repair or replace damaged areas in the body, offering new hope for chronic diseases and injuries [7, p. 4].

Telemedicine and digital health another important trend of contemporary medicine. Accelerated by the COVID-19 pandemic, telemedicine has

become a crucial aspect of healthcare delivery. This trend includes not only virtual doctor visits but also long-term monitoring and management of chronic diseases through digital platforms. Telemedicine can improve the management of patients through digital platforms allowing teleconsultation, telemonitoring or tele-coaching. Intended use involved remote consultation with a doctor, applications to enhance education, self-management, follow-up or adherence to treatment or lifestyle changes. Telemedicine offers innovative perspectives to improve access to care in distant locations and optimize care through patients' empowerment and personalized follow-up, contributing to the development of precision medicine. More efforts remain necessary for its implementation in daily clinical practice and involve ethical, legal, technical, economic and cultural considerations [8, p. 5].

The development of wearable devices that can continuously monitor health indicators such as heart rate, glucose levels, and sleep patterns is a significant trend. This technology is integral for real-time health monitoring and early disease detection. There is growing research focused on understanding the human microbiome's role in health and disease. This research aims to uncover how microorganisms contribute to conditions like inflammatory bowel disease, diabetes, and even mental health disorders, paving the way for microbiome-based therapies. As populations age globally, there is an increased focus on diseases such as Alzheimer’s and Parkinson’s. Research is focusing on understanding the pathological mechanisms of these diseases, identifying biomarkers for early diagnosis, and developing novel therapeutic strategies. With the recent experiences of the COVID-19 pandemic, there is renewed interest in epidemiology, vaccine development, and strategies to combat antimicrobial resistance. The focus is not only on treatment but also on prevention strategies, including vaccine development and deployment.

These trends reflect a broad spectrum of advancements that aim to address both persistent health challenges and emerging global threats, illustrating the dynamic nature of medical research in striving for improved global health outcomes. Some of the most prominent current trends in medical research include precision medicine, immunotherapy, gene editing technologies, regenerative medicine with stem cells, telemedicine and real-time health monitoring using AI technologies with the possibility of early disease detection, prediction outcomes and precision medicine.

References:

1. What is the Precision Medicine Initiative? MedlinePlus 25, National Library of Medicine, 2024 URL: https://medlineplus.gov/genetics/understanding/precisionmedicine/initiative/

2. The Precision Medicine Initiative, NIH, 2024 URL: https://www.nih.gov/sites/default/files/research-training/initiatives/pmi/pmi-infographic

3. Lekha Mikkilineni, James N KochenderferCAR T cell therapies for patients with multiple myeloma. *Nat Rev Clin Oncol*. 2021 Feb;18(2):71-84. doi: 10.1038/s41571-020-0427-6

4. Jennifer N Brudno, Irina Maric, Steven D Hartman, et all. T Cells Genetically Modified to Express an Anti-B-Cell Maturation Antigen Chimeric Antigen Receptor Cause Remissions of Poor-Prognosis Relapsed Multiple Myeloma. *J Clin Oncol.* 2018 Aug 1;36(22):2267–2280. doi: 10.1200/JCO.2018.77.8084

5. Thomas Gaj, Shannon J. Sirk, Sai-lan Shui, and Jia Liu Genome-Editing Technologies: Principles and Applications Cold Spring Harb Perspect Biol. 2016 Dec; 8(12): a023754. doi: 10.1101/cshperspect.a 023754

6. Ahmed Al Kuwaiti, Khalid Nazer, Abdullah Al-Reedy A Review of the Role of Artificial Intelligence in Healthcare. *J Pers Med*. 2023 Jun 5;13(6):951. doi: 10.3390/jpm13060951.

7. Angelo S. Maoa, David J. Mooneya Regenerative medicine: Current therapies and future directions Proc Natl Acad Sci U S A. 2015 Nov 24; 112(47): 14452–14459. doi: 10.1073/pnas.1508520112

8. Fabien Lareyre, Hava Chaptoukaev, Sharon C Kiang Telemedicine and Digital Health Applications in Vascular Surgery. *J Clin Med*. 2022 Oct 13;11(20):6047. DOI: 10.3390/jcm11206047