

Advanced technology eliminates most cardiovascular disease, fundamentally changes health delivery, and creates superlongevity

Forecasts:

- In 2039 biomarkers detect disease risks and targeted therapies often prevent the development of cardiovascular and other diseases.
- Bioengineering is used to create replacement organs and directed combinations of humeral agents stimulate the body to rebuild damaged hearts and brains.
- Health Advocate Avatars support self-care, disease management, and community health.
- Those with access to advanced technologies can expect a healthy life beyond 120 years.
- Neurotechnology enhances learning, skills and sensory acuity besides effectively managing the toughest mental health disorders.

During the three decades leading to 2039, synergistic collaborative research efforts between biological, physical, and social sciences has fostered dramatic advances and the proliferation of new technologies. Western science and Eastern wisdom came together to create a deep understanding of biology and humanity. Academia, government and business collaborated to share intellectual property and to translate this knowledge into new diagnostics and therapeutics.

Examples of major accomplishments:

1. There is a comprehensive understanding of health and disease at the genetic and cellular levels, including the strong influence of social and environmental interactions on cellular function, leading to advanced prevention and therapeutics.
 - **Prospective Medicine** is the use of genetic, proteomic and other profiles to forecast risk so that personalized preventive interventions can either prevent the disease or manage it at a pre-disease phase.
 - **Personalized Medicine** is the selection of the best therapies for the unique characteristics of the individual's disease and pharmacogenomics (differences in a body's drug metabolism).
2. A plethora of biomonitoring devices are available for early detection, diagnosis, therapeutic decisions, follow-up, prognosis, home self-management and environmental monitoring.
 - Simple noninvasive biomarker tests, such as a rapid saliva test for breast cancer screening, are available for community health and self-care. Point-of-care modular diagnostic provide immediate results for intervention while the patient is being seen.
 - **Ubiquitous biomonitoring** devices embedded in clothing or placed in rooms automatically monitor the health status of patients and keep track of the elderly living independently. Remote environmental sensors monitor for public health risks.
3. Imaging technologies can investigate inside individual cells and simple handheld devices make rapid diagnoses at the point-of-care anywhere.
 - Nanomolecules for imaging the location of cancer, also deliver powerful therapies directly into cancer cells, and confirm that that the tumor is destroyed.

4. Many classes of innovative therapeutics are used for personalized prevention and treatment of almost all known diseases.
 - Biology is controlled in sophisticated ways for effective gene therapies; stem cells and targeted humeral engineering stimulate the body to repair or build new tissues.
5. Smart agents and robotic assistive devices support care providers, allow patients to self-manage health at home, and ensure safe elder independent living.
 - Robotic arms provide normal dexterity and exoskeletons return function to quadriplegics.
6. Powerful knowledge tools such as grid computing, comprehensive databases and intelligent agents convert huge amounts of data into knowledge and disseminate it in useful ways to researchers, clinicians, patients, policy makers and consumers.
 - Ubiquitous biomonitoring combined with personal health records provide vast amounts of privacy-protected data for real-time research on the health status and effects of medical interventions. Powerful digital agents continuously analyze this to provide real evidence-based medicine and effectively manage health delivery systems with maximal efficiency.
 - **The Health Advocate Avatar** is a knowledge interface that can mediate interactions between individuals and the vast store of medical knowledge in a personalized and ethical way through voice recognition, haptic devices and high resolution displays. The Avatar is a coach, educator, navigator and health manager that tailors interventions to the needs and preferences of the individual health consumer.
7. Advanced materials and nanotechnology are used in precise drugs, durable artificial organs and medical nanodevices.
 - Implants with sensors, adaptive intelligence and a therapy delivery system can automatically and continuously manage a brittle diabetic patient.
 - **"Nanobots"** (intelligent miniscule robo-doctors) circulate throughout the body to assess injuries, repair tissues and fight infections.
8. **Neurotechnology (NT)** is the convergence of nano-info-bio-cogno technologies to restore normal brain function and enhance it. The field grew exponentially over the past two decades due to sophisticated functional imaging, nanowire electrochemical brain probes and brain-computer interfaces. NT is used to improve training through enhanced memory, concentration, emotional intelligence, and wearable brain-interfaced computers for accessing web-based intelligence and downloading specific skills. Sensory enhancement includes bionic eyes, full spectrum hearing and environmental sonar. NT has revolutionized the treatment of post traumatic stress disorder and other challenging psychiatric diseases. On the horizon is the prospect of direct brain-to-brain communication and exchange of "mind-files."

Further Reading:

- Institute for Alternative Futures, *The 2029 Project: Achieving an Ethical Future for Biomedical R&D*, www.altfutures.com/2029.asp
- Institute for Alternative Futures, 2019 Healthcare That Works for All: Science & Technology Base in 2019, www.altfutures.com/2019_Healthcare_That_Works_For_All
- Beane, B., Gingrich, N. and Kerry, J., "How to Take American Health Care from Worst to First", *New York Times*, October 24, 2008.
- L Zhang et. al., "Nanoparticles in Medicine: Therapeutic Applications and Developments", *Clinical Pharmacology & Therapeutics*, Volume 83 Number 5, May 2008. See also: <http://www.nano.gov/>.