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The Next Revolutions In Health Care

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OVERVIEW

Health care costs both governments and businesses trillions of dollars annually. The World Bank reports that an average of 10 percent of global GDP is spent on health each year, and in some countries this figure is even higher – the U.S. spending an average of 17.1 of GDP on health care annually from 2010 to 2013.

The U.S. Center for Disease Control says that about half of all American adults suffer from one or more chronic health conditions, while as much as 70 percent of the U.K. National Health Service's budget goes to treating long-term conditions, according to the Guardian.

Medical breakthroughs that can reduce these costs have the potential to have a much wider impact on the economy than the direct health benefits and economic advantages of a healthier, more productive workforce.

Not all medical revolutions can be predicted – the discovery of antibiotics, one of the most significant medical moments of all time, was famously the result of a happy accident.

So the next big breakthrough could come from nowhere. Yet researchers in labs around the world are seeking to solve some of humanity's biggest health challenges – and many are getting close. From manufactured human organs-on-chips to the Internet of DNA and breakthroughs in stem cell research, we could be on the cusp of a new medical age.

IN DEPTH

Organs-on-chips

Part of the reason that medicine costs so much is that medical research is incredibly time-consuming and expensive. A 2013 Forbes study of 98 pharmaceutical companies found that the average cost of developing a new drug is over $5 billion, largely because 19 out of every 20 drugs in development ends up failing. The process can involve combinations of animal and human testing, with extensive – and expensive – trials needed to determine not only if the drug works, but also if it has any side-effects. Even then, the sample sizes can be too small to learn everything.

First announced as a concept in 2010 and now with working versions up and running, Harvard Univerity's Wyss Institute's organs-on-chips solution is set to revolutionize drug testing, vastly reducing both the cost and the need for animal and human testing. Simply, they are microchips that mimic the architecture and functions of living human organs, lined with real human tissue, enabling real-time observation of the impact of different drugs at a cellular level. The chips can even be linked together to link organs as if in a real body.

This means that drug trials will not only be able to provide far more accurate data, thanks to being able to analyse the impact at a cellular level, but also happen much faster, with significantly less cost. To test a drug using animals is hugely expensive, as they need to be reared, fed, and looked after – and animal responses may not be the same as human ones. To test on humans requires extensive research to find people with the right medical histories and conditions who are willing to take part. With organs-on-chips, scientists can manufacture exactly the conditions they need, in bulk.

Big Data DNA Analysis

In recent years, DNA sequencing has become much cheaper – falling from around $95 million per genome in 2001 to under $5,000 today, and is on track to fall even further, according to the U.S. National Human Genome Research Institute. Where it took 13 years to sequence the first human genome, this can now be done in just half an hour, and is already revolutionising medical treatment.

The real breakthroughs will come from DNA comparison. By searching a DNA database of millions of human genomes to identify other people who share similar DNA and the same medical conditions, scientists will have a better chance of identifying underlying causes of illnesses, and the most promising cure based on how people with similar DNA have responded to treatments in the past.

In an age of increasing cyber risk, there are significant security and privacy concerns with sharing DNA data. Organizations like the Global Alliance for Genomics and Health are working to create standards to both comply with varying privacy laws and facilitate collaboration around the world. But these challenges look set to be overcome in the next one to two years, according to the MIT Technology Review.

Grow your own replacement body parts

The world of stem cell research promises even greater breakthroughs in the world of medical personalization. In 2014 scientists discovered a revolutionary way to create induced pluripotent stem cells – reverting adult stem cells back to their original embryonic state. Having become embryonic, they can then be modified to grow into any type of cell in the body. This means we now have a way to manufacture embryonic stems cells, which could lead to a complete revolution in medical treatment, while also avoiding the controversy surrounding the use of human embryos for research.

The injection of stem cells can give the body's own native repair mechanisms a boost. A recent clinical trial by the University of Utah saw significant improvement in cardiovascular patients, a potentially major advance with cardiovascular disease the world's leading cause of death. Meanwhile, researchers from U.C. Berkeley and the Gladstone Institutes have successfully grown beating human heart cells from stem cells, while others have grown lungs, brain cells and nerves.

This could lead to a world where we can grow replacement organs, blood, skin, muscle and bone from our own cells – a perfect genetic match, so less likely to be rejected by the body. This has led some futurists to predict that we are at the dawn of the age of immortality, replacing worn out body parts with genetically-matched lab-grown alternatives.

TALKING POINTS

"The computing resources needed to handle genome data will soon exceed those of Twitter and YouTube... the computing needs of genomics will be enormous as sequencing costs drop and ever more genomes are analysed. By 2025, between 100 million and 2 billion human genomes could have been sequenced." – Nature

"Over the next five years, there are going to be a lot of strides made in translating stem-cell-based products into commercial use, especially in the scaled-up manufacturing of these products." – Asha Shekaran, biomaterials and cell therapy researcher, A*STAR Bioprocessing Technology Institute

"The next step is developing a truly personalized medicine. A drug can be tested on *your* lung, or *your* brain, not a dog's, or the 'average' person doing a trial." – Don Ingber, Founding Director, the Wyss Institute

"It's what I see as a new era of medicine based on regenerative biology... This will inevitably lead to the possibility of changing our bodies in a way that was previously unimaginable." – Douglas Melton, Thomas Dudley Cabot Professor of Natural Sciences, Harvard University

FURTHER READING

- The Death of Ageing: Will We Soon be Living Forever? – SBS, June 9, 2015
- Disruption In Healthcare Could Be Costly – TechCrunch, August 3, 2015
- Are 'Stem Cell Factories' The Future of Regenerative Medicine? Scientists Eye Possible Breakthrough – International Business Times, July 23, 2015
- A Chip that Mimics Human Organs is the Design of the Year – Wired, June 23, 2015
- Data Analysis: Create a Cloud Commons – Nature, July 8, 2015
- Regenerative Medicine: Historical Roots and Potential Strategies in Modern Medicine – Journal of Microscopy and Ultrastructure, September 2015
- Global Health Care Update – archive of quarterly Aon reports on industry trends

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