

Exponential Trends in Healthcare

A Singularity University
Industry Insights Report

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Introduction

It's not surprising to see the central role that medical technology has come to play in our society today. Technological innovation in both pharmaceuticals and diagnostics is solving health problems the world over, while healthcare itself is a growing portion of most economies. Healthcare currently represents approximately one-sixth of the economy of the USA, and worldwide healthcare spending is estimated to be \$8.7 trillion by 2020. Healthcare is the ultimate inelastic good; people will always be interested in investing more of their money into better outcomes. In addition to the obvious economic realities, the aging cohort of baby boomers provides an enormous incentive for companies to adopt

technologies that will serve this population efficiently, while also discovering treatments for conditions like Parkinson's disease, Alzheimer's disease, and others.

At the same time that we're seeing major advances in terms of what we can cure, medical technology is also grappling with the huge challenge of delivering this care efficiently to the entire globe. Technologies like artificial intelligence (AI), smartphone-peripheral diagnostics, and basic internet access are converging to expand the reach of care, ensuring that the whole of humanity can benefit from these innovations. As more and more healthcare functions and operations are digitized

and automated, they will become democratized worldwide, helping to solve the healthcare concerns of billions.

Here are some of the most exciting trends in healthcare we're monitoring here at Singularity University:



The Genomic Crystal Ball

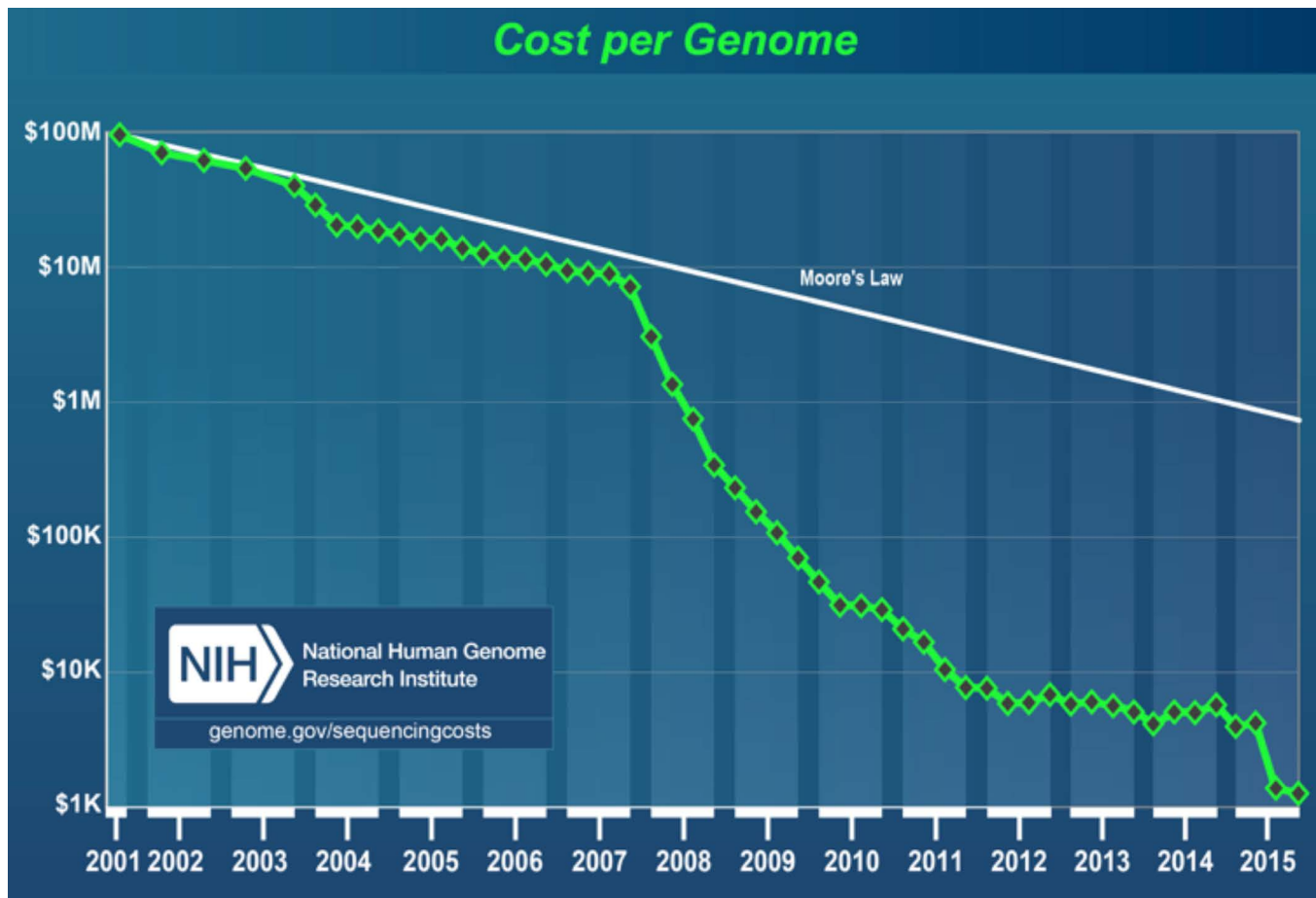
Moore's Law plays a central role in much of Singularity University's vision of the future. The continuing exponential growth in processing power performance (namely, that processing power performance doubles approximately every 18 months) is at some points unbelievable. However, one technology, in particular, is greatly outstripping even the exponential improvements in Moore's Law: genome sequencing.

The ability to completely determine the DNA sequence of a person's genome at a single time has powerful implications for personalized medication and a whole host of other fields, yet was prohibitively expensive when first developed. The original Human Genome Project budgeted at \$3 billion to sequence the first human genome. Fast forward to 2018, when biotech firm Illumina and others are offering a full sequence of the human genome for \$1,000. As the cost performance of this technology continues to improve, the marginal cost of sequencing could fall to mere pennies.

What does this mean for healthcare? Cheap genome sequencing could pave the way for incredibly affordable personalized therapies for individuals, replacing the generalized and cohort-based therapeutic approaches of current

medicine. Genomic sequencing will shift healthcare from a model focusing on treatment of conditions to one of preventing them, as low-priced scans will reveal risk factors that can be ameliorated with inexpensive remedies. For instance, it is much cheaper to avert a potential heart attack in an at-risk individual by prescribing a daily aspirin regimen with lifestyle modifications than it is to perform an artery bypass surgery after the heart attack occurs. In fact, genomics has already been used (in conjunction with AI) to predict whether an individual is likely to suffer from an aortic aneurysm, a particularly fatal heart condition, allowing for preventative therapies and potential interventions in the patient. As our ability to identify at-risk individuals via genomic sequencing grows, preventive and personalized medicine could provide a much more economical healthcare experience, reducing the ballooning healthcare costs seen today.

Genome sequencing will affect every layer of healthcare; pharma, biotechnology, healthcare IT, and medical device industries could all leverage this technology. Additionally, epidemiology could become a big winner if smart devices become data collectors for genomic sequencing. Devices like Oxford Nanopore's MinION DNA and RNA sequencer will greatly multiply the amount of genetic information collected in the most geographically disparate areas, giving genomics new reach in the fight against some of the most intractable illnesses we suffer from today. Eventually, diseases and epidemics could be tracked on a minute level, providing public health boons to our entire society.



Source: genome.gov

Artificial Intelligence Healthcare Revolution

Artificial Intelligence will pervade all facets of society as it continues its exponential development. As healthcare continues to rise in importance in the US and globally, AI will be used to provide more accurate and effective care at lower costs around the world. IBM Watson is one of the best known AIs currently, and it is already being used to find genes linked to amyotrophic lateral sclerosis (ALS or Lou Gehrig's disease), develop new drugs, and provide clinical decision support to assist doctors with diagnoses. This addition of AI augments doctors' abilities to make decisions, increasing the availability and quality of care a patient receives.

At the same time, AI is automating some of the tasks that previously were performed by human specialists, greatly reducing the costs of these actions. For example, AI-based convolutional neural networks are predicted to replace a large portion of the daily work of radiologists. The dramatic developments in computer vision have led to the potential for the bulk of a hospital's radiology department to be completely automated. AIs work unceasingly, at a much lower cost than people, and improve as they gather more data. As AI continues to develop, it could provide the panacea the world needs (in conjunction with cheap genetic sequencing) to curbing the exploding cost of healthcare.

The Doctor Kiosk Will See You Now

As the applications and power of AI continue to develop, people may begin to turn to artificial doctors for their primary care in lieu of family physicians. We are already witnessing the change in primary care with the rise of in-pharmacy clinics (such as CVS Minute Clinics). One can be sure that the CVS Minute Clinic offering will soon evolve as the CVS/Aetna acquisition is completed. People are using Minute Clinics today at a lower cost and instead of Urgent Care or other primary care facilities. This trend of changing primary care will only accelerate as AI doctors are set up as kiosks, providing a similar level of service as a Minute Clinic, but at a much lower cost, and with better performance.

Technology will continue to make this model more attractive, in terms of both price and performance. AIs have a low variable cost, access to the entirety of medical literature, and knowledge of a patient's entire health history in order to make informed decisions. New sensor technology, like electronic nose technology, could give these AI-based primary care providers the ability to ascertain diseases a human doctor could never detect. Israeli startup Breathtec has developed a sensor that can “smell” Parkinson's, multiple sclerosis, Crohn's disease, ulcerative colitis, irritable bowel syndrome, and high blood pressure, as well as ovarian, kidney, and prostate cancers. 3D printing of prescription drugs could also add a pharmacy capability to a medical kiosk. In short, an AI-based kiosk doctor could provide superior primary care at a significantly reduced price, greatly disrupting that avenue of care.

Mobile Computing Penetration and Healthcare

While developed countries will certainly benefit from innovation in healthcare technology, citizens of the most disadvantaged countries in the world will also soon have access to new healthcare tools thanks to the mass adoption of smartphones. Diagnostic tools that are designed as peripherals to smartphones are already being developed and commercialized, and these technologies will ride the wave of exponential adoption of smartphone technology. Senosis Health, a startup purchased by Google in 2017, has one massive overarching goal: to turn smartphones into mobile medical monitoring devices. Senosis provides a suite of applications aiming to ascertain vital medical information such as pulmonary function or hemoglobin levels. This mode of designing medical diagnostic devices that utilize mobile computing power for their function greatly reduces the cost of delivering care, as these smartphone-based solutions don't require nearly as much investment to use.

Mobile phone access continues to grow amongst the globe's poorest citizens, opening the door to exciting diagnostic technological breakthroughs being delivered much more quickly to developing countries. As mobile computing and smartphone usage continue to grow worldwide, and as more and more health applications and cheap smartphone peripherals are developed, life-changing care will be delivered to millions, if not billions, of people worldwide.

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Healthcare has undeniably taken center stage in our society. It represents one-sixth of the economy of the USA and has dominated the US political debate for decades, and this situation is mirrored worldwide as our societies grapple with the questions of how to best allocate healthcare efficiently. Our ability to deliver high-quality care and to cure disease has never been better, but currently, not all people have access to life-changing healthcare interventions, creating torturous choices for our world's poorest citizens.

This is not necessarily a permanent state of affairs, however. Our intense focus on healthcare will eventually converge with the exponential trends that Singularity University views as the key to designing beneficial futures. AI, smartphone proliferation, genomic scanning, and cheap peripheral diagnostic tools will be essential components in our global society's goal to make the huge medical breakthroughs of today and tomorrow accessible to all who need care. In this way, we can ensure that these exponential technologies help to solve the problems of billions.

At Singularity University, we're laying the groundwork for exponential change. With our learning and innovation platform, proven tools and methods, and world-class faculty, Singularity University helps transform companies of all sizes into adaptable organizations that can get out in front of market disruptions and achieve exceptional business results. To learn more about how Singularity University can help your company and leadership team be exponential, visit su.org/futureproof.