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Living longer and healthier lives: A McKinsey perspective

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In the science fiction universe of *Star Trek*, Mr. Spock exhorts those he meets to "live long and prosper," but are these goals mutually exclusive? Recent and expected breakthroughs in medical science have moved such questions from the theoretical to the practical. Modern medicine is allowing mankind to live longer and healthier, but unless broader implications – to the environment and global society generally – are considered, prosperity might prove more elusive.

Humanity stands at the cusp of a healthcare revolution that will eclipse the achievements of past centuries in its speed and impact. Scientific and medical breakthroughs, often pushed by big data analytics, have the potential to increase human life spans significantly while improving the overall quality of life. Medicine is moving quickly from a focus on reacting to disease and injury to one that emphasizes stronger and healthier bodies.

As medical and scientific researchers march forward the broader implications of longer, healthier lives require questioning. Such questions must be considered not to halt or slow progress, but to prepare for and mitigate any harmful consequences. Longer, more active lives will consume more resources – food, water, energy, and space – and supply is not infinite. In addition, the shift requires a different approach to how healthcare is delivered, and businesses and other organizations must operate differently as well. Public health officials, corporate leaders, investors, entrepreneurs, and other stakeholders must grasp the relevance of such concerns to create a sustainable future for healthcare and the planet.

In this paper, we consider some of these longer range implications by first examining advances that have already improved healthcare generally, as well as those on the brink of significant breakthroughs. Second, we consider how best to distribute the benefits of these advances to developing countries so that medical science can deliver the greatest overall impact on longevity and quality of life. And, finally, we examine more broadly, the overall impact of these advances on global sustainability.

Scientific advances enable longer and healthier lives

Over the past two centuries, the average human life span has almost doubled, increasing from less than 40 years in 1800 to a global average of about 70 today. Human longevity was given a sharp boost in the late 19th Century from a better understanding of the role of germs in the spread of disease and, later, the discovery of antibiotics. Safer urban sewage systems, more secure food supplies, and improved education, among other factors, contributed greatly to longer, healthier lives during this period. Humanity, in general, has moved over the past 200 years from a primordial fight for mere survival against external adversaries to an internal battle to manage health and fitness.

Looking forward, modern technology will soon allow us to overcome diseases and conditions considered incurable today (Exhibit 1). For example, regenerative medicine holds the potential to recreate a spinal cord to overcome spinal cord injuries or malfunctions. Advances in the understanding of the human genome and gene therapy are enabling and accelerating the treatment of genetic mutations that was inconceivable only a few years ago. Technologies being developed will enable 3D printing of lungs, hearts, and kidneys to overcome organ failure.

In addition, chronic diseases that are now difficult to manage will be fought with very different methods. For instance, diabetes could be managed using an electronic skin patch that detects glucose levels in sweat and automatically discharges drugs through micro-needles. RNA-based technologies, taking advantage of the body's natural machinery, could lead to treatments that require much less administration, for instance injections only once or twice a year for conditions as commonplace as high cholesterol, in effect creating a cholesterol vaccine. Bioelectronics that selectively stimulate the nervous system are being developed to activate a body's own systems to manage autoimmune and neurological degenerative conditions.

Exhibit 1

Innovations that will support longer lives

Gene therapy

7000 Number of rare diseases without treatment today that could be addressed by genome editing

Regenerative medicine

795 Regenerative medicine therapies in clinical trials for cell, tissue, organ replacement

3D printed organs

20 People die every day waiting for compatible organs for transplant; 3D-printing uses patients' cells

Sensor technology

6-8 months — Innovation cycle for new and improved sensor technology, compared to 3-4 years in the past

Artificial intelligence

40 million — Number of scientific documents IBM Watson can read in 15 seconds to deliver a diagnosis

Robot-assisted surgery

35 percent — Of all surgeries performed will be robot-assisted by 2021

Modern data analytics also help practitioners break from the traditional approach to medical care. A collaboration bringing together insurer WellPoint, the Memorial Sloan Kettering Cancer Center in New York, and IBM, using its Watson computing system, offers a powerful illustration. Sloan Kettering estimates that only 20 percent of the knowledge that physicians use to diagnose a cancer patient and prescribe treatment relies on trial-based evidence. The Watson supercomputer, on the other hand, can sift through millions of pages of medical evidence covering decades of treatment history to provide a diagnosis and treatment options within seconds.

The possibilities from these breakthroughs are wide-ranging. For example, genetic fingerprinting, possibly at birth, could signal a predisposition for specific disorders or syndromes. Constant monitoring through sensors that record vital statistics and biomarkers could provide an early warning of some impending conditions, such as a heart attack or stroke, and treatment could be delivered before the condition is triggered and permanent damage inflicted. Post-treatment behaviors and conditions could be monitored to improve treatment outcomes. Real-time feedback would help ensure that patients are following their regimens and alert them and perhaps medical staff if there are any lapses. Evidence-based medicine, enabled by big data analytics, can reduce the levels of waste resulting from incorrect or incomplete diagnoses.

These innovations will also raise new social and moral challenges that will need to be addressed. For one, there are ethical risks from directly

intervening in the genome. As Siddhartha Mukherjee argues in his recent book, *"The Gene: An Intimate History"*, we cannot be sure that as our ability to correct and coerce our DNA increases, society will show restraint from trying to create superior versions of humans. Second, an older society will have implications on economic productivity and the affordability of western social benefit systems. Our ability to keep people alive might come much earlier than our ability to give older people productive, higher quality lives, and the burden of an ageing society might get exacerbated well beyond the levels seen today.

While it will still take several years for these advancements to reach patients, many are likely to be available sooner rather than later. These advancements could help create healthcare systems that not only react to problems as they appear, but incorporate preventive measures and predictive models that help individuals and health authorities stay ahead of problems before they develop. These advancements will also raise legitimate concerns, which need to be addressed to manage unintended consequences.

Delivering true impact across the globe

Modern healthcare innovations will undoubtedly increase life spans and improve the quality of life for the people they reach. In a practical sense, however, because of costs and infrastructure shortfalls, these advances will likely arrive in the richest parts of the world well before they get to the poorest. But to achieve the greatest impact – for instance, to noticeably extend average life spans globally – modern medicine must find ways to reach into developing economies, overcoming barriers to equitable access.

The benefits of bringing medical innovations to the developing world can be illustrated with simple arithmetic. To increase global life expectancy by five years only by targeting the developed world, the average life span in the richest countries would have to increase by more than 20 years from an average that is already more than 80 years. In contrast, the same result could be accomplished by increasing the average life span in the poorest half of the world by just seven years, from 66 years to 73 years, which would still be much lower than the current average life span in the richest countries.

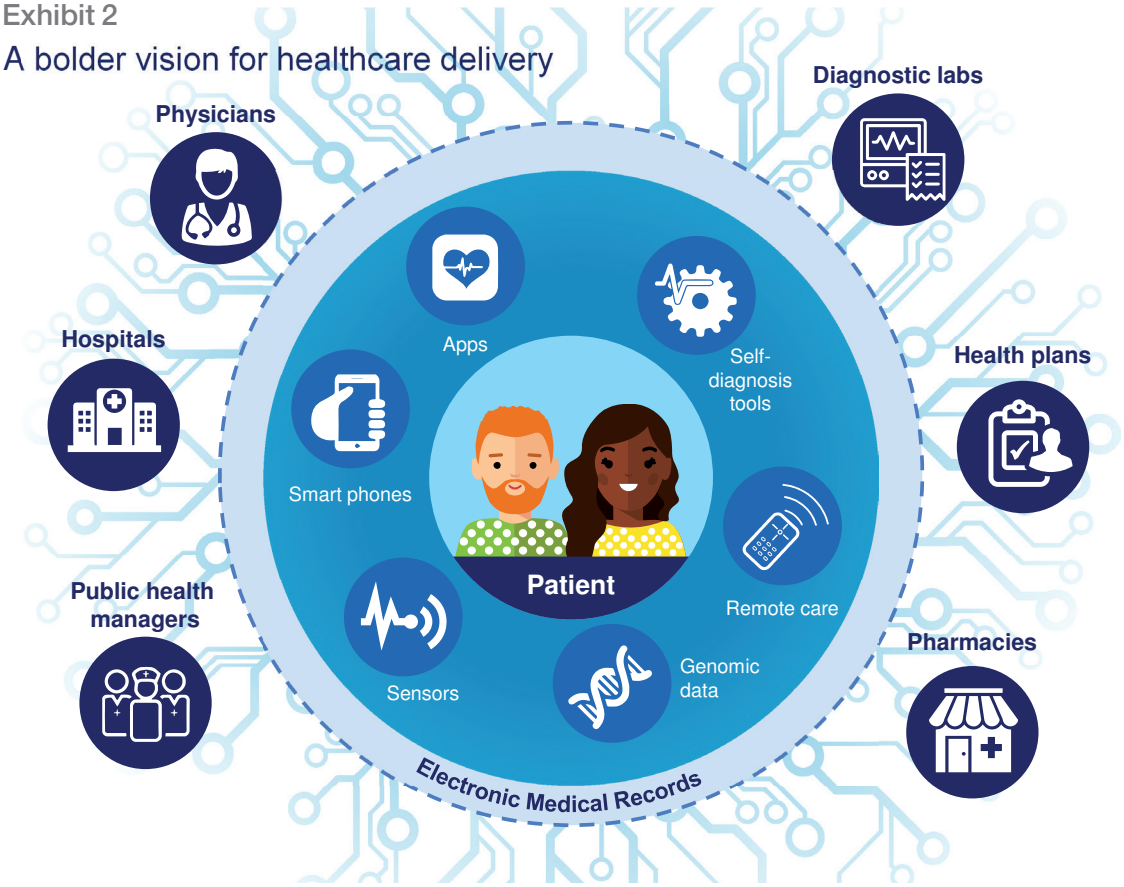
Much of the medical technology needed to address the disease burden in developing economies already exists. Governments are working to make this technology accessible, but many developing countries lack the resources to deliver on their ambitions. For instance, in 2012, there were three physicians for every 10,000 people in Indonesia, a country that has resolved to provide universal health coverage by the end of the decade. This compares to an average of 33 physicians per 10,000 people in member states of the Organisation for Economic Co-operation and Development (OECD). Between 6,000 and 7,000 new physicians are licensed each year in Indonesia, and at this pace OECD standards would not be reached for decades. Similar infrastructure shortfalls are also seen in hospital beds, nurses, diagnostics labs, and elsewhere.

Given these challenges, developing countries will need to create a different model for delivering healthcare than that used in richer nations. In Exhibit 2, we lay out a bolder vision for what this might be. In this model, patients will still have access to universal healthcare coverage, but they would be encouraged to track their activities and vital statistics using monitoring devices issued by a public or private insurer. These devices would link to the patient's electronic medical records and the data would be used to predict emerging health problems.

In such a system, healthcare practitioners would analyze the data and prescribe treatment, focusing on preventative care and minimizing the need for expensive hospital stays. The role of general hospitals would diminish further as home-based care becomes more feasible under improved patient monitoring and remote care systems. Rural and remote populations would also be connected and have access to higher quality physicians through telemedicine or remote care tools. Health plans or insurance agencies would analyze the incoming data more broadly to identify disease and

Exhibit 2

A bolder vision for healthcare delivery



health-risk patterns that might help practitioners detect and treat conditions sooner and better.

A model like this could help to significantly improve healthcare quality across several dimensions. It leans on evidence-based medicine, ensuring that services delivered are founded on the best scientific knowledge and tailored to individual needs. Its primary focus is on timely, preventative care, reducing delays that may permanently compromise health. The model also does not require the expensive and time-consuming development of human and physical infrastructure to reach underserved populations.

The challenges in realizing this vision are immense. Many of the technologies needed are still several years away from the market. Although funding needs may ultimately be lower than traditional models, public and private insurers may be unwilling to make the significant upfront investments to build infrastructure in exchange for future savings. New or expanded capabilities, including data scientists and medical specialists, would be needed, and physicians would need to incorporate new capabilities into their roles, such as interpreting data analysis and basing decisions on data. Ultimately, the biggest challenge may be in shifting the attitudes of consumers to pay for and participate in such a model. Legitimate privacy and safety concerns are raised by the prospect of an individual's medical information being available to public or private institutions, and consumers may distrust such a model and balk at paying for it.

Perhaps surprisingly, developing countries may be in an advantageous position to overcome these challenges. Many developing countries don't have expensive legacy infrastructure, which they might be reluctant to retire, and could invest directly into the new model. Several developing countries already have widespread digital connectivity, a pre-requisite for such a model. For example, The Future Health Index, published by Dutch medical technology

company Royal Philips, showed that developing markets have been faster to embrace digital technology and data sharing than developed ones. And finally, the demand for affordable universal healthcare amid funding and resource constraints could make compromises on personal privacy more acceptable in developing countries, especially if strong safeguards are in place to prevent misuse.

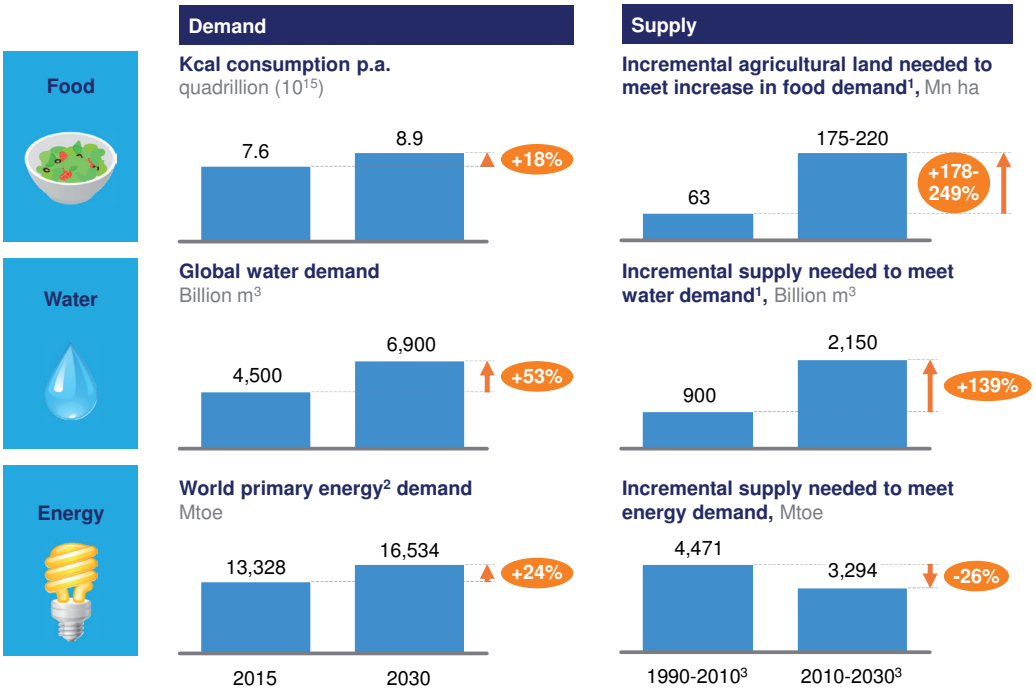
The impact on global sustainability

Even facing challenges of equitably allocating healthcare advancements, it is easy to become dazzled by the potential for science and technology to improve and prolong our lives. But advances in longevity and quality of life have a price. A more crowded planet with more demands on its resources will likely exacerbate the strain on the environment. By taking a step back, industry participants can consider the effect of healthcare advancements on local and global ecosystems and even question whether these scientific advancements will truly deliver longer and better quality lives.

Already under existing population projections, food and water will become constrained resources in the medium term. The United Nation's Food and Agriculture Organization estimates that by 2030, humans will need almost 20 percent more food compared with requirements in 2015 as a result of global population growth and dietary changes. To deliver this, the supply of arable land must more than triple, but adding to the supply of arable land means reversing the trend that's seen the amount of arable land and agricultural yields declining over the last several decades. Demand for water is expected to increase by more than 50 percent by 2030, and meeting this demand will require a greater increase in supply than realized in the last 20 years (Exhibit 3).

Exhibit 3

Demand and supply of resources to support projected population in 2030



1 Calculated as incremental supply plus replacement rate; does not tie to total demand as it does not include efficiency gains
2 Energy form found in nature that has not been subjected to any conversion or transformation process
3 For energy supply, data reflects 1990-2012 increase and 2012-2030 increase respectively

SOURCE: McKinsey analysis

Further, human development has caused unprecedented environmental damage. The World Wide Fund for Nature (WWF) estimates that 230 million hectares of forest will disappear by 2050 under current trends. Some also argue that irresponsible land and water use, pollution, and overharvesting could lead to a sixth mass extinction, with half the world's species of plants and animals potentially going extinct between 2000 and 2100.

The loss of biodiversity and environmental destruction will lead to large economic losses, for instance by eliminating vegetation that contributes to flood control and hampering pollination of crops. Other losses can also be significant, such as the opportunity costs of medications based on plant and animal substances left undiscovered. Also, biodiversity provides direct benefits to mental and physical health, with an increasing number of studies demonstrating improved health outcomes and cognitive abilities for individuals exposed to nature.

Several ideas are being explored to improve resource use, such as the circular economy in which governments and companies strive to create a closed loop for resources where everything is reused rather than discarded. Rotterdam, for example, has established a fresh seafood distribution hub, using new technology that helps avoid spoilage losses. The city has built networks of manufacturers, producers, and recyclers to improve recycling rates and ensure greater reuse of copper found in discarded electronics. These circular economy initiatives and others have reduced waste levels with, for example, the amount of electronic waste being incinerated in Rotterdam dropping by more than 50 percent.

Similarly, advanced analytics are being applied to optimize food production and supply chains. In 2007, the amount of food wasted globally equated to yields from 1.4 billion hectares of agricultural production. Cutting such losses would provide enough food to feed a billion people. Improved weather forecasting, demand planning, and the management of products near their expiration, among other areas, could bring enormous social, economic, and environmental benefits. For example, the French start-up Phenix connects supermarkets with expiring food stocks to agencies and consumers that could use them. The platform allows supermarkets to save disposal costs, uses consumable products more effectively, and alleviates some of the social and environmental burden of waste.

While such sustainability initiatives remain young, they should be pursued in parallel to advances in medical science. History shows that human innovation has regularly stretched our ability to make more productive use of the earth's resources. As longevity and quality of life slowly improve over the coming years and decades, sustainability innovations must also be implemented to assure that mankind can survive longer and healthier lives.

Conclusion

It would be difficult to argue that healthier, longer lives are undesirable. But all participants in the healthcare industry must understand and contemplate the broader implications of these aspirations. To live long and to prosper, mankind must address resource constraints and craft an equitable distribution of the many benefits of medical advances.

Amid exciting healthcare advances, leaders and investors cannot lose sight of opportunities for global impact through investing in and spurring innovation in equitable and sustainable development. Medical advancements are arriving quickly, and so must initiatives and technologies that expand medical access to the developing world or clear obstacles to living longer and better, such as improved food management, greater use of renewable energy, and the development of smart cities.

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