How can we engineer effective yet affordable health care everywhere?

This paper was published in June 2015. The ideas and recommendations within it are among dozens of suggestions that arose from the Stanford Engineering Future process. Share your thoughts with us at SoEFutureFeedback@stanford.edu.
Engineering’s focus on solving important practical problems has enormous potential to improve human health and well-being.

Health care concerns pose tremendous challenges to humanity, but evolving technological trends present tremendous opportunities to address these challenges.

The School of Engineering is particularly well situated to have a major influence in this area, not only because of our proximity to Stanford’s world-class School of Medicine, but also because of our proximity to the innovation and entrepreneurship in Silicon Valley’s health care sector. A significant opportunity exists for investments in this area in the School of Engineering, particularly in partnership with the School of Medicine, the Graduate School of Business, the School of Humanities and Sciences, and others.
Health care delivery.

Changes in technology and infrastructure are driving a revolution in health care delivery. Some examples:

- Health care operations will be more efficient as refined patient classification and resource scheduling (doctors, nurses, beds, operating rooms, supplies, transplants) allow an increase in patient throughput because of higher resource utilization (i.e., without increasing investment).
- New products and processes are emerging that will change how we deliver health care, including personalized medicine, new diagnostic and treatment technologies, biomaterials, smart prostheses and improved vaccine production technologies.
- Remote monitoring and telemedicine are creating a sea change in the role of the physician: It’s no longer necessary for the physician to be physically near the patient for many types of diagnoses or even treatments.

Major opportunities exist, but careful design is needed. Some health care systems have better patient outcomes, lower costs and higher staff satisfaction than others, even when controlling for external variables. This suggests significant opportunities and challenges for system-level health care designs that improve quality and reduce costs.
Patient informatics and health care analytics.

As in other fields, health care data is being transformed at a massive scale. Every specialty of medicine, from mental health to management of chronic illnesses to surgical treatment and beyond, is undergoing radical change as technological advances promise new possibilities for treatment, monitoring and diagnosis. As with other application domains undergoing an information technology revolution, these new health care technologies promise incredibly rich and detailed data on patient care.

The result is tremendous opportunities to learn about human health through real-time patient data monitoring. For example, it is possible to record streams of vital signs of every patient who has ever been connected to a monitor or had lab tests, and to create a massive database of human populations to be mined for identifying normal/abnormal patterns. In principle, data mining on this scale could enable a new era of epidemiological studies on human populations, with statistical resolution that would be orders of magnitude higher than before.

The challenge is ensuring that expertise in data analysis is properly matched to expertise in clinical diagnosis. Stanford is uniquely positioned to seize such collaborative opportunities. For example, the partnership between Stanford’s Management Science and Engineering Department and Lucile Packard Children’s Hospital Stanford addresses these issues by partnering world-class clinicians and professors to analyze well-understood patient data.
Affordability of the U.S. health care system.

News stories in the past several decades have described the ongoing crisis in health care affordability in the United States: Aggregate health care spending is more than $2.5 trillion a year, or more than 17 percent of the GDP since 2010. At the same time, there are serious concerns about the quality of care Americans receive. Problems have been reported in both overutilization and underutilization of care. In large part, these issues can be linked to distorted incentives for the various stakeholders.

Making health care more affordable requires a multidisciplinary approach. The hope is to leverage the new data and computational infrastructure in health care to deliver a more affordable cost structure for the industry. This requires collaboration between computer scientists, data scientists and economists.
Public health.

Examples of current public health challenges include:

• Controlling communicable diseases such as HIV and tuberculosis.
• Controlling chronic diseases such as heart disease, cancer and diabetes.
• Identifying and controlling emerging pathogens such as Ebola and pandemic influenza.
• Promoting healthy lifestyles via weight-loss and smoking-cessation campaigns.
• Improving public health preparedness, including plans for response to public health emergencies and associated federal stockpiles.
• Managing an aging population by engineering solutions to enhance our active lifespan and improve patient care for the elderly.

When deciding which programs to invest in, public health decision makers face a number of challenges, including limited resources, competing objectives and limited information about uncertain events. Despite these difficulties, public health planners must make choices about programs they will invest in and acknowledge that the quality of their choices affects the health benefits achieved in the population.

Good decisions require information about the likely costs and health consequences of alternative interventions. This is where quantitative modeling of the type performed in SoE can play a leading role. By providing a structured framework that uses the best available evidence, imperfect as it may be, and that captures relevant uncertainties, complexities and interactions, mathematical and computational models can be used to evaluate the potential impact of alternative public health programs — and thereby inform good decisions.
Global health.

Many of the public health challenges outlined here require a coordinated global effort. For example, significant attention must be devoted to the aging population not only in the United States, but also around the globe (after all, this problem is even more severe in Japan and China). Underserved communities — especially in emerging economies — are at risk of being left behind as health care technology advances.

Exporting preventive care and affordable treatment, particularly to developing regions, is a significant challenge that involves the entire spectrum of engineering expertise. For example, engineers can contribute to structure and infrastructure with solutions for clean air and water, effective sanitation systems, healthy buildings, a healthy built environment and design of efficient, effective health care infrastructure. Opportunities for new products and processes in developing countries include affordable drugs and medical devices, affordable systems for health and sanitation, and low-cost medical technology, such as telemedicine.

Finally, application of social scientific, computational and mathematical modeling techniques can contribute to effective design of health clinics and health care supply chains, evaluation of the affordability of potential health interventions, evaluation of the role of social factors in health care delivery, and effective health care entrepreneurship.