The future of health care

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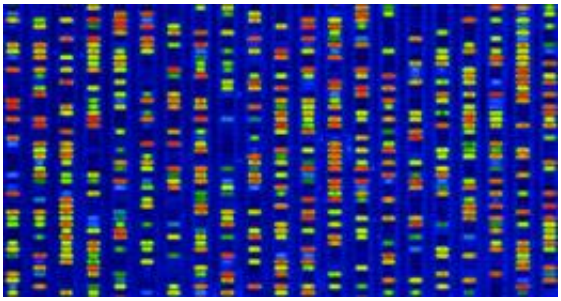

A DNA microarray displays gene sequences. ASU researcher Stuart Lindsay is developing a method for sequencing the human genome at a small fraction of the current cost. Credit: ASU Biodesign Insitute

The United States spends more per capita on health care than any other developed nation, and has the highest growth rate in health care costs, as well. In 2009, these costs reached $2.5 trillion, making up almost 1 in every 5 dollars – or 17 percent – of our gross domestic product.

In spite of these expenditures, the U.S. is far from the top of the list in terms of health care quality, efficiency or access. The World Health Organization ranked the U.S. only 37 out of 191 countries for overall health, responsiveness of the health system, and fairness in financing. Life expectancy in the U.S. ranks only 50th in the world, according to the CIA World Factbook.

To address these issues, a group of researchers at ASU are approaching health care from multiple, innovative perspectives. Their goals are to

improve human health and well-being while simultaneously reducing the costs of care.

Creating high-value health care

One important reason that health care costs have skyrocketed while quality has not is that our current system is not designed to promote high-value health care, says Denis Cortese, the director of ASU's Health Care Delivery and Policy Program.

“There are a bunch of stakeholders that come to the table to maximize their own sector. It’s like an orchestra. If every player decided they were going to play as loud as they could, they’re not going to make very nice music,” Cortese says.

One factor driving up costs is that not everyone is insured. The law mandates that emergency rooms must treat anyone in need, regardless of whether or not they are insured. While this is good and necessary, Cortese says it encourages the uninsured to wait until they are very sick, and then go to the most expensive place for treatment. With 50 million uninsured Americans, those costs add up quickly.

The way in which health care providers are paid also increases costs, Cortese says.

“We pay money in a fee-for-service environment, which means I make more money if I keep you sick” Cortese says. “We pay doctors and hospitals and nurses more money the sicker you are – just the reverse of what we say we want. We’re not paying people to keep you healthy, we pay them when you’re sick.”

In order to receive payment from the federal health insurance program Medicare, which covers 47 million Americans, health care practitioners

must keep extensive documentation of everything they do in treating a patient. This is where the “fee-for-service” concept comes in.

“The sicker you are, the more procedures you’re going to have done, the longer you’re in the hospital, the more money everybody makes. But the patient is getting sicker and we’re not getting the results we want,” Cortese says.

Doctors should be rewarded for keeping people healthy, rather than getting paid based on the tests and procedures they have done to treat a patient, he says.

At the Health Care Delivery and Policy Program, Cortese is working with 16 different organizations that want to provide high-value care for their patients, rather than participate in the fee-for-service model. The program connects these organizations with insurance providers who are willing to pay doctors and hospitals that want to provide better care for their patients.

Some of these health care providers are small, such as a single hospital, while others are large, spreading across multiple states and many different hospitals. All of the organizations want to provide better care at a lower cost to their patients.

“We need that mindset in health care that you’re not going to get paid until you’re producing high-value care,” Cortese says.

Technology to the rescue

One of the challenges in providing better care is that many hospitals and doctors’ offices have been slow to adopt technology that could simplify health care for everyone.

It's common these days to get current traffic alerts on a smartphone, or to read about breaking news as it happens on Facebook or Twitter. With the capabilities to access instant, real-time information from almost anywhere, it's surprising that many medical doctors are using outdated information technologies.

"It's a frequent and bitter joke in the health care field that your average truck driver has better information technologies available to him than a doctor does in the office," says Michael Birt, director of the Center for Sustainable Health in ASU's Biodesign Institute.

Birt says that doctors often don't have a good idea of how their patients are doing over time because no one continuously acquires and records that data.

"You go to a doctor every three months or six months, she tells you what to do, and then you ignore it until you go back again. That's essentially how our health system works for prevention or primary care," Birt says.

The center is working to implement technology that monitors a patient's health over time and feeds that data back to their doctor. This will allow for a more meaningful health assessment than could be achieved in a single visit. That real-time data would also lead to faster diagnoses, and it will help patients recognize behaviors that are negatively impacting their health.

"It will be harder to pretend that something isn't happening if that data is available," Birt says.

In addition to improving individual health, a focus on technology and metrics could make health care more affordable and economically sustainable for the country. Birt says having access to current health data would allow doctors to determine a patient's "biosignature," or the most

effective strategy to tackle that patient's health issues.

A biosignature is a spectrum of health information that allows a system to know which diagnostic capabilities to use in a way that is cost-effective.

"The problem has been that technologies are often in silos, and our ability to integrate them has been very limited," Birt says. For example, an X-ray will provide a completely different set of information than a blood test. They both meet a need, but one may be more appropriate than the other in a given situation.

"It's not just doing the maximum number of tests. It's doing the right one, at the right time, the right way, and with a cost impact," Birt says.

Getting personal

Another way to lower costs, as well as reduce suffering, is to detect diseases early – possibly even before symptoms arise. For some diseases, like cancer, early detection can drastically improve the odds of survival.

Joshua LaBaer is the director of ASU's Center for Personalized Diagnostics at the Biodesign Institute. One of the ongoing projects in his lab is identifying breast cancer biomarkers, which are unique molecular indicators of disease. These biomarkers will allow doctors to detect breast cancer earlier so that treatment can be administered earlier.

Using a new, powerful method for rapidly screening molecules associated with disease LaBaer's team has identified a broad panel of 28 biomarkers that could aid in early diagnosis. They have also pinpointed more than 30 breast cancer gene targets – including several novel genes – that are involved in drug resistance to a leading chemotherapy treatment.

These gene targets exemplify a common problem in medical diagnosis and treatment. A single disease can affect people in different ways, because of their unique molecular composition.

“If you’ve got brothers and sisters, you’re probably astounded at how different they all are from you,” says Stuart Lindsay, the director of the Center for Single Molecule Biophysics at ASU’s Biodesign Institute. “Though your siblings carry basically very similar genomes, the way in which those genomes are ordered is radically different from child to child. This is the result of a process called meiotic recombination, which sort of throws the Darwinian dice every time a new human is conceived.”

The genome is the sum of a person’s hereditary information, encoded into his or her DNA. Genetic variation can cause two people diagnosed with the same type of cancer to respond differently to the same therapy. For example, the people with the genes identified by LaBaer’s group won’t derive much benefit from tamoxifen as a treatment for breast cancer, even though the drug is a lifesaver for many.

Knowing the genetic makeup of their patients could allow doctors to provide the best possible care for each patient. What’s the catch? Sequencing an entire human genome can cost tens to hundreds of thousands of dollars.

Lindsay developed a new method of sequencing and reading genomes that is faster and less expensive than other techniques currently available, because it doesn’t rely on chemical reactions. Instead, he uses the electronic properties of DNA to read the genome. He hopes that in five to 10 years, his technology will bring the cost of sequencing down into the double digits.

“The actual reading mechanism is done by passing the DNA through a

nanopore," Lindsay says. A nanopore is a tiny hole, about the size of a single DNA molecule, drilled into in a special silicon diffuser chip. Embedded in the nanopore is a tiny pair of electrodes. As each piece of the genome passes through the nanopore, researchers observe and record its reaction with the electrodes.

"It sounds like magic, but it actually works very well," Lindsay says.

The ability to easily sequence a person's genome will allow scientists to develop more personalized and precise therapies for diseases like cancer. Although the process is still expensive, it would ultimately save a lot of money.

"Right now there are cancer therapeutics on the market that cost tens of thousands of dollars per month and, on average, extend a person's life by a few months. Hidden underneath that average statistic is the fact that one person in a large number goes into complete remission," Lindsay says.

Investing in precision

If drug companies could profile the genomes of people who respond well to a particular treatment, they could customize treatments to the individual for maximum effect.

However, it's not yet certain who will invest in the development of these treatments, LaBaer says, as pharmaceutical companies are not particularly interested in developing drugs that only work for a small number of people.

"If you were a pharmaceutical company, which would you rather do – develop a drug like Lipitor that you can give to millions of people who are at risk for heart disease, which is the most common killer in our

country, or develop a drug for a small subset of women with a particular type of breast cancer?" LaBaer asks.

But there is an incentive for drug companies to invest in precision medicine, which brings us back to Stuart Lindsay's genome sequencing. The ability to know on a molecular level which patients will respond well to a drug means that drug will have a high response rate. It also means doctors could identify people who won't respond well to a drug and prevent negative side effects.

Some companies are already beginning to invest in precision. Lindsay's lab has partnered with Roche, an international pharmaceutical company, and the technology and consulting corporation IBM. Roche will provide support for biochemical activities and IBM will construct the diffuser chips used to read the gene sequence.

"The hope of everyone in personalized medicine is that in some short number of years or decades at the most, this will be how medicine is practiced, and it will be lower-cost and make it much more effective," Lindsay says.

Provided by Arizona State University

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