Making a life plan based on your DNA

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Lee and his wife are the first patients of Dan Carlin to have their entire genome mapped.

A successful hedge fund manager, Lee has been reading about mapping for some time. After watching the cost fall from millions of dollars to single-digit thousands of dollars, he approached Carlin, the founder of WorldClinic and a pioneer in digital health care delivery, with the idea of having his own genome mapped, a step he saw as an essential investment in his family's health.

Lee, who agreed to be identified only by his first name, understands the pros and cons of genome mapping. He knew that he and his wife could learn things about their health that they would not be able to do anything about, but they also would learn about the likelihood of future health problems that could be prevented with proper treatment.

"You can know what your potential health problems are and deal with them over time, or you can someday be confronted with a massive smack in the face," Lee said.

After researching the options, Carlin recommended the couple send saliva samples to Genomics Personalized Health (GPH), one of the first genome sequencing companies to take that saliva, extract its DNA and feed it into a DNA sequencing machine that spits out massive amounts of data.

That data is composed of a long list of the four essential building blocks of DNA: adenine, thymine, guanine and cytosine. For computing purposes, these names are shortened to just A, T, G and C respectively.

It is the myriad combinations of these four molecules that are subject to the GPH sequencing analysis that yields the actionable information needed to make sense of such a huge amount of data.

Genome mapping is in its early stages, at the beginning of a massive revolution that began in 2000 when the National Institutes of Health and a private initiative simultaneously sequenced the entire human genome. Human Genome Project international researchers compared the feat to the Apollo moon landing and the splitting of the atom, envisioning the dawn of a new age, "the era of the human genome."

Like Lee and his wife, every person has about 6 billion DNA letters or 3.2 billion base pairs of genes, out of which 99.9 percent are the same. The other 0.1 percent or 3.2 million pairs of DNA represents the differences in how people look and act, their unique traits and what their health risks are. Those are the genes that are analyzed and interpreted by highly trained geneticists.

Once the raw data became available, Carlin recommended that Lee and his wife's genetic health profiles be interpreted by Brandon Colby, a medical doctor, geneticist and author of the book "Outsmart Your Genes." Colby founded and runs sequencing.com, an online platform where people can securely store their genetic data and find apps that make genetic data understandable and useful.

Ten years ago, geneticists would look only at one or two genes and test for individual diseases. Now, with Next Generation Sequencing, a more rapid, cost-effective approach to genome sequencing, experts can obtain data on thousands of genes with a single test.

When Colby used apps at sequencing.com to interpret the data from the genome sequencing for Lee and his wife, he was able to determine the level of risk for numerous preventable diseases. Together, he and Carlin were then able to translate that information into actionable, meaningful health plans.

"By learning about genetic risk, we can modify nongenetic risk factors and reduce a person's overall risk of a disease," Colby said.

The data from Lee and his wife show increased risk

for heart disease for both. Lee's wife is at particularly high risk because her genome indicates that she is predisposed to Long QT syndrome, an electrical variation in the heart rhythm that can cause sudden death. Lee has a handful of distinct gene combinations in his genome that signal an increased risk for coronary heart disease as he ages. Both are at risk for macular degeneration, and Lee's wife is at increased risk for osteoporosis and multiple sclerosis.

The absolute accuracy of genetic data, however, is dependent upon the amount of research that has been conducted for a specific disease. In the case of heart disease, it is extensive, so going forward, Carlin will oversee the plan to lessen Lee's wife's risk for an electrical heart malfunction and Lee's risk for coronary atherosclerosis.

"Genomics has reached a point," said Colby, "where we can use a patient's genetic information to personalize health care and lifestyle. We now have the ability to outsmart our genes to protect our health and longevity."

A common reaction is for people to be afraid to know what diseases and conditions they may be genetically predisposed to. A person might not want to know, for example, that she has a high chance of developing Alzheimer's disease. But Colby and Carlin say knowing can be lifesaving.

For a person at risk for Alzheimer's, a disease about which much remains unknown, measures can be taken early in life to lessen that risk. Head trauma for someone who has the risk for developing Alzheimer's, says Colby, is like throwing gasoline onto a fire. If parents know through genome sequencing that such a risk exists for their child, preventive measures can be taken to protect against Alzheimer's later in life such as avoidance of contact sports.

The plan for the ongoing health care for Lee and his wife is being put into action. The day after receiving the genome sequencing results from Colby, Lee's wife had a baseline EKG done to determine whether she has Long QT syndrome at rest, a sign that her genome was fully expressing that particular defect. The good news, said Carlin, is that her EKG was completely normal, indicating that she probably has a low risk for cardiac sudden death, though the issue will not be completely resolved until after she has been evaluated by a cardiologist specializing in electrical disturbances of cardiac rhythm.

Lee's heart risk appears to increase with age, but he already lives a healthy, active lifestyle, so when he reaches the age of about 45 he will have a heart scan to look for plaque and other evidence of atherosclerosis of the heart's arteries.

To stave off macular degeneration, each is being started on a vitamin supplement regimen, each has begun eating more leafy green vegetables and each has upgraded to a pair of sunglasses that polarize or filter and block intense reflected light.

For her osteoporosis risk, Lee's wife will continue her current exercise regimen but also have a bone density scan within the next six to 12 months, and her vitamin D levels will be periodically checked and supplemented if the need arises. Her risk for MS is a bit trickier, Carlin said. Her initial genome report precipitated a screening that looked at one particular genetic variant that can be made less severe with vitamin D supplements, but she was found not to have that variant.

Because the couple is concerned about what all of this means for their children and because it would only require those children to spit into a test tube, they will probably have the genome of each of their children sequenced to keep them healthy and protect their future well-being and that of their children's children.

Colby says genome sequencing has precipitated a revolution in the evolution of medicine that will be a key determinant in transforming the practice of medicine from a model of one size fits all to one of personalized preventive precision health care.