The Future of Medicine is Personal

Video transcript

[TedxIndianaUniversity logo and words appear: ALL TOO HUMAN]

[Image of Anantha Shekhar and words appear: ANANTHA**SHEKHAR]**

[IUSA, IU Grand Challenges, Hutton Honors College, Indiana University Foundation logos and words appear: IU Research]

Anantha Shekhar speaks: Going to talk today about precision health or precision medicine. The power of precision.

[PowerPoint slide appears titled “Precision Health”: Diagram with the word “INDIVIDUAL” on the top line with an arrow moving from the left of “INDIVIDUAL” through the three words “HEALTH” “DISEASE” “POST-DISEASE” in a line below “INDIVIDUAL” and back to “INDIVIDUAL” forming a closed rectangular loop; a DNA helix image with the words “GENETICS” “DEVELOPMENT” “BEHAVIOR” “ENVIRONMENT” stacked vertically along the right side of the helix at the top of the slide; a horizontal red line with four notches with the words “Lifestyle Choices” “Primary Prevention” “Precision Medicine” “Post Disease Prevention” from left to right across the bottom of the slide.]

How that's going to change medical care. How that's going to change our health system and disrupt everything that we currently do for better. What is precision health? Now that we have the technology to actually synthesize large amounts of data, we can actually create individualized data sets for any given person that includes everything about them, all the way from their genetic code that they were born with, to the biological changes that have occurred in their body through development, through early childhood, through environmental exposures, and their behavior patterns.

Do they smoke? Do they not smoke? Do they eat healthy? Do they exercise? All of these behaviors matter because that impacts a person's biology, that impacts a person's genetic material in a permanent way that results in health or disease. That's the concept of precision health. How is that going to disrupt our healthcare? It's going to disrupt our healthcare in a number of ways.

[Words appear: Cure a Cancer!]

But some of the major things that will happen over the next few years is that we're going to be able to treat diseases like cancer that previously were not treatable or previously were uniformly fatal.

How's that going to happen with precision medicine?

[PowerPoint slide appears: Image of normal cell division in top-half; image of cancer cell division in bottom-half, showing uncontrolled growth]

What is cancer? Simply it's a genetic malformation in the cell's code that determines how the cells divide and how the cells integrate themselves into the rest of the body. As we all know, most of our organs are constantly generating new cells. Old cells are dying off. New cells are replacing them. Like everything in this world, it's constant new replacing the old. That normally happens in a very systematic way. There are hundreds of genes that regulate that process. The process involves clearly as the cells are getting older, they go through a gradual death and the new cells take their place and appropriately arrange themselves with the rest of the organ.

Unfortunately, in certain situations that genetic gets messed-up. These cells that are born with these messed-up genetic codes don't take instructions correctly. They start growing uncontrollably. They start cannibalizing cells next to them. They have no turn-off signals within them. A number of such malformations suddenly make them start growing out of control. That's what you see. These cells are abnormal. Normally, if there's an abnormality in those cells they go through a natural death process but that doesn't happen in cancer.

When this happens then cancer cells grow uncontrollably, tumors happen, and the person eventually fails to survive this onslaught of pathological cells. How is precision medicine going to change that?

[Words appear: Genomic Medicine]

Right now, we can do a lot more with the technology and the data that we can collect and synthesize. Through a variety of mechanisms, genomic medicine is one of those where we can actually look at the entire genetic code of the cells and see what kind of mistakes there are and then try to correct them or try to target them.

[PowerPoint slide appears: Image of six-year-old Emma on the left side; CAT scan image of Emma’s ovarian cancer cells on the right side.]

Let me illustrate this with the case of Emma. Emma is a six-year-old girl, as you can see. Bright-eyed, beautiful girl. Going to school. Normal child. Suddenly starts complaining of stomach aches. Within two months, she starts to lose weight. She's brought to Riley Hospital. Turns out with a variety of testing, they find out that she has a very aggressive form of ovarian cancer. This kind of disease is extremely aggressive. She's just a child and ovaries don't develop cancer at that age unless there's some serious cell difference.

She goes through traditional chemotherapy. Absolutely no effect. You see in this CAT scan that there are tumors everywhere in her body, spreading aggressively. We're telling her parents that Emma probably won't live beyond another six weeks. At this point, what do we have to do? Let's go ahead and get her genome sequencing done. What does that mean? It just means that we are reading the entire genetic code of this tumor cells. Her tumor tissue was sent for whole genome sequencing which is not a trivial task. As you can imagine, it's literally reading every alphabet in her genetic code, in this cell's genetic code.

[PowerPoint slide appears: Image of a *Moby Dick* book on the left side; the words “1,500,000 alphabets” above the book; image of a human genome on the right side; the words “3,000,000,000 base pairs” above the image; the words “3,000,000 base pair difference between two people” appears across the bottom of the slide.]

Just to give you a concept of what that means, here is *Moby Dick*, the famous novel. We all know about. It has about 203,000 words in it. Little over 1.5 million alphabets in it. The human genome has 3 billion base pairs or 3 billion alphabets in it. If I were to tell someone find two letters that are misplaced in this entire copy of *Moby Dick*, it's going to take us weeks to figure out which one it is. Imagine a book with 3 billion alphabets and you have to find the spelling mistakes somewhere in that book. That's what whole genome sequencing does. We do have the technology now to do that.

When the human genome was sequenced completely and the data was finally available in 2003, it took nearly 12 years. Almost $27 billion to sequence the first genome. Today, we can do it in four days for $2700. It's going to be probably done for less than $1000 in a couple of years. This is going to totally change the way we are looking at diseases wherever you're looking at how to treat individual patients.

How did this help Emma? We did that with her tumor. Turns out that she had a one aggressive mutation which is called ALK or alt-mutation, which is normally seen in older people who develop a rare form of lung cancer. She had this unique mutation in her ovary that caused this cancer. Fortunately, we have a drug that works against this particular mutation. Usually it's currently approved for lung cancer. Never been used in children, never been used for ovarian cancer. We had nothing to lose. Right? With Emma. We started her on that.

[PowerPoint slide appears: Image of six-year-old Emma on the left side; CAT scan image of Emma’s ovarian cancer cells greatly reduced on the right side.]

Within four weeks, her cancer started to disappear. Within three months, it's completely gone and Emma went to Disney World last month.

[Audience claps.]

I'm sorry. I still get choked up every time I tell her story. Emma was the lucky one because we already had a drug that would address this mutation. Not all children are this lucky. Not all cancer patients are this lucky yet, but the technology's moving so fast. Lots of wonderful things are happening in biology.

[Word appears: Immunotherapy]

Today we have another way to approach this. Instead of simply drugs, depending on drugs which take years to develop. One of those revolutionary technologies is immunotherapy. This is another technology that we're beginning to build at IU.

What this does is in addition to the genetic code? We can actually look at the proteins that are on the cells so that we can profile the cells and then target the immune systems to attack those cells. We can engineer a person's immune system. Let me illustrate this quickly with another story.

[PowerPoint slide appears: Words “Profile the disease causing cells” on the top left; Words “Engineer our immune system to defend against cancer cells” on the bottom left; image of 11-year-old Josh appears on the right.]

This is a story of Josh. Josh, again, is currently an 11-year-old boy. At age five, he came to Riley with acute lymphoblastic leukemia. Common leukemia that occurs in children. Josh went through chemotherapy radiation. 95% cure rate for this generally. Josh responded nicely. We said, "Great. We'll follow you up. If you're free of disease for five years, lucky. You're one of the lucky ones." We think that happens in 95% of the cases. Josh was going along fine. Literally four years to the day, the disease comes back. He's one of the unlucky 5% that didn't have that response.

What we were able to do then was the typical approach is a bone marrow transplant which takes out the entire bone marrow and replaces it with a new bone marrow. Extremely difficult, painful procedure. Months in the hospital. Josh went through that. Got cleared of his leukemia. Two years disease-free. Age 11, the disease comes roaring back. We're out of all options.

[PowerPoint slide appears: Diagram of an image of a person receiving an anti-CD 19 CAR infusion to attack cancer cells replicating in the body.]

Turns out that Josh's lymphoma cells have a protein on them called CD 19. It's a common protein that occurs in leukemias and lymphomas.

We were able to take Josh's immune cells, called T cells. Introduce a new gene into these cells through a virus and now several of his T cells are programed to go kill any cell that has this protein, CD 19. We did that. Within two months these cells have been replicating in his body, completely killing all the cancer cells. What's more important is that these cells will be in his body for the rest of his life. They'll be circulating. They'll be watching for these cancer cells to pop-up anywhere. They're going to kill them.

It's almost like a permanent chemotherapy that constantly waiting for the cancers to appear. That's the power of precision medicine, that's going to change the way we think about diseases, change the way we think about health, and how we can manage our own bodies better.

[PowerPoint Slide appears: A chart is divided in half by a vertical line; The words “CLINICAL” “CURE” and “PREVENT” appear in the top half. The words “Type of Cancer” and “Childhood Disease” appear under “CURE”, and the words “Chronic Illness” and “Neurodegenerative Disease” appear under “PREVENT”; the words “ACADEMIC” “GROW” “CREATE” appear on the bottom half. The words “Research Capabilities” appear under “GROW,” and the words “New Educational Programs” appear under “CREATE”]

With the IU proposal and the grand challenge, what our hope is that we will actually kill some diseases. We particularly want to cure cancer. We want to cure at least one childhood disease.

Beyond cancer, this approach is going to change many other disease. I think after cancer, the next disease to fall will be Alzheimer's. That's also prime for all of these technologies. We can predict who might become demented. We can predict what biological pathways might cause the dementia and we can literally change the course of the disease over the next 10 years. Beyond that we also hope to create new generation of scientists, a new generation of education programs that would make us prepared for this kind of revolution in healthcare.

The power of precision medicine is going to totally disrupt and transform the way we think about healthcare, diseases, treatments, and the way we take care of ourselves. Thank you very much and hope to see a very happy and healthy future for humanity over the next 20 to 30 decades. Thanks very much.

[Audience claps and Anantha Shekhar exits stage]

[Logo words appear: ALL TOO HUMAN]

[Transcript ends]