Paula Hammond TED talks live

A new superweapon in the fight against cancer

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I. Cancer affects all of us -- especially the ones that come back over and over again, the highly 1)…….. and drug-resistant ones, the ones that defy medical treatment, even when we throw our best drugs at them. Engineering at the molecular level, working at the smallest of scales, can provide exciting new ways to fight the most 2)…….. forms of cancer.

II. Cancer is a very clever disease. There are some forms of cancer, which, fortunately, we've learned how to address relatively well with known and established drugs and surgery. But there are some forms of cancer that don't respond to these approaches, and the tumor 3)…….. or comes back, even after an onslaught of drugs.

III. We can think of these very2)…….. forms of cancer as kind of supervillains in a comic book. They're clever, they're adaptable, and they're very good at staying alive. And, like most supervillains these days, their superpowers come from a genetic 4)…….. The genes that are modified inside these tumor cells can enable and encode for new and unimagined modes of survival, allowing the cancer cell to live through even our best chemotherapy treatments.

IV. One example is a trick in which a gene allows a cell, even as the drug approaches the cell, to push the drug out, before the drug can have any effect. Imagine -- the cell effectively spits out the drug. This is just one example of the many genetic tricks in the bag of our supervillain, cancer. All due to mutant genes.

V. So, we have a supervillain with incredible superpowers. And we need a new and powerful mode of attack. Actually, we can turn off a gene. The key is a set of molecules known as siRNA. siRNA are short sequences of genetic code that guide a cell to block a certain gene. Each siRNA molecule can turn off a specific gene inside the cell. For many years since its discovery, scientists have been very excited about how we can apply these gene blockers in medicine.

VI. But, there is a problem. siRNA works well inside the cell. But if it gets 5)…….. to the enzymes that reside in our bloodstream or our tissues, it degrades within seconds. It has to be packaged, protected through its journey through the body on its way to the final target inside the cancer cell.

VII. So, here's our strategy. First, we'll dose the cancer cell with siRNA, the gene blocker, and silence those survival genes, and then we'll whop it with a chemo drug. But how do we carry that out? Using molecular engineering, we can actually design a superweapon that can travel through the bloodstream. It has to be tiny enough to get through the bloodstream, it's got to be small enough to penetrate the tumor tissue, and it's got to be tiny enough to be taken up inside the cancer cell. To do this job well, it has to be about one one-hundredth the size of a human hair.

VIII. Let's take a closer look at how we can build this nanoparticle. First, let's start with the nanoparticle core. It's a tiny capsule that contains the chemotherapy drug. This is the 6)…… that will actually end the tumor cell's life. Around this core, we'll wrap a very thin, nanometers-thin blanket of siRNA. This is our gene blocker. Because siRNA is strongly negatively charged, we can protect it with a nice, 7) …….. layer of positively charged polymer. The two oppositely charged molecules stick together through charge attraction, and that provides us with a protective layer that prevents the siRNA from degrading in the bloodstream. We're almost done.

IX. But there is one more big obstacle we have to think about. In fact, it may be the biggest obstacle of all. How do we deploy this superweapon? I mean, every good weapon needs to be targeted, we have to target this superweapon to the supervillain cells that reside in the tumor.

X. But our bodies have a natural immune-defense system: cells that reside in the bloodstream and pick out things that don't belong, so that it can destroy or eliminate them. And guess what? Our nanoparticle is considered a foreign object. We have to sneak our nanoparticle past the tumor defense system. We have to get it past this mechanism of getting rid of the foreign object by disguising it.

XI. So we add one more negatively charged layer around this nanoparticle, which serves two purposes. First, this outer layer is one of the naturally charged, highly hydrated polysaccharides that resides in our body. It creates a cloud of water molecules around the nanoparticle that gives us an invisibility cloaking effect. This invisibility cloak allows the nanoparticle to travel through the bloodstream long and far enough to reach the tumor, without getting eliminated by the body.

XII. Second, this layer contains molecules which bind specifically to our tumor cell. Once bound, the cancer cell takes up the nanoparticle, and now we have our nanoparticle inside the cancer cell and ready to deploy.

XIII. Alright! I feel the same way. Let's go! (Applause)

XIV. The siRNA is deployed first. It acts for hours, giving enough time to silence and block those survival genes. We have now disabled those genetic superpowers. What remains is a cancer cell with no special 8)…… Then, the chemotherapy drug comes out of the core and destroys the tumor cell cleanly and efficiently. With sufficient gene blockers, we can address many different kinds of mutations, allowing the chance to sweep out tumors, without leaving behind any bad guys.

XV. So, how does our strategy work? We've tested these nanostructure particles in animals using a highly aggressive form of triple-negative breast cancer. This triple-negative breast cancer exhibits the gene that spits out cancer drug as soon as it is delivered.

XVI. Usually, doxorubicin -- let's call it "dox" -- is the cancer drug that is the first line of treatment for breast cancer. So, we first treated our animals with a dox core, dox only. The tumor slowed their rate of growth, but they still grew rapidly, doubling in size over a period of two weeks.

XVII. Then, we tried our combination superweapon. A nanolayer particle with siRNA against the chemo pump, plus, we have the dox in the core. And look -- we found that not only did the tumors stop growing, they actually decreased in size and were 9)…… in some cases. The tumors were actually regressing. (Applause)

XVIII. What's great about this approach is that it can be personalized. We can add many different layers of siRNA to address different mutations and tumor defense mechanisms. And we can put different drugs into the nanoparticle core. As doctors learn how to test patients and understand certain tumor genetic types, they can help us determine which patients can benefit from this strategy and which gene blockers we can use.

XIX. Ovarian cancer strikes a special chord with me. It is a very aggressive cancer, in part because it's discovered at very late stages, when it's highly advanced and there are a number of genetic mutations. After the first round of chemotherapy, this cancer comes back for 75 percent of patients. And it usually comes back in a drug-resistant form. High-grade ovarian cancer is one of the biggest supervillains out there. And we're now directing our superweapon toward its defeat.

XX. As a researcher, I usually don't get to work with patients. But I recently met a mother who is an ovarian cancer survivor, Mimi, and her daughter, Paige. I was deeply inspired by the optimism and strength that both mother and daughter displayed and by their story of courage and support. At this event, we spoke about the different 10)…… directed at cancer. And Mimi was in tears as she explained how learning about these efforts gives her hope for future generations, including her own daughter. This really touched me. It's not just about building really elegant science. It's about changing people's lives. It's about understanding the power of engineering on the scale of molecules.

A) PROTECTION (n) B) SURVIVOR (n) C) INVADE (vb) D) POISONOUS (adj) E) TECHNOLOGY (n) F) MUTATE (vb) G) DEFEND (vb) H) EXPOSURE (n) I) AGGRESSION (n) J) ELIMINATION (n)