Cancer Nanotechnology: What Is It and Where Does It Stand Today?

Anna Barker, Ph.D.

Joe Balintfy: An estimated 1.5 million adults were diagnosed with cancer in 2009, with more than 562,000 dying from it in that one year alone. About 11.4 million men and women alive today in the United States have been diagnosed with some form of cancer during their lifetimes. Those are some somber statistics, but mortality rates and incidence have decreased over the last decade and more people are surviving the disease; and now, nanotechnology is poised to further advance this progress through improved screening, diagnosis, monitoring and treatment of cancer.

We're kicking off a series of interviews about nanotechnology and cancer. In this first, Calvin Jackson talks with Dr. Anna Barker, Deputy Director at the National Cancer Institute. They discuss where nanotechnology is since the launch of the Alliance for Nanotechnology five years ago. Calvin starts by asking what is nanotechnology and how can it be used to combat cancer?

Dr. Anna Barker: So nanotechnology is a fairly simple concept: It's a micro machine basically. And to put it in real perspective, a human hair—a nanometer's about 50 thousand times smaller than that. So we're talking at the range of 10 nanometers up to say a thousand nanometers as being, sort of, the range that we think about when we talk about nanotechnology. So, the thing about nanotechnology that's really interesting, is that nanotechnology really employs functionality. So not only is it small, it's functional.

And when it comes to cancer, this is a way to get things very specifically into cancer cells, and a way to understand how cancer evolves and develops in cells. And so it's a very powerful technology for cancer.

Calvin Jackson: And I would imagine that using the nanotechnology to combat cancer would be much more efficient than traditional methods we have now such as chemotherapy or radiation, which destroy even healthy cells.

Barker: Yeah and that's a very interesting question because one of the earliest applications for nanotechnology has been to take drugs that are already on the market—and by putting them in a new construct, a new nanotechnology delivery vehicle—where some of those drugs are actually performing much better. Why is that? Because you're delivering the drug more directly to the cancer cell, you're sparing the normal cells.

So, I mean, it's a very interesting time right now because people are starting to think about this technology not just to build new drugs, but also to better utilize the drugs that we have. I think it's a win-win.

Jackson: So, now why is collaboration among scientists so critical to nanotechnology and cancer research?

Barker: At a level where you get down below, say, a hundred nanometers, the size and shape and charge all those things are studied by physicists and predicted by mathematicians.

When you think about the behavior of cells and how they actually migrate in a body and what they do, that actually has been the domain of biologists.

So what happens in nanotechnology is those areas have to come together. So the physicists, the biologists, the mathematicians, the engineers, chemists, all have to come together to understand how do these tiny particles—and they're very multifunctional sometimes—how do they behave, how can we make them behave the way we want them to behave by functionalizing them.

So now all of a sudden it requires entirely new teams of people and the Nanotechnology Alliance for Cancer in its first five years has brought together some unbelievably powerful teams of physicists, mathematicians, cancer biologists, oncologists even, people treating, taking care of patients in the clinics. So it requires a new sort of approach to science which is in the first five years of Nanotechnology Alliance for Cancer, we very effectively have done that by bringing some very unique teams together.

Jackson: Speaking of the alliance, I understand the NCI has just recently decided to continue to invest in the program for another five years. What is NCI's goal for nanotechnology over this time period?

Barker: When we started the alliance, we had a lot of goals, I mean, as you always do for programs like this. This was the largest initiative ever undertaken in medical nanotechnology. This is medical nanotechnology. There is a National Nanotechnology Initiative which we're part of, but this is focused on medical nanotechnology, specifically cancer.

So how have we done in five years? Well, we've done pretty well.

In these first five years we've developed a field, we've got a lot of new agents coming out of the alliance already in clinical trials and we have many in the pipeline coming into clinical trials. So by putting the patients at the center and saying we want you to transfer your technology has been very effective.

So, we decided to give this program another five years because we really want to see this science really translate into patients in the next five years. And so that's the focus for the next five years: translate, translate, translate.

Jackson: You sort have answered my next question. I know it's always hard to predict what's going to happen in research, but what Alliance for Nanotechnology breakthroughs can we expect in the future?

Barker: Well I think it's always hard to predict the future, but we can at least go with the present in terms of what we know is going on from alliance investigators. For example, we have breakthroughs that I think are going to be coming fairly quickly in imaging.

Nanotechnology is used pretty effectively to improve and enhance imaging. For example, Dr. Ralph Wislider at Harvard has actually created a new nanoparticle that is able to detect as few as two cancer cells in one microliter of biospecimens and that's patient materials. And that's pretty amazing because that means you'll be able to with imaging to look at exactly what you're delivering to cells.

We have a lot of things going on at early detections so I would predict that in the next five years we are going to see a lot of progress in terms of new technologies to detect cancer very early and actually detect its recurrence very early.

In terms of drug development, I think the earliest winds, which are already occurring in nanotechnology, are in delivery of drugs. Well it turns out that one of our—Dr. Mark Davis actually—one of our investigators in the alliance is actually able to deliver RNAI in a nanoparticle and it's never been done before. I mean ranging all the way from established drugs to very new drugs, I think you'll be able to see some real advances in the way we deliver drugs to patients.

Then last, there are some of the alliance investigators that are actually putting together combinations of diagnostics and drugs.

So I think you're going to see real progress in this area of very complex constructs that can detect disease, deliver drug, monitor patients.

Jackson: I just have one final question for you. And again, this is an open ended question, but how much longer before we begin to see nanotechnology being commonly used in the clinic to diagnose, treat, and maybe even prevent cancer?

Barker: Well it's a very interesting question because although people aren't thinking much about it, we already use nanotechnology in the clinic pretty broadly. This isn't a new chapter for us.

What you will see though, I think, is see these new constructs coming forward that are either entirely new particles that are actually things like Mark Davis's particle, for example, delivering something like RNAI to patients. But I think in the next five years, the most progress may occur in early diagnosis. Right behind that is going to be these very combined—these very complex, combined constructs. These combinations of diagnostics and therapeutics—this about the only way we can do this. So I think nanotechnology is going to be a leader in that area. It's a longer time frame but I think in five years, you're going to see real progress in that area.

But we don't want to over promise, but by the same token we want to make sure that we're communicating about it regularly because we are doing everything we can to make sure that these approaches are safe for patients, but also that if they're better for patients they get to patients as effectively and as efficiently as we possibly can. So we'll continue to push our investigators to translate the science to patients.

(THEME MUSIC)

Balintfy: That was Dr. Anna Barker at NCI speaking with Calvin Jackson. For more about nanotechnology and cancer, visit www.cancer.gov. Also, be sure to tune in to future episodes as this series on nanotechnology continues. For now, that’s it for this episode of NIH Research Radio. Please join us again on Friday, September 24th when our next edition will be available. I'm your host, Joe Balintfy. Thanks for listening.

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