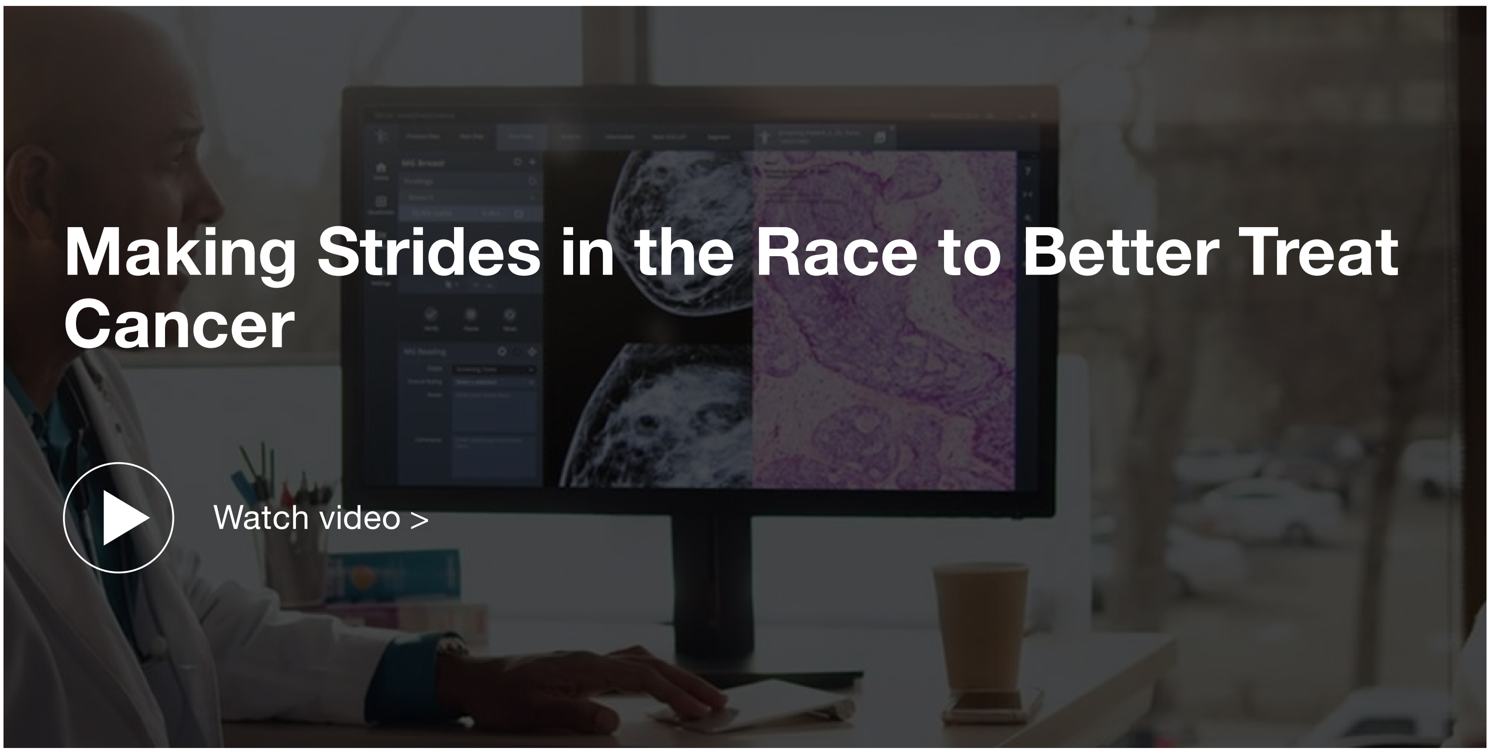
Technology and Oncology: A Powerful One-Two Punch



After surgeries—including a double mastectomy—radiation, and chemotherapy, the aggressive breast cancer Beth Shia had been diagnosed with in 2011 showed no signs of quitting. In 2018 her oncologist found tumors in her brain, lymph nodes, and lungs. The prognosis, she knew, wasn't good.

Then her oncologist suggested she enroll in an Oregon Health & Science University clinical trial studying "precision" cancer medicine. Researchers took a variety of measurements of her tumors and analyzed their composition. They also took high-resolution images of her tumors, a laborious manual process. After researchers and oncologists concluded their advanced study of Shia's tumors, a tailor-made treatment plan was devised.

Whether any of it would work, no one knew. Shia was only the third person to enroll in the study, so there wasn't much data to go on. But she gave the plan a try. At that point, she had nothing to lose—and everything to gain.

Technology's life-saving potential

New and emerging technologies are being used to collect and analyze data from patients like Shia to teach scientists about the makeup and proclivities of various cancers all the way down to their DNA.

Keys to innovative treatments—such as new drugs and combinations of drugs that attack the tumor, not the patient—may lurk in the unique molecular structure of each cancer cell run amok. Unlocking those secrets using AI, memory, storage, and deep learning acceleration technologies is enabling medical professionals to tailor individual treatments for individual tumor types.

"Personalized cancer medicine," also known as "targeted therapy", "precision oncology" and "precision medicine," is the hot trend in cancer research, one that scientists say holds great promise. Although still in its infancy, scientists have high hopes for its use.

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And as technologies improve at an ever-increasing pace, so will our knowledge of cancer. Its mysteries revealed, scientists hope to downsize this dreaded disease from death sentence to treatable illness, its victims no longer sickened by invasive therapies.

"This is a very good time to be involved in cancer research," said Dr. Sadik Esener, director of the Knight Cancer Institute's Cancer Early Detection Advanced Research (CEDAR) Center at OHSU in Portland. OHSU is a leader in the fields of personalized cancer medicine research and precision cancer early detection research, and Micron is working in collaboration to provide OHSU and CEDAR with the technologies it needs to do its work.

"This is a time where we are going to make some progress, and are making progress very rapidly," Dr. Esener said. "Whether we can cure cancer, I cannot say, but we will, hopefully, be able to turn it into a chronic yet manageable type of disease."

That's more a control than a cure, Dr. Esener admits. But it's one that could save the lives of cancer victims while preserving their quality of life.

Tailor-made treatments

Precision medicine is a relatively new approach in cancer therapy, and only used on a small percent of patients today. But as the amount of data generated on cancer patients and tumor genetics grows, and scientists discover more medicines to work on specific tumor types, targeted therapies stand to become the rule rather than the exception.

Today, physicians prescribe treatments according to the part of the body affected, such as lung or breast cancer, and its stage of progression. In recent years, however, researchers have discovered that the changes in DNA that cause formerly healthy cells to become cancerous differ from patient to patient. These differences may help explain why tumors that appear identical—affecting the same organ and at the same stage—may react differently to the same treatment.

Researchers at OHSU and other organizations are using technology to study and record the compositions of tumors. By analyzing their DNA and proteins, and examining high-resolution images of the tumor cells and their environments, they try to discern which drug or combination of drugs will halt their growth, shrink them, or even eradicate them completely.

With the research in early stages and data limited, deciding which medicines to use can be a guessing game. But each new trial provides more information about what works on specific tumor types and what doesn't, increasing the chances of success for subsequent cancer patients.

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Director, Knight Cancer Institute's Cancer Early Detection Advanced Research Center

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At OHSU, researchers built the SMMART (Serial Measurements of Molecular and Architectural Responses to Therapy) platform to study tumors and their responses to treatment, then design therapies according to what has worked before on tumors with similar compositions. Often, they prescribe drug combinations to launch a multi-pronged attack before the tumor can develop resistance. Patients on the program are followed over time, so that treatments can be adjusted as the tumors change. This allows the SMMART platform to have the best chance of benefiting the individuals in the program.

The current focus of the SMMART program is on advanced metastatic cancers where the aim is for durable and tolerable control of disease. While the program may not be able to provide a cure for these patients, the hope is that the strategies developed by the program to control advanced cancers may well be curative when applied to tumors detected at an earlier stage.

After the OHSU team was able to analyze Shia's cancer, they recommended a two-drug combination for her specific genetic makeup: a "targeted" therapy they thought might be effective against her tumor type, and a medicine that activates the immune system to fight cancer. Shia's aggressive form of cancer had not responded to her previous treatments, her cancer was spreading as the clock continued to tick by.

To treat, or not to treat?

If there's one thing all cancers have in common it may be this: Early detection increases the likelihood that treatment will succeed. Some cancers hide in their host's body for decades before being discovered. Lung cancers are notoriously difficult to detect in the early stages.

To help oncologists find and treat cancers in the early stages, CEDAR scientists are developing "fluid biopsy" techniques for detecting cancer "biomarkers," or indicators, in body fluids, Dr. Esener says. Blood tests appear especially promising for early detection—so much so, he says, that pharmaceutical companies are expressing interest in the research.

Far trickier is the question of what to do once cancer is found. Aggressive tumors—those that spread quickly—require aggressive treatment. Others do not grow beyond a certain size or may grow so slowly that they are unlikely to cause suffering or death. But how can doctors differentiate lethal cancer tumors from non-lethal ones? Doing so is a cornerstone of CEDAR's research.

"We don't think that we can do it with only human thinking," Dr. Esener said. "We believe that we need deep-learning algorithms and machines to help us differentiate lethal cancers from non-lethal cancers as early as possible, so that we can give the right drug to the right person at the right time."

Cancers tend to change as they progress, Dr. Esener says. Drugs that might work in the early stage could be ineffective in later stages, and vice versa. In cancer as in life, timing can be everything.

A dearth of data

As promising as precision medicine seems for effective cancer treatment, a few obstacles remain to "ending cancer as we know it."

Data is a major hurdle: There isn't enough of it—yet—to enable researchers to find the right treatments for most cancer patients. The science is still new and collecting information about specific cancers and their progression takes time.

"Cancer is not one disease, it's maybe thousands of diseases," Dr. Esener said. "First of all, there is a large variety of cancers, depending on the organ. But also, for the same organ, two people that have the same organ disease, cancer, may have totally different diseases. And worse than that, as the disease progresses, the disease changes, and new types of cells are generated. The disease changes over time."

With so much going on at once, having massive amounts of data for analysis and comparison will be key for developing targeted cancer therapies, Dr. Esener says.

"It's very important to be able to take longitudinal data," he said. "We need to take data in time. For example, to do blood biopsies, and analyze the blood every other week or every month. And then to learn from that data the progression of the disease and be able to predict how the disease is going to progress.

“From every patient, we learn a bit more, and we try to apply what we have learned to the next patient. And also, to the same patient, as they progress through the disease.”

Dr. Sadik Esener

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As scientists collect more data, they hope to achieve more accurate cancer diagnosis and prognosis for a chosen treatment’s success. Institutions and individual researchers are forming collectives to share data, and the OHSU Knight Center’s own “Healthy Oregon Project” has its own plans to collect data from at least 100,000 state of Oregon residents and perform ongoing tests on those at high risk for cancer.

The Cancer Genome Atlas program (TCGA), a project by the National Cancer Institute (NCI) and the National Human Genome Research Institute, has compiled 2.5 petabytes of data for 33 cancer types, all publicly available. Many other institutions and private projects are researching and collecting data, too. For example, OHSU and the SMMART program are participating in the NCI’s Human Tumor Atlas program, in which the amount of data generated per patient will be 10-100 times as much as in TCGA.

Now, the onus is on technology to keep pace. To store and process all that data, a vast amount of fast memory is imperative. Micron is working with researchers at OHSU to provide them with the memory and deep learning acceleration solutions they need.

“What Micron is offering us is a great thing,” Dr. Esener said.

Micron’s targeted technologies

Groundbreaking research requires innovative technologies—not the “one size fits all” approach that computer design has taken in the past, but memory and acceleration solutions tailor-made for specific needs.

To enable OHSU’s precision cancer team to view three-dimensional, high-resolution images of tumors; process complex data sets quickly and accurately to find the right cancer therapy at the right time for each patient, and aid in not only diagnosis but also differentiation between lethal and non-lethal tumors, Micron’s Advanced Computing Solutions team (ACS) is asking questions, listening to answers, and building their deep learning accelerators especially suited to tackle the research projects at the Knight Cancer Institute.

“We’re doing some heavy lifting,” said Mark Hur, Micron’s Director of Operations of Advanced Computing Solutions “giving them a way to accelerate their inference engine using Micron’s Deep Learning Accelerators (DLA). We’re building it from the memory chip through to the end product; we're talking streamlined vertical integration to create [a solution] that's optimized for their workload."

An "inference engine" is the component of AI that solves problems using data. To work, it needs to read, analyze, and organize enormous volumes of information, which can take massive amounts of memory and a lot of time and power.

"We're helping the healthcare providers find solutions to their real-world problems."

Bambi DeLaRosa
Micron's Healthcare AI Principal Investigator and OHSU collaborator

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For instance, viewing tumor cells microscopically in 3D, and gathering the data scientists hope to use to accurately diagnose and treat a tumor requires a very high-resolution image. The memory required is so large that, in the past, the tumor images had to be processed in segments, rather than as a whole; the images losing clarity where they are stitched back together to be viewed.

But Micron's ACS team found a way to double the memory on its high bandwidth Deep Learning Accelerator and speed up processing using Micron's programmable FPGA inference accelerator. Combining Micron's FPGA-based computing power with its fastest memory technologies such as its DDR4 and high speed memory will enable Knight Cancer Institute researchers to process entire high-resolution tumor images as a whole—critical to the OHSU mission.

"We're focusing on these very, very data-rich machine learning application spaces: What does that look like? How are we building next-generation memory technologies to solve those particular problems?" said Bambi DeLaRosa, Micron's Healthcare AI Principal Investigator and OHSU collaborator. "We're helping the healthcare providers find solutions to their real-world problems."

From hopeless to 'hopeful'

Two months after Beth Shia began the combination of drugs and therapies recommended in her trial, tests showed that the metastasized cancer had vanished from her brain. The tumors in her lungs and lymph nodes had reduced by 70-80 percent.

Six months into the trial, scans found no cancer at all.

Shia told a local newspaper that she remains cautious. Rather than a cure, she said, she views her treatment as a way to live with the disease.

“Truthfully, I don’t believe this will make it go away. This will just allow me to live many years with this, continuing some treatment,” Shia said. “I’m hopeful if this particular protocol or combination of drugs doesn’t work, then there will be something else I could try.”

If the world hopes to “end cancer as we know it” as Dr. Esener and the OHSU team are striving to do, it will need a mighty collaboration across a multitude of industries and disciplines. Micron’s vision is to transform how the world uses information to enrich life. Providing researchers with the technology they need to fight cancer is one way that is being done.

For Dr. Esener, the fight against cancer is rooted in his own story. The loss of his wife and his mother to cancer, and the emotional toll those deaths took, spurred him to dedicate his research to precision oncology.

“I decided to focus the remaining ten years of my scientific life to cancer,” he said. “I think it’s one of the most serious problems that we need to address. We feel a responsibility on our shoulders to try to come up with solutions to this terrible problem.”

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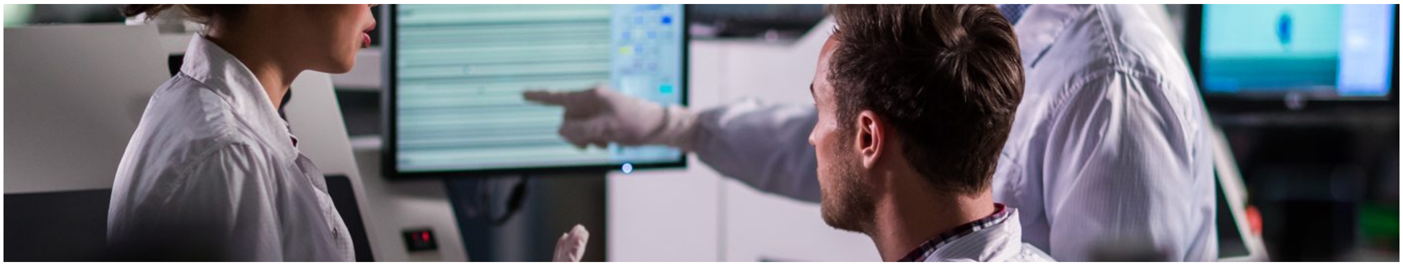

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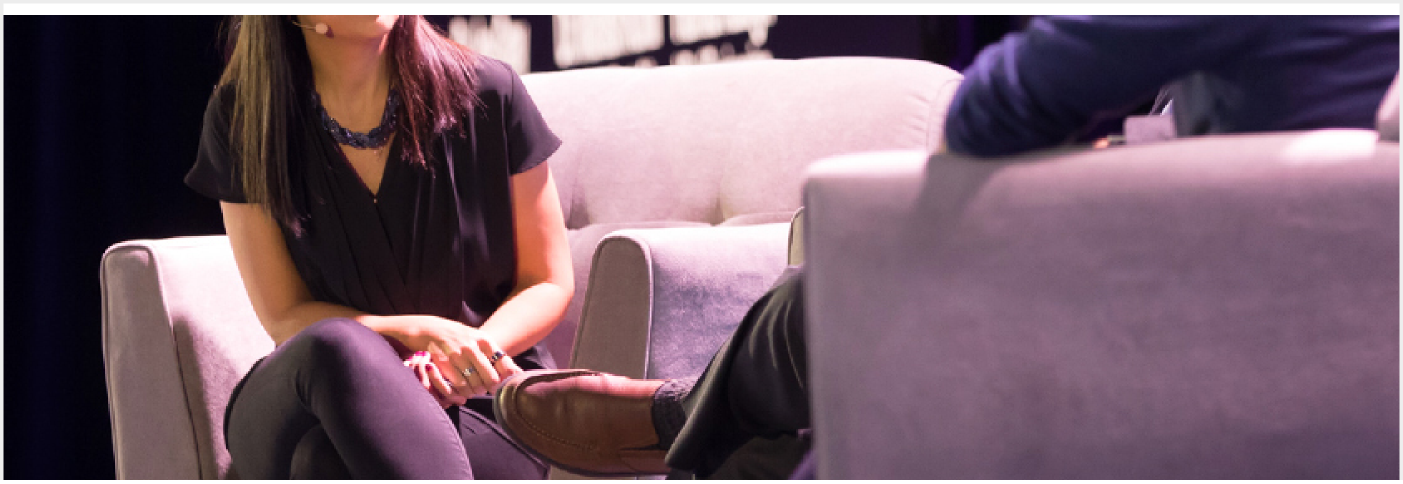

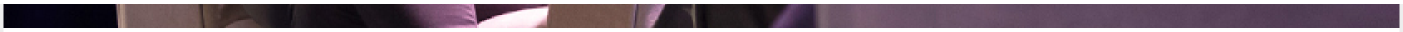

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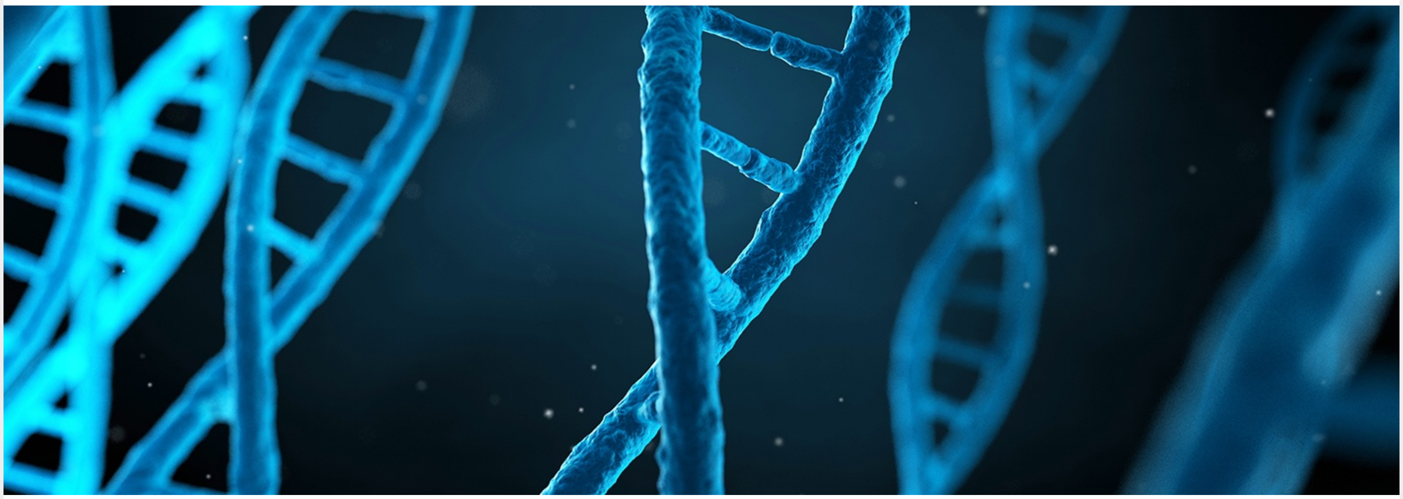

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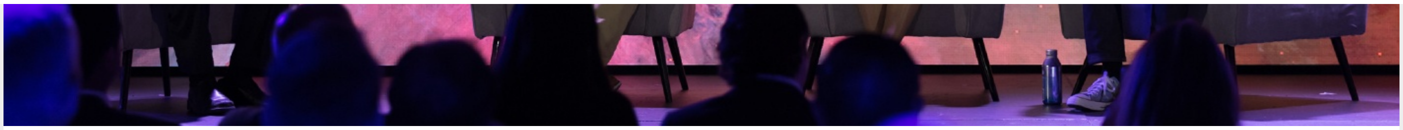

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