Not your grandparents' nuclear medicine

Discovery
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In the late 1800s, at a time when people still traveled in horse-drawn carriages and lit homes with wax candles, scientists discovered nuclear power. They found curious elements, such as uranium and radium, which emit invisible rays of energy. They called this energy radiation.

When they noticed that radiation had the power to burn skin, they applied it to treat cancer. The benefits were evident, but it would take scientists decades to understand how to wield the energy that emerges from the core of these special atoms safely.

Now, a different form of nuclear medicine is on the scene and it looks nothing like the radiation therapy of the past. Targeted radioligand therapy harnesses the power of radioactive atoms and is designed to deliver it directly to cancer cells no matter where they are in the body. Novartis is investing in this emerging form of nuclear medicine because it believes it has the potential to become a foundational pillar of cancer therapy.

Marie Curie discovered radium’s radioactive properties and championed its use in the treatment of cancer. Early efforts to use radioactive elements to treat cancer (this image circa 1926) showed promise but were imprecise.

Photo: General Photographic Agency/Getty Images

Beam radiation uses computers to direct beams of energy at tumors to destroy them. The approach is a staple of cancer therapy today but is limited to spot treatment.

Photo: Mark_Kostich

Targeted radioligand therapy is an unconventional form of nuclear medicine that is infused into the bloodstream, where it is designed to seek out cancer cells in the body and unleash radioactive energy to kill tumor cells.

Photo: Novartis

Today, more than half all cancer patients receive some form of radiation during the course of therapy. A familiar treatment involves focused beams of radiation that provide “spot” treatments typically for disease that has not spread widely.

Targeted radioligand therapy explores this ability to focus radiation. It is infused into the bloodstream, where it is designed to reach cancer cells throughout the body and unleash radioactive energy to kill tumor cells.

“It’s cool because the idea is so simple,” says Germo Gericke, a leader in research and development for nuclear medicine at Novartis.

A century of learning

Scientists began to harness radiation for medicine in the mid-20th century, when they learned how to focus beams of radiation to treat spots of cancer. Computer-guided therapies sharpened the aim and reduced damage to healthy skin and tissue nearby.

Video of Nuclear Medicine is Changing

This different form of nuclear medicine, targeted radioligand therapy, has the potential to deliver radiation precisely to tumor cells throughout the body. This unconventional medicine consists of two main components: a radioactive atom and a tumor-specific molecule.

The tumor-specific molecule is like a puzzle piece that matches complementary molecular puzzle pieces on the surface of cancer cells. These surface molecules are ready and waiting for arrivals that fit. The two snap together when the medicine gets close. The chemical puzzle pieces rarely match surface molecules on healthy cells, so the medicine passes most of them by.

“We’re able to deliver the radiation to a little speck of cancer anywhere in the body because we’re exploiting the cancer’s hunger for tumor-specific molecules,” says Chris Leamon, a nuclear medicine drug discovery expert at Novartis.

Researchers only have matching puzzle pieces for a few forms of cancer right now, so the range of approved and experimental radioligand therapies is limited. Leamon’s team and other Novartis researchers are working to discover more and hope to expand the use of targeted radioligand therapy to treat more forms of cancer.

Harnessing nuclear power

The radioactive atom at the heart of targeted radioligand therapy is, in reality, just an atom that emits energy. Atoms chosen for use in this medicine have specific properties that have medical value.

For instance, these atoms have the ability to destroy cancer cells. The destructive energy emitted from radioactive atoms is primitive, a little bit like throwing stones at a tumor cell’s vital machinery and causing it to crumble. This destructive energy is designed to travel no more than a few millimeters from the atom, so the damage can stay relatively focused on tumor cells.

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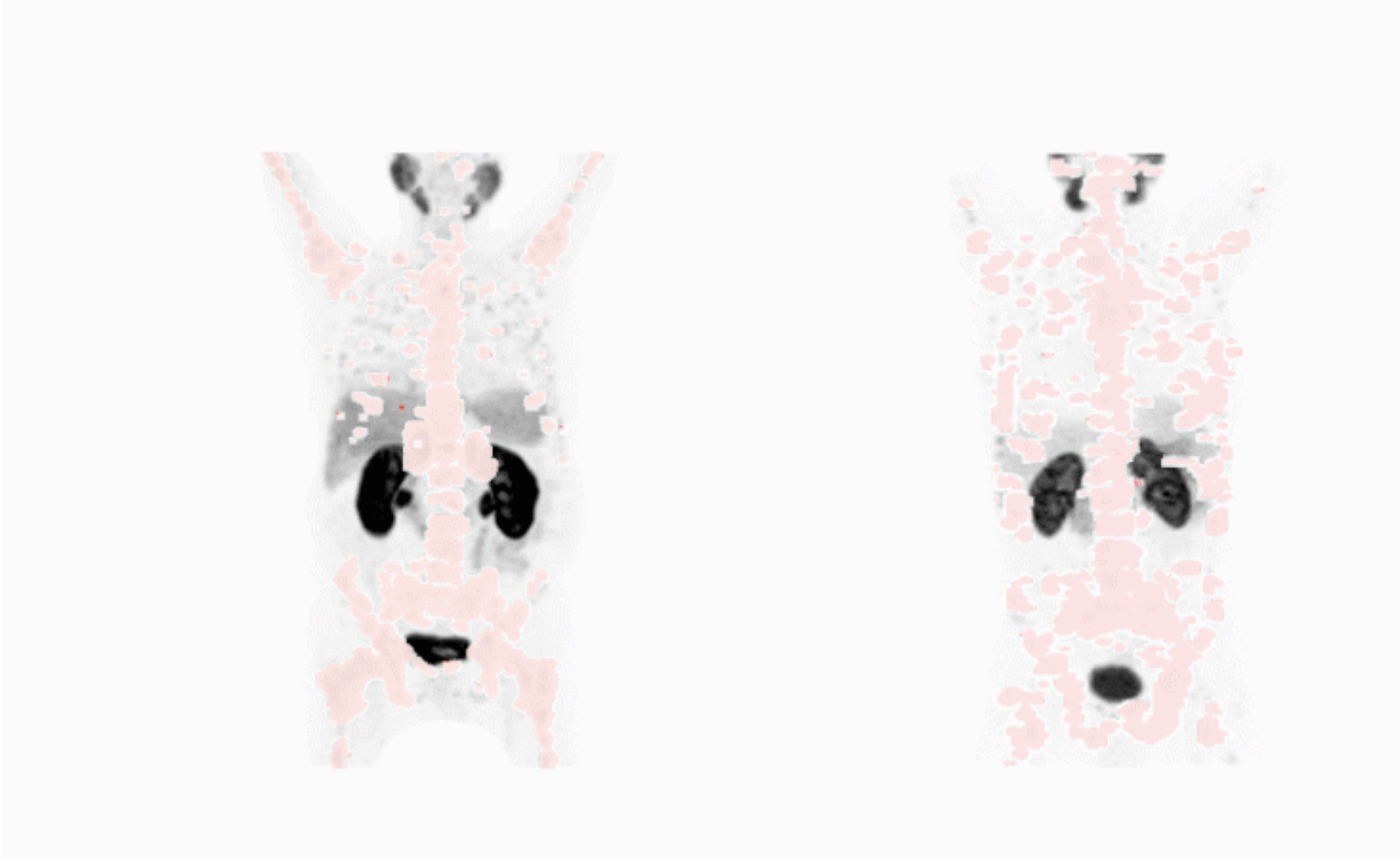
>
> **Germo Gericke**

Once infused into the bloodstream, targeted radioligand therapy carries individual radioactive atoms through the body. When many radioactive atoms coat a tumor, they collectively have power to do real damage.

“Once a tumor cell reaches a threshold of damage, it just gives up and dies,” says Leamon.



Nuclear medicine has a diagnostic component. It uses the same tumor-specific molecule as the therapeutic, but delivers radioactive atoms that have the potential to unveil cancer. Those atoms emit gamma rays that are detected by specialized imaging devices. If the medicine finds the specific form of cancer, the approach will reveal the cancer no matter where it is throughout the body - even in tiny spots no surgeon could see or excise. Image by Michael Hofman courtesy Journal of Nuclear Medicine. Animation by Fidelis Onwubueke

Nuclear medicine also has a diagnostic component. The diagnostic uses the same tumor-specific molecule as the therapeutic, but delivers radioactive atoms that have the potential to unveil cancer.

These atoms emit a form of energy that can be detected outside of the body by imaging scanners. This form of radiation enables doctors to see the cancer no matter where it has spread in the body.

The diagnostic will only reveal a patient’s cancer if the molecular puzzle pieces match. If they do, targeted radioligand therapy using that same tumor-specific molecule is potentially a good match for the patient.

This “see it, treat it” capability enables doctors to choose the right medicine for the patient’s specific form of cancer. In addition, future scans can help doctors determine if the medicine is

working as treatment progresses.

“We can see where the drug is going, how long it stays there, and what’s going on while it’s there,” says Gericke. “This allows us to do studies that help us understand more about this approach.”

A foundational pillar

In 2018, Novartis acquired Advanced Accelerator Applications, a company based in France that had figured out the logistics involved in harnessing radioactive atoms for targeted radioligand therapy [1] and pioneered its clinical development. The purchase of another company, Endocyte, which was pursuing novel approaches to targeted therapies for cancer, soon followed.

The teams are now working as one, alongside Novartis colleagues, to expand the reach of targeted radioligand therapies to treat a broad range of cancers. They are also conducting clinical trials to learn more about how patients respond to this advanced form of nuclear medicine.

“We’re in a position to leverage our collective expertise in nuclear medicine for the benefit of patients with cancer in both diagnostics and therapy,” says Gericke.

This story has been updated to improve clarity.

From Our Labs [2]

Turning the power of nuclear technology into a medical force [1]

Links
[1] https://www.novartis.com/stories/from-our-labs/turning-power-nuclear-technology-medical-force
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