



# STRONGER AND MORE FLEXIBLE X-RAY RADIOTHERAPY

Researchers hope that a **POWERFUL AND MORE RESPONSIVE X-RAY RADIOTHERAPY SYSTEM** could target cancers with great precision, shortening treatment times and reducing damage to healthy tissue.

**X-ray radiotherapy, or radiation therapy**, which uses beams of ionizing photons to kill cancerous cells, is a common weapon against cancer. But there's a lot of room for improvement, says Mitsuhiro Yoshida, who heads an X-ray radiotherapy project within the multinational corporation Hitachi, headquartered in Tokyo, Japan.

An advantage of X-ray-based radiotherapy is that it allows

▲ A new, more flexible X-ray radiotherapy system (pictured) means that patients are less likely to have to be painstakingly repositioned on the table to align the irradiation zone with a tumour.

patients to receive treatment during brief visits, allowing for continuation of normal life, he explains. However, while it is very effective at damaging cancer cells, it's difficult to restrict the radiation to the tumour, rather than nearby healthy cells.

"We identified many aspects of conventional X-ray radiotherapy that could be improved, ranging from the flexibility of beam movement to the X-ray source," Yoshida says.

## BETTER MOTION

Hitachi's original expertise was in another type of radiotherapy, called particle beam therapy, which uses beams of protons

or other charged particles instead of photons, Yoshida explains. But after Hitachi acquired X-ray radiotherapy technology from Mitsubishi Heavy Industries in 2017, the company began developing it as a more accessible and affordable option than particle beam alternatives. This led to a new radiotherapy system.

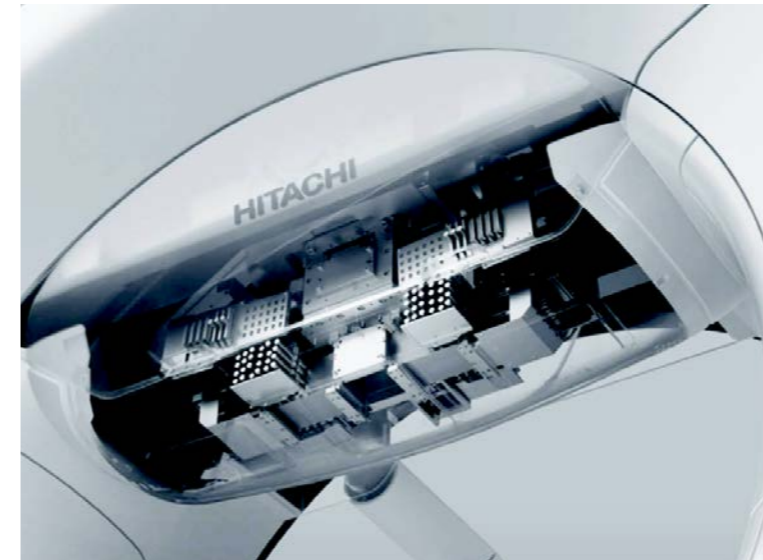
One issue they tackled was the size and weight of an X-ray source, the unwieldy size of which means that conventional X-ray radiotherapy systems have a limited range of beam motion. Because of this, patients must be painstakingly positioned and repositioned on a table to carefully align the

irradiation zone with a tumour.

This also means that it's often difficult to prevent radiation straying into surrounding healthy tissues, says Yoshida.

"We realized that to create more freedom of motion, we needed to make the X-ray source much more compact in order to be able to add pan and tilt rotation," says Shuji Kaneko from the Hitachi project team.

The researchers developed a new X-ray source that can achieve the standard beam strength at half the standard size. They then incorporated it into a new machine design, called the Dynamic SwingArc, which achieves a greater



▲ Hitachi has developed a new X-ray source that can achieve the same beam strength as conventional X-ray radiotherapy systems at half the standard size.

range of swivel and dual-axis rotation motion than most current models.

This new range means that the patient doesn't need to be specifically positioned or repositioned — instead the beam itself can be repositioned, explains Kaneko.

The precision of the new system is the culmination of many other precisely engineered improvements too, adds Kaneko. Among them, is a dual-imaging system that reduces X-ray imaging snapshot times for one part of the system, called cone beam computed tomography, from 30 seconds to just 15. These images help provide guidance on where to focus the photon beam — and faster double snapshots using one button allow for clearer images and less time spent on positioning.

"With this system we can now be so precise, that we should be able to irradiate single vertebrae without impacting the spinal cord, or irradiate a thyroid gland without impacting other tissue

in the head, neck or shoulders," says Yoshida. "This also means X-ray therapy can be used for a wider range of tumours and sites in the body, which could greatly expand the use and benefit of this increasingly important treatment."

**"OUR SYSTEM BENEFITS PATIENTS BY SHORTENING THE TIME THAT THEY NEED TO SPEND ON THE TREATMENT TABLE."**

## WORKING WITH BREATH

Another issue with older X-ray radiotherapy systems, says Yoshida, is the movement generated by a patient breathing. This movement means that for certain cancers the X-ray beam needs to be applied intermittently, as the tumour moves into and out of the focal area — a process called 'gating' that can greatly extend the patient's time in the treatment room.

With Hitachi's system,

4D modelling of respiratory motion over time and fast X-ray fluoroscopy imaging allows the tumour to be accurately tracked in real time to allow continuous treatment without gating.

"Our system benefits patients by minimizing the radiation dose to healthy tissue, and also by shortening the time that they need to spend on the treatment table, often to less than seven minutes, without the discomfort of repeated repositioning during long treatment sessions," says Naonobu Sukegawa, a computing specialist and head of the planning office at the Hitachi Healthcare Business Division.

"From a hospital's perspective, the new system can likely achieve much higher patient throughput with the potential for more precise treatment outcomes," he says.

The system — which has been approved for use as a medical device in Japan, but not yet elsewhere — may be used in hospitals in Japan as early as April 2024.

## HITACHI HEALTHCARE

A new Hitachi division is devoted to creating technologies that **SPAN THE ENTIRE PATIENT JOURNEY**.

In April 2024, Hitachi Group plans to consolidate its Healthcare Business division and a group company, Hitachi High-Tech, into an integrated and patient-focused organization that develops technologies that can address the entire journey from diagnosis through to treatment and management.

By connecting diagnostic and therapeutic systems with enhanced digital technologies, such as new softwares and artificial intelligence systems, Hitachi aims to address emerging issues surrounding healthcare. These include the needs of an ageing population and its associated increase in cancer prevalence, and rising medical costs. The focus will be on early diagnosis and treatment and advanced personalized medicine.

## IMPROVED OPTIONS

The new system has been developed as part of the Hitachi Healthcare Business, which hopes to cover the whole patient journey seamlessly with their technologies. The company's technologies already ranged from those covering advanced molecular and biochemical diagnosis for cancer and other diseases — developed by Hitachi High-Tech's sister division, Hitachi's Healthcare Business Division — to more complex systems, including the particle beam therapy systems.

Upcoming projects, Sukegawa says, will develop digital technologies to support diagnoses. Others will focus on treatment offerings to minimize gaps in the patient's journey, and improve the efficacy, efficiency and personalization of treatments. ■

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