



## WHY JAPAN IS A LEADER IN RADIOLOGICAL RESEARCH

From X-ray tech as far back as 1896, through to the adoption of **AI FOR DIAGNOSING DISEASES FROM MEDICAL IMAGES** today, Japan has long been at the forefront of radiology.

**Japan has a rich history in radiology** and its experts in the field have broken boundaries to achieve greater accuracy and improved technology for their patients.

This tradition began with the nation's first X-ray image taken in 1896 — a mere 10 months after their discovery by Wilhelm Röntgen, and has continued through other innovations, including the development of the world's first upright 320 channel

▲ **A patient undergoing a magnetic resonance imaging (MRI) scan.**

CT (computed tomography) machine in 2017.

Supporting this pursuit of continuous excellence are many learned associations such as the Japanese Radiological Society, the Japanese Society for Radiation Oncology, the Japanese Society for Magnetic Resonance in Medicine, the Japanese Society of Interventional Radiology, and the Japanese Society of Radiological Technology.

### AI MEETS RADIOLOGY

Artificial intelligence (AI) is one of the latest technologies on the

radar of Japanese radiologists.

According to Shigeki Aoki, president of the Japan Radiological Society (JRS), based in Tokyo, by training radiologists to work alongside AI and use it as a tool to enhance what they are doing, it may be possible to increase focus on preventative care as well contribute to the advancement of health and welfare.

To that end, JRS is promoting big data and AI-enabled medical care to contribute to public health. One of the projects it is

spearheading — supported by the Japan Agency for Medical Research and Development (AMED) — is the establishment of a national database for diagnostic imaging.

The Japan Medical Image Database (J-MID), established in 2018, contains CT and magnetic resonance imaging (MRI) scans and diagnostic reports uploaded from major university hospitals in Japan.

Transformed from on-premises to cloud-based infrastructure in 2023, J-MID now contains approximately 500 million images.

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## WHAT IS RADIOLOGY?

A WIDE-RANGING FIELD OF RESEARCH, radiology includes a number of distinct disciplines.

Radiology is a branch of medicine that uses X-rays and other forms of radiation for imaging, diagnosis and treatment, and can be split into four main specialities:

- **Diagnostic Radiology** — takes images of the interior of the body and uses them to diagnose medical issues.
- **Interventional Radiology** — uses image-guided procedures to diagnose and treat medical conditions. Common procedures include angioplasty, drainage stent placement.
- **Radiation Oncology** — treats malignant diseases using ionizing and other modes of radiation.
- **Radiological Technology** — focuses on developing and improving technologies to provide optimal image quality for diagnosis and treatment.

There are also a number of subspecialties including: magnetic resonance, nuclear medicine, neuroradiology, pediatric radiology, chest radiology, and more.



▲ **An angiography system that interventional radiologists use for image guided procedures.**

Japan has one of the highest numbers of CT and MRI installations per capita in the world. As a result, the volume of image data sets is also very high, making it possible to collect a large amount of data in a short period of time.

**"ARTIFICIAL INTELLIGENCE IS USEFUL BUT IT HAS TO BE USED APPROPRIATELY FOR DIAGNOSIS AND MUST NOT DISADVANTAGE PATIENTS."**

Japan is one of few countries that has adopted a national health insurance system that provides CT and MRI scans for all citizens, says Aoki. "This allows us to collect unbiased image data regardless of age or socioeconomic status," he adds, as opposed to countries where some low-income patients are unable to access CT and MRI scans due to limitations by their private insurance coverage.

The database will be used to improve medical technology, patient safety, reduce radiation dose, while maintaining image quality.

Research and development on the uses of AI for radiology is also being conducted at J-MID. JRS is considering generating AI-based radiology reports using J-MID data.

Use of AI in medical imaging is something that JRS is monitoring, with an aim to maintain quality and guide implementation. "Many AI products have already been released, but their performance varies," says Aoki. He expects the number of AI medical imagery tools to grow, noting that it's important to verify and control their quality before they are released to the market. "AI is useful, but it has to be used appropriately for diagnosis and must not disadvantage patients or medical economics," he adds.

To do this, JRS has established guidelines for medical image AI, which require vendors to be certified

by JRS and registered to the JRS database. As a result, users can easily recognize what kind of AI medical image tool is available and certified. Aoki says that performance tests for AI tools will also be considered in the future.

JRS was formed in 1950 after the unification of its predecessors, the Japan Röntgen Society and the Japanese Society of Radiological Sciences, which were founded in 1923 and 1933, respectively. It represents more than 10,500 members. It publishes *the Japanese Journal of Radiology* as well as running training and educational courses, communicating and collaborating with academic organizations, and conducting promotional and educational activities. The society also certifies specialists and healthcare institutions in general radiology, diagnostic radiology, and radiation oncology.

### PARTICLE THERAPY

"Japan is leading the world

in particle beam therapy", a technology that has really been championed in the country, says Hideyuki Sakurai, board member of the Japanese Society for Radiation Oncology (JASTRO), based in Tokyo, and a professor of radiation oncology at the University of Tsukuba.

Particle beam therapy includes proton beam therapy (PBT), heavy ion therapy (HIT), and boron neutron capture therapy (BNCT). In cancer radiation therapy, it is important to concentrate radiation on the cancer while minimizing side effects on normal tissues. Particle beams, such as PBT and HIT, are able to stop at the site of a cancer lesion and release energy in the cancer tissue, making it easier to concentrate radiation on the cancer and not surrounding tissue, explains Sakurai.

"Particle therapy has been actively applied to thoracic, abdominal, and pelvic cancers, and has contributed to the expansion of its clinical indications worldwide," he adds.

There are now 27 particle therapy facilities in Japan, and the number is expected to continue to grow. "Japanese manufacturers have sold the particle beam therapy systems they have developed to the United States and the rest of the world, making it an important industry for Japan," says Sakurai.

"Clinical research promoted by JASTRO has led to the universal health insurance coverage in Japan for the treatment of several tumours such as liver and pancreatic cancers," he adds.

But there is still much work to be done. Sakurai highlights in particular, the importance of generating evidence. For example, clinical research on BNCT for invasive tumours such as head and neck tumours, skin cancer, and brain tumours is now ongoing — and fundamental research for the future, such as the development of multi-ion particle therapy as well as the development of compact devices based on PBT and HIT.

JASTRO, formed in 1988, aims to contribute to the development of academic and scientific technology, by engaging in collaboration and promotion of radiation oncology and any related research. The society represents more than 4,000 experts. It holds regular meetings, performs educational outreach and publishes *the Journal of Radiation Research*.

#### MAGNETIC RESONANCE

The glymphatic system, an important mechanism related to waste clearance in the brain, and neurofluid dynamics are important topics that have recently emerged within the field of neuroscience, especially related to Alzheimer's disease.



▲ Artificial intelligence can be applied in a variety of areas for both radiologists and radiological technologists.

Many developments in this area have been made by Japanese radiologists through the contributions of the Japanese Society for Magnetic Resonance in Medicine (JSMRM), based in Tokyo.

**"JAPAN IS LEADING THE WORLD IN RADIATION MANAGEMENT TECHNOLOGY SPECIALIZING IN MEDICAL IMAGES."**

"Many of the key studies on the glymphatic system have been published from Japan," says Osamu Abe, president of JSMRM and the head of the Radiology and Biomedical Engineering department at The University of Tokyo.

One example is an explanation of how leakage of a gadolinium-based contrast agent (GBCA), commonly used in MRI, into the cerebrospinal fluid can trigger its deposition and accumulation in the brain<sup>1</sup>. Another is the proposal of a popular tool for evaluating glymphatic systems called the diffusion tensor image analysis along the perivascular space (DTI-ALPS) method<sup>2</sup>. Both of these advances were developed by JSMRM members.

The JSMRM was established in 1986 as a non-profit corporation. It represents more than 3,600 members, holds an annual meeting, conducts educational workshops and publishes two journals: *Magnetic Resonance in Medical Science* and *the Japanese Journal of Magnetic Resonance in Medicine*.

#### WHEN TO INTERVENE

"Interventional radiology (IR) is an innovative and minimally invasive treatment, which is delivered through blood vessels or a small incision in the skin for a targeted site under image guidance for a wide range of diseases," says Koichiro Yamakado, president of the Japanese Society of Interventional Radiology (JSIR), based in Saitama, and a professor at Hyogo College of Medicine in Hyogo, Japan.

Examples of IR include liver and renal radiofrequency ablation for cancer patients, and emergent arterial embolization — a standard therapy to stop bleeding after traffic accidents, surgery and childbirth.

"Although IR procedures have become well known to Japanese citizens, awareness

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of the name of IR is still low," says Yamakado. The JSIR is working to change this, seeking to raise awareness of IR, as well as developing and championing new IR procedures.

The society, founded in 1982, represents more than 3,000 full members, including nearly 1,000 JSIR accredited IR specialists. It is a non-profit medical foundation aiming to improve science and technology in the IR field, to support awareness of this treatment, and to serve patient care through education, science and research activities.

#### TALKING ABOUT TECH

"With a history going back 81 years, the Japanese Society of Radiological Technology (JSRT) is a rare academic society that aims to advance scientific radiological technology in



▲ A linear accelerator for cancer radiation therapy.

medicine," says representative director, Takayuki Ishida, who is also a professor at Osaka University's Graduate School of Medicine.

Ishida highlights Japan's radiological research strengths as developing technologies to improve the quality of clinical images; studying and defining the safe use of radiation for the human body; and applying radiation therapy technologies at a high level for daily medical treatment.

"This sort of research makes it possible to optimize the invasion of radiation into the human body while maintaining diagnostic quality and treatment results," he says. "Japan is leading the world in physical and clinical evaluation technology and radiation management technology specializing in

medical images," he adds.

JSRT, based in Kyoto, was founded in 1942, and currently represents more than 17,000 members. It has seven divisions including: image sciences, nuclear medicine, radiotherapy, diagnostic imaging technology, measurement, radiation protection, and medical informatics. It holds two annual meetings and publishes two journals: *Radiological Physics and Technology* and *the Japanese Journal of Radiological Technology*.

#### BRINGING IT ALL TOGETHER

With the world, and particularly Japan, experiencing a shortage of radiologists, dedicated societies that offer support, certification and continued educational opportunities in a wide range of specialities are essential.

The Japan Radiological

Society, the Japanese Society for Radiation Oncology, the Japanese Society for Magnetic Resonance in Medicine, the Japanese Society of Interventional Radiology, and the Japanese Society of Radiological Technology, are striving both to make Japan a better and more enticing place for radiologists to thrive and to advance public health and welfare. ■

#### REFERENCES

1. Naganawa, S. et al., *Magn Resonance Med. Sci* **18**, 163-169 (2019).
2. Taoka, T. et al., *Jpn. J. Radiol.* **35**, 172-178 (2017).