Cancer-treating radiopharmaceuticals gain ground in Asia thanks to IAEA

By Miklos Gaspar

A specialist at INMOL in Lahore, Pakistan checks the quality of radiopharmaceuticals before they are used on patients.
(Photo: INMOL)

Radiopharmaceuticals — medical drugs containing radioactive materials — used for treating cancer have taken root in healthcare systems in many parts of the world, but they are only now beginning to gain ground in developing countries. Thanks in part to an IAEA technical cooperation project, these drugs, which can increase patients' life expectancy, are reaching more countries in Asia. This includes lutetium-177 (Lu-177)-DOTATATE — a radiopharmaceutical for treating neuroendocrine tumours, which are deadly gastrointestinal cancers. The drug has been successfully produced and is now in clinical use, through the project, in Iran, Jordan, Pakistan and Thailand.

As part of the three-year project on radiopharmaceutical production, which ended in December 2018, the IAEA provided support to radiochemists, radiopharmacists and technologists from 20 countries. They received training in the development, quality control and use of therapeutic radiopharmaceuticals. Of the participating countries, 4 are already using these radiopharmaceuticals in clinical practice, and over 100 patients have received treatment.

"This project has had a great impact on improving the management of cancer patients by introducing new treatment options that had not been available previously, particularly given the absence or limited value of other treatment modalities like chemotherapy and radiotherapy in certain cases," said Amer Al-Hourani, radiopharmacist at the Jordanian Royal Medical Services institute, where ten patients have so far been treated with the radiopharmaceuticals.

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Targeted therapeutic radiopharmaceuticals

Radiopharmaceuticals are medical drugs made with radioisotopes usually linked to biological molecules that can target specific organs, tissues or cells within the human body. Since the early 1950s, radiopharmaceuticals have become more commonly used in the diagnosis of various diseases and, to a lesser extent, in the treatment. With recent advances in nuclear medicine research, new radionuclides and radiopharmaceuticals have been developed with greater targeting potential, which is expanding the range of possibilities for customizing and combining radiopharmaceutical diagnostic and treatment options.

The main therapeutic drug that the project participants learned to develop and use is Lu-177-DOTATATE. Targeted therapeutic radiopharmaceuticals, like

Lu-177-DOTATATE, mostly consist of biomolecules such as peptides (amino acids linked in a certain order), antibodies and proteins that are chemically radiolabelled with beta emitting radionuclides, such as Lu-177.

Lu-177 is the radioisotope of choice because, after it is manufactured in a research reactor, it survives long enough to be linked, or labelled, to the right biological molecule, taken to the hospital and then injected into the patient.

Once inside the body, the biological molecule carries the Lu-177 quickly and directly to the tumour, where it concentrates and then bombards the tumour with radiation. Since the molecule targets only the cancer cells, and Lu-177 has a limited lifespan, this technique maximizes treatment of the cancer while minimizing harm to healthy cells in the body. It is most commonly used to treat tumours in the stomach, intestine, prostate and pancreas.

The targeting ability of certain radiopharmaceuticals, like Lu-177-DOTATATE, makes them a useful treatment option for cancers that have spread to several organs through the lymphatic system or the bloodstream. In such cases, removal of the original tumour site with surgery is insufficient, and radiotherapy would require exposing substantial parts of the body to radiation, putting the patient at risk. They are also one of the preferred treatment methods for patients whose immune systems are too weak for chemotherapy, which is a treatment type that affects the patient's whole body.

Treating patients, extending life expectancy

Along with developing and adopting Lu-177-DOTATATE cancer care services, several countries involved in the project have also been expanding their theranostics capacities. Theranostics is a cancer care method that combines the use of radiopharmaceuticals for diagnosis and treatment (learn more on page 8).

In Pakistan, for example, 15 doctors have been trained and equipped, in part through the IAEA, to help set up the country's theranostic radiopharmaceutical services. Each year, there are more than 170 000 new cancer cases in Pakistan.

"The launching of theranostic facilities at INMOL, for the very first time in Pakistan, is a landmark achievement," said Irfan Ullah Khan, Deputy Chief Scientist at the Institute of Nuclear Medicine and Oncology Lahore (INMOL) in Pakistan. "Although the [IAEA] project has ended, we [now] have the technology in Pakistan, so we are continuing the successful treatment of patients. This has really changed patients' lives."

A three-year follow-up IAEA project, launched in early 2019 as a second phase of support, assists the countries involved in the original project in continuing and completing licensing applications and the full operationalization of the method, said Mykola Kurylchyk, the Project Management Officer at the IAEA in charge of this initiative.

"Any country with a research reactor can, in principle, produce these isotopes, and the IAEA is committed to making the technology available to all interested countries," Kurylchyk said.

From beta to alpha

The IAEA project also aims to help countries lay the foundation for the use of alpha emitters as radiopharmaceuticals.

Radiopharmaceuticals using radioactive material undergoing alpha decay — emitting a helium-4 isotope of two protons and two neutrons — rather than beta decay are more effective for cancer treatment but harder to produce. Alpha particles have higher levels of energy transfer and a shorter range. They can therefore better penetrate cancer cells and are up to ten times more effective in destroying these cells than beta particles.

"After countries have learned to produce and administer beta emitters, the production and use of alpha emitters is one of the next steps for even more effective and targeted treatment," said Amir Jalilian, a chemist specializing in radioisotopes and radiopharmaceuticals at the IAEA.

The IAEA has helped experts from Kuwait and Thailand to acquire this more advanced technique, and two hospitals, one in each of these countries, are now using it for treatment. Specialists in some of the other participating countries aim to start the production and use of alpha emitters by 2021, thanks to the follow-up technical cooperation project.