Cyclotrons could alleviate medical isotope shortage

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The most widely used medical radioisotope, Technetium-99m (Tc-99m), is essential for an estimated 70,000 medical imaging procedures that take place daily around the world. Aging reactors, production intermittencies and threats of permanent reactor closures have researchers striving to develop alternative methods of supply. In a comparative study presented at SNM's 57th Annual Meeting, researchers show that medical cyclotrons could be capable of producing this medical isotope.

"This research provides a near-term solution for the medical isotope shortage and the associated global interruptions of Molybdenum-99 (Mo-99) supply, the high costs of reactor maintenance, radioactive waste processing and eventual reactor decommissioning," said Brigitte Guérin, lead author and researcher at the CHUS's Centre de recherche clinique Étienne-Le Bel and the Université de Sherbrooke, Québec, Canada. "These realities make the use of safe cyclotron technology attractive for the regional supply of Tc-99m, while facilitating the expanding role of molecular imaging in diagnosing and treating critical medical conditions, including cancer and heart disease."

The vast majority of the supply of Tc-99m's parent isotope, Molybdenum-99 (Mo-99), is produced by a handful of reactors and distributed to medical centers via generators. About two thirds of the world demand for Tc-99m is supplied by the NRU reactor in Chalk River, Canada, and the Petten High-Flux Reactor in The Netherlands. Both reactors are now over 45 years old and currently out of production for maintenance. NRU is expected to end production permanently by 2016. Nuclear medicine centers across the U.S. and internationally have felt the impact of reactor closures and temporary shutdowns for maintenance, resulting in a growing crisis.

Producing Tc-99m in decentralized cyclotrons could supplement reactor production and act as an alternative during lags in reactor production. Cyclotron production involves bombarding Mo-100 with protons, which does not entail uranium fission. This process is aligned with efforts to reduce reliance on production involving highly enriched uranium, which is also used to produce nuclear weapons.

This study focused on the direct production of Tc-99m from Molybdenum-100 by high-current, medium-energy medical cyclotron and compared the chemical, radiochemical and biological properties of cyclotron and generator-produced technetium for medical use. In the study, researchers compared both cyclotron and generator-produced Tc-99m and prepared imaging agents used in molecular imaging of the thyroid, bone and heart. Both formulations were found to be identical and cyclotron-produced technetium was deemed appropriate for the development of medical-grade radiopharmaceuticals. However, it is important to note that most PET radiopharmacies have lower energy cyclotrons that are not equipped to produce large quantities of Tc-99m using this method.

Further large-scale studies need to be implemented before full-scale production of Tc-99m could begin in regional medical cyclotrons. Funding to further pursue these studies has been awarded by the Natural Sciences and Engineering Research Council of Canada and the Canadian Institutes of Health Research.

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