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Innovations in Isotope Production: How Canadian Technology Can Play a Role in the Future of a Global Isotope Supply

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Abstract

Concern over past and impending shortages has led to renewed interest in alternative production methods for technetium-99m (^{99m}Tc), the world's most commonly used medical isotope. With 30 to 40 million patients relying on this isotope every year, the world is in need of a stable, secure and modern supply of ^{99m}Tc. Many of the >950 medical cyclotrons around the world today operate between 16 and 24 MeV, an ideal range for the production of ^{99m}Tc via the ^{100}Mo(p,2n) reaction. Canada itself is in an enviable position, with most major urban centres possessing a cyclotron capable of direct ^{99m}Tc production from ^{100}Mo. Since 2010, a consortium of 5 institutions from across the country, have been studying the parameters for producing ^{99m}Tc on three different cyclotron models: A PETtrace (at 16.5 MeV), a TR19 and more recently a TR30 (at 24 MeV). The team has now demonstrated a reliable commercial scale (TBq) process for producing ^{99m}Tc using ^{100}Mo coated tantalum plates at energies up to 24 MeV. Our approach was approved by Health Canada and a clinical trial is currently underway.

Beyond ^{99m}Tc, TRIUMF's Life Sciences research program is also keenly interested in leveraging the laboratory's high power 500 MeV cyclotron to produce scarce and costly therapeutic isotopes for both research and clinical application. TRIUMF seeks to leverage its unique infrastructure and deep expertise in high power cyclotron target design to produce and isolate a number of promising radiotherapeutic isotopes. Recent efforts in the production and isolation of ^{209,211}At, ^{223,224,225}Ra, ^{225}Ac and ^{213}Bi from proton irradiation of ^{238}U and ^{232}Th will be discussed. Progress on the isolation of ^{211}At (via ^{211}Rn decay) and ^{225}Ac will be presented. Both ^{211}At and ^{225}Ac are alpha-emitting isotopes with the potential to treat micro-metastases and/or monocellular malignancies such as leukemia. TRIUMF seeks to become a major supplier of radiotherapeutic isotopes and enable clinical trials, potentiating a new paradigm in cancer treatment for all Canadians

Overall, Canada possesses a powerful isotope production infrastructure enabled by a coast-to-coast fleet of particle accelerators (cyclotrons). Through coordination and a sustained investment, these machines are capable of providing a stable, secure and reliable supply of life-saving diagnostic and therapeutic isotopes for years to come.