SCIENCE MEDIA CENTRE OF CANADA
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- Backgrounder -
MEDICAL ISOTOPES

February 19, 2012

At the AAAS Annual Meeting in Vancouver, a symposium will discuss new developments in producing isotopes for medical imaging without using nuclear reactors:

Mastering production of medical isotopes

Embargoed until 8:00 a.m. PST / 11:00 a.m. ET Feb 20, 2012

Canadian Speakers: Paul Schaffer, TRIUMF; François Benard, BC Cancer Agency

News briefing: Feb 20th, 8:00 AM

Event: Monday, February 20, 2012: 9:45 AM-11:15 AM — Isotopes for Science and Medicine: Rare, Radioactive, and Useful.

Radioactive isotopes are essential to thousands of medical imaging procedures every day – but they are only produced in a handful of nuclear reactors worldwide (including the NRU reactor at Chalk River, Ontario). Isotope shortages become more frequent as the reactors age. Canadian researchers are working to use linear accelerators and cyclotrons to produce these vital isotopes, stabilizing the supply and eliminating the production of nuclear waste.

As always, if you'd like some help locating a Canadian expert to interview on this or any other science stories, we are on the ground at the AAAS. Please call us at **613-249-8209**.

Additional stories you want to cover at the AAAS meeting in Vancouver? Let us know! We're here to help.

Register with SMCC (click on the "For Media" tab at www.sciencemedia.ca) to access references, additional resources, and a list of Canadian experts available for media interviews about the Higgs boson. Or call us at **613-249-8209.**

Medical Isotope Production in Canada

Medical isotopes are produced in nuclear reactors. As reactors age, global supply is threatened. The isotope technetium-99m is used in about 80 per cent of medical diagnostic imaging procedures worldwide. Ninety-five per cent of the world's supply of Tc-99m is produced at just five nuclear reactors: in Canada, Belgium, France, the Netherlands, and in South Africa. As the National Research Universal (NRU) reactor in Chalk River, Ontario, faces shutdown in 2016, Canada needs alternatives to reactor-based production to keep meeting demand. In 2010, the federal government allocated $35 million through the Non-reactor based Isotope Supply Contribution Project (NISP) to develop non-reactor based technologies for the production of medical isotopes.

Uses of Technetium-99m

Technetium-99m is a radioisotope of the element technetium. *Goodhand et al.* estimates that globally, 30 million patients each year undergo procedures with Tc-99m. Isotopes are injected into a patient's body. Single Photon Emission Computed Tomography (SPECT) cameras detect gamma rays emitted by decaying isotopes. Many organs and systems can be imaged by injecting, ingesting, or inhaling substances tagged with Tc-99m. For example, Tc-99m-methoxyisobutyliso-nitrile (MIBI) can detect abnormal blood flow to the heart, and can be used after cardiac arrest to determine damage to heart. Tc-99m tagged to white blood cells can detect hidden abscesses.

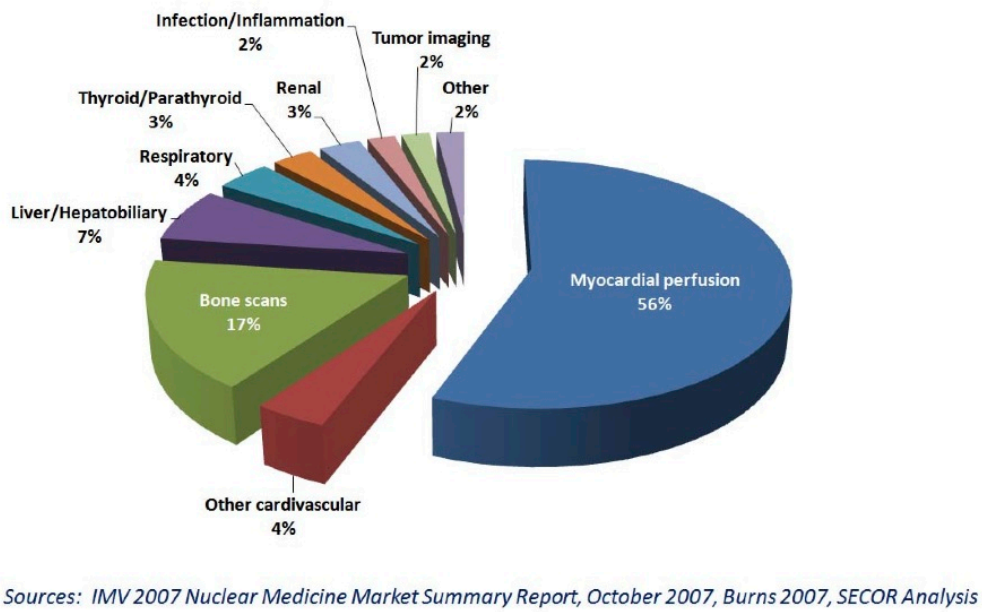

Fig. 1.1: Uses of Technetium-99m in medical imaging: a breakdown of the medical images that can be produced. (Goodhand et al., 2010; to use this image please call 613-992-4447) and/or email (media@nrcan.gc.ca)**)**

Tc-99m's short half-life (six hours) minimizes patient radiation exposure, and produces an easily detectable gamma ray. Unfortunately, this half-life means that it can't be stockpiled. To ensure that Tc-99m is available around the world, its parent isotope, Molybdenum-99, is produced and shipped.

How we currently get Tc-99m – the supply chain in Canada

Highly enriched uranium-235 is imported from the United States to the National Research Universal (NRU) reactor in Chalk River, Ontario. In the reactor, U235 is split into daughter products, 6 per cent of which is Mo-99. The half-life of Mo-99 is 66 hours, and so the product must be shipped rapidly. The half-life is the time for half the sample of the parent molecule to decay to daughter isotopes. After 66 hours, half a sample of M0-99 will decay to Tc-99m. Mo-99 is quickly shipped to processing plants for purification. In Canada, this happens at MDS Nordion in Kanata, about two hours from Chalk River. After processing, which takes from two to six hours, Mo-99 is shipped to the U.S, where Tc-99m generators extract the decayed daughter Tc-99m isotopes from the parent Mo-99. The isotopes are shipped on to final destinations in North and South America, Asia, and Europe.

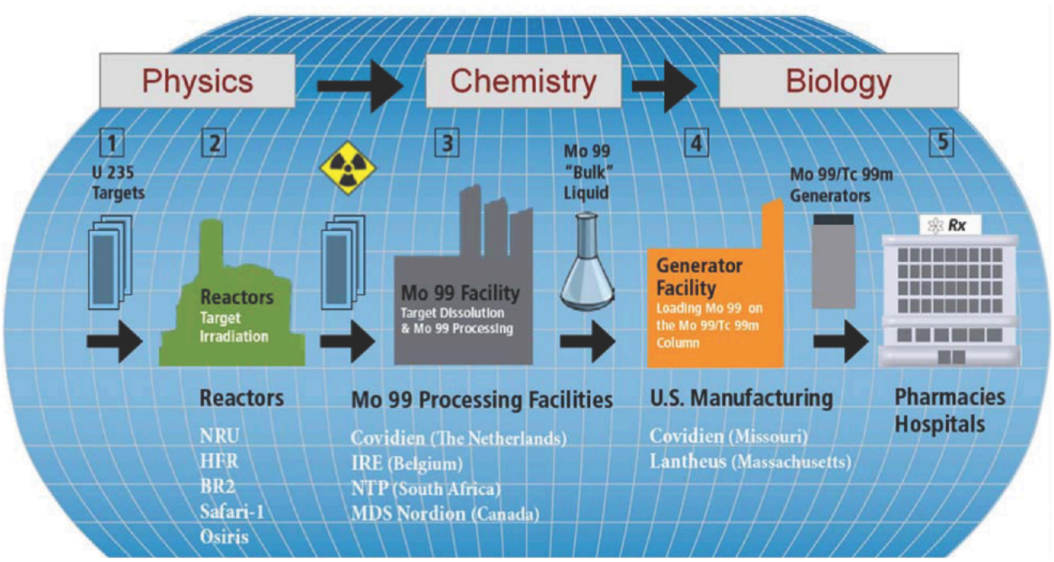

Fig. 1.2: The current production model (TRIUMF) (You are free to use this image in your stories. Please contact Tim Meyer at tmeyer@triumf.ca for high-quality version.)

Issues with the current supply chain
In addition to the aging reactors' safety issues, all reactors that produce Tc-99m use highly enriched, weapons-grade uranium. To reduce security risk, Canada is trying to finding safer methods of production. The United States has announced that they will decrease or cease export of weapons-grade uranium between 2016 and 2019. Manufacturing isotopes also produces nuclear waste, which needs to be disposed of and monitored.

Canadian projects looking for alternative technology
Instead of using nuclear reactors, the federal government requested proposals to develop technologies that utilize one of two particle accelerator technologies: cyclotrons, or linear accelerators.
Some of these methods will use Mo-100, a naturally occurring isotope of Molybdenum, eliminating the need for uranium and the production of nuclear waste.

Cyclotron technology
Two consortia - one led by TRIUMF in BC, and the other, Advanced Cyclotron Systems Inc., led by the Université de Sherbrooke and the University of Alberta - will manufacture Tc-99m using cyclotrons. These circular accelerators direct protons at Mo-100 to produce Tc-99m directly. Some university hospitals already have cyclotrons that manufacture other radioisotopes, so these projects will show how they could adapt the process to produce Tc-99m.

Linear accelerator technology
Another proposed technology transforms Mo-100 into Mo-99 with linear accelerators, using beams of electrons. The electron beams are fired at a metal screen, where they produce X-rays that irradiate Mo-100, producing Mo-99 that decays into Tc-99m. Linear accelerators could be distributed directly to hospitals to manufacture and use Tc-99m directly. Alternately, offsite linear accelerators could produce Mo-99, and hospitals will extract the Tc-99m. Teams developing this

technology include a consortium led by Canadian Light Source, and another led by the Prairie Isotope Production Enterprise (PIPE), including the University of Winnipeg and the University of Manitoba.

Other medical isotope technologies

Positron Emission Tomography (PET) scans use different radioisotopes for imaging. The most common is Fluorine-18 (F-18), which emits a positron as it decays that is detected by the PET machine. There are 31 PET machines in Canada, 15 in Quebec. Each machine needs to be near a cyclotron that can produce F-18. While PET scans are faster, higher resolution, and give similar or lower does of radiation to patients, they're more expensive than scans using Tc-99m.

References:

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Thomas Burnett and Jill Chitra. "Medical Isotopes Supply: A Global Conversation," in Canada's Isotope Crisis: What Next? ed. Jatin Nathwani and Donald Wallace. (Kingston: Queens University Press, 2010).

The Global Medical Isotope Crisis: Winnipeg to the Rescue! Jeff Martin, University of Winnipeg and Prairie Isotope Production Enterprise; Inaugral Lecture Series 2009

Report of the Expert Review Panel on Medical Isotope Production; Presented to the Minister of Natural Resources Canada 30 November 2009. Peter Goodhand, Richard Druin, Thom Mason, Eric Turcotte