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# OP-ED: INSOURCING NUCLEAR MEDICINE

BY

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There is a certain radioactive isotope of Technetium, abbreviated Tc-99m, that is used in over 30 million diagnostic imaging procedures annually. In fact, it is estimated that over 80 percent of nuclear medicine procedures involve Tc-99m[1]. Tc-99m is used in over 70 procedures to diagnose the severity of heart disease, track the spread of cancer, diagnose brain disease, and more applications are developed for its use every year. There is just one problem – millions of patients have been denied procedures involving Tc-99m simply because there is no reliable supply of Tc-99m in the US.

Tc-99m is derived from a parent isotope (Mo-99) which is produced in large quantities in special types of nuclear reactors, dubbed medical isotope reactors. Unfortunately, this parent isotope decays rapidly. When Mo-99 is packaged and shipped to hospitals throughout the country, it can only produce Tc-99m for about a week before it decays and more Mo-99 is needed. While providing a steady source of Mo-99 is currently a challenge, medical isotope reactors have proven effective at producing large quantities of Mo-99. In fact, 95 percent of the world's supply of Mo-99 comes from only five producers; wherein lies another problem. There are currently no medical isotope reactors operating in the US. Furthermore some existing reactors are near or are even beyond the lifetime for which they were designed.

In May 2009, the National Research Universal (NRU) reactor in Canada, which is responsible for producing the majority of the Mo-99 used in the US, was shut down for repairs. This unscheduled shutdown caused a major shortage in the US supply, leading to thousands of cancelled imaging procedures and prevented thousands more from being scheduled. During the NRU shutdown period other European providers ramped up production and shipment to the US. However, even with the increased production, the US demand for Mo-99 could not be met; the NRU reactor outage is estimated to have caused a 40 percent reduction in the US Mo-99 supply.

Not only are the current Mo-99 sources aging, but since they are abroad they also represent a risk to national security. Most medical isotope reactors are designed to produce Mo-99 using highly-enriched uranium, or HEU. HEU is enriched to a high enough degree that a nuclear weapon can be fabricated using the material. For Mo-99 production, HEU must be shipped from the US to Canada and Europe where the US no longer has the ability to closely monitor the material. While Canada and Europe both have very good relationships with the US, the act of shipping HEU across international borders and overseas represents a significant proliferation risk. The proliferation risk from the international transport of HEU would be completely resolved if there were a domestic source of Mo-99.

Another factor to consider is economics. The unreliable source coupled with the overwhelming demand for Mo-99 has led to a seller's market, needlessly driving up the price of many imaging procedures when supplies do become available. The typical medical imaging procedure tends to cost thousands of dollars. If a reliable and abundant supply of Tc-99m could reduce the price of these scans by even a modest 10 percent, this would represent a decrease in healthcare costs in the hundreds of millions of dollars annually. Such a decrease would alleviate some of the financial burden placed on national programs such as Medicare, as well as allow more patients access to the procedures due to lowered cost. Furthermore, the Mo-99 production industry nets a multi-billion dollar profit annually. Since the US lacks significant production of Mo-99, US companies fail to capitalize on a multi-billion dollar industry with the potential to help stimulate the economy.

The Mo-99 industry in the US is unique in that it is not limited by technology, but rather by policy. Significant amounts of research have produced designs for small research reactors to produce large quantities of Mo-99, as in Canada, Belgium, the Netherlands, and several other countries. The design-basis knowledge required to build viable and safe medical isotope reactors in the US is robust; all that is needed is a change in policy. In the US, the Nuclear Regulatory Commission (NRC) is charged with the task of evaluating and licensing all commercial nuclear reactors. The NRC's analysis of reactors is based in large part on existing empirical data. Unfortunately, there is very little in the way of operational experience with medical isotope reactors in the US. Despite an obvious need for Mo-99 and the existing technical capability to produce it, it would be very difficult to license a first-of-a-kind medical isotope reactor under the current NRC framework.

While commercial nuclear reactors are the focus of the NRC, there are other options for licensing reactors. Namely, the US Department of Energy (DOE) is responsible for licensing and operating non-commercial test reactors. The DOE has operated several reactors for non-power producing applications, such as the Advanced Test Reactor at Idaho National Lab. It would be greatly beneficial to construct and license a medical isotope reactor under the more flexible DOE framework. Thus US engineers could build an empirical knowledge base for medical isotope reactors that would allow for future designs to pass more readily through the NRC licensing process, making medical isotope production attractive for commercialization. Furthermore, the DOE licensing process is accelerated, allowing for the more timely design, construction, and operation of a medical isotope reactor to ensure a stable US supply. A medical isotope reactor fits nicely within the framework used for previous reactor licensing by the DOE; however, medical isotope production is not currently part of the DOE's mission. Action should be taken to lobby Congress for the addition of medical isotope production to DOE's mission. By doing so, a medical isotope reactor could be built under the DOE framework ensuring the stability of the supply of life-saving Mo-99, while also building the technological basis to allow US companies access to a multi-billion dollar industry.

[1] Hansell, C. (2008). "NUCLEAR MEDICINE'S DOUBLE HAZARD – Imperiled Treatment and the Risk of Terrorism". *The Nonproliferation Review, 15(2),* 185-208

[2] Westmacott, C. et al. (2010). "The Supply of Medical Radioisotoes – An Economic Study of the Molybdenum-99 Supply Chain". *OECD - NEA No. 6967.*

## About the Author

Ross Barnowski is a first-year PhD student in Nuclear Engineering at the University of California-Berkeley. Ross's research interests include medical isotope production, particle transport and nuclear data, and radiation detection with an emphasis on medical applications. A long-standing interest in science policy, especially as it relates to the nuclear field, began at the University of Michigan (B.S.E. 2010 - Nuclear Engineering and Radiological Science) and has resulted in his involvement with the American Nuclear Society. Ross plans to pursue a technical career in nuclear engineering/medical physics, with plans to ultimately pursue teaching and research in academia. When not working on research or class work, Ross enjoys hiking, biking, and playing drums.