The Implications of a Decline in Isotope Supplies

Nuclear medicine is a field that is often taken for granted. It is a scientific miracle, a marvel of human ingenuity in the 20th century, and it is continuing to be developed today. With the aid of nuclear medicine, many in the United States can take a non-invasive diagnostic exam. Nuclear medicine is used to diagnose various cancers, cardiovascular diseases and neurological disorders. Isotope supplies are vastly important for nuclear medicines. In fact, nuclear medicine would be impossible to perform without isotopes. Indeed, over 18 million people undertaking nuclear diagnostic exams every year in the U.S. would be left in the cold ("Radioisotopes in Medicine," 2014). Without nuclear isotopes, thousands of lives would be lost unnecessarily.

In order to understand the importance of medical isotopes, one must first define what they are. According to TRIUMF, Canada's national laboratory for particle and nuclear physics, "A medical isotope is an unstable (i.e., radioactive) atom derived from a stable one" (FAQ on Medical Isotopes, n.d.). When an unstable atom decays, it emits a particle. Scientific methods of biological imaging, such as SPECT (single-photon emission computed tomography) and PET (Positron emission tomography) can then detect and determine the location of this particle. One can chemically bind this particle to a biological molecule and inject the resulting compound into a human body. Thus, physicians can "see" where the body is using the biomolecule, by using a CT X-ray machine. If these biomolecules are appearing at unnatural rates in certain parts of the body, then doctors know where the disease is. For example, cancer cells use an exorbitant amount of glucose compared to normal cells. Medical professionals can bind nuclear isotopes to glucose molecules and inject them into a person. Then, SPECT scans will show where the glucose is going to, and thus where the cancer is.

One of the most important isotopes used in nuclear medicine is technetium-99 (Tc-99m). According the Nuclear Energy Institute, technetium-99 accounts for over eighty percent of nuclear medicine procedures (“Medical Isotopes In Short Supply,” 2009). Tc-99m is an excellent isotope for medical imaging because it has a half-life of only six hours, making it relatively safer for the patient than other isotopes. In order to obtain Tc-99m, molybdenum-99(Mo-99) is first created in nuclear reactors by irradiating uranium-235. The Mo-99 is extracted, purified, and then transported to hospitals. The Mo-99 decays into Tc-99m and is removed by Tc-99m generators.

Only five reactors, located in Belgium, Canada, France, South Africa, and the Netherlands, produce the vast majority of the world’s Mo-99 supplies. This makes the supply of Tc-99m potentially unstable, as the loss of one reactor would have astronomical implications for the nuclear medicine industry, especially since four of the reactors are more than forty years old, making them more likely to need maintenance. The fears of many health physicists came true when two of the most productive nuclear reactors, Chalk River in Canada and Petten in the Netherlands, which produce two-thirds of the world’s supply of Mo-99, shut down for maintenance in 2009. According to the Health Physics Society, “Many patients were given alternate radiopharmaceuticals that delivered higher radiation doses in order to obtain medical information, and there was not enough Tc-99m available to provide to all patients,” during the time that the reactors were down (“Supply of Medical Isotopes Has Dangerously Decayed, 2013). Specifically, a survey by the Nuclear Energy Institute during that period suggested that seventy-five percent of physicians had to delay diagnostic procedures by at least a day, and a third of them by a month or more (“Medical Isotopes In Short Supply”, 2009). If the shortage had been prolonged, it would have massively affected the population those at-risk. Clearly, the supply of isotopes is dangerously unstable. In order to combat this instability, scientists must act in response. We must come up with new solutions to replace the archaic system of today.

Many resolutions to the isotope supply problem have been proposed. Paul Schafer, of TRIUMF, suggests that small cyclotrons be installed near hospitals ("Radioisotopes: The medical testing crisis," 2013). The cyclotrons would shoot beams of protons into a sample of Mo-100, making Tc-99m. Unlike other methods, the cyclotron method directly produces Tc-99m. The cyclotrons need to be near hospitals, because of the short half-life of the Tc-99m. Thus, there would need to be at least one cyclotron per urban area. A criticism of the cyclotron method is that it would be too costly for the United States to implement. This method could also result in a shortage of Tc-99m if a cyclotron needed to go down for maintenance. On the other hand, Piefer, of SHINE lab in Madison, Wisconsin, proposes to make Mo-99 by accelerating neutrons into low-enriched salts of uranium. This would produce some nuclear waste, but much less than the orthodox method now used by most reactors, such as NRU in Canada.

Ultimately, scientists must act fast to stabilize the supply of Tc-99m. The implications of not acting are too severe to ignore. It may already be too late. The Chalk River reactor in Canada is set to shut down in 2016, only two years from now. One third of the total production of Tc-99m will stop. Many patients will be negatively affected by this shortage. One can only hope that the problem will be fixed, or the world will suffer.

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