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Scholarship Essay

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Isotopes in Medicine: How They Are Used and Where We Get Them

Nuclear energy and nuclear reactors play a significant role in the everyday lives of people around the world. Whether as weaponry or as energy for electricity, nuclear power has touched nearly every aspect of humanity's life, but most people view nuclear energy as an evil that hurts people. When people think of nuclear uses, they think of nuclear bombs such as the ones dropped in Japan during World War II, or they think of radiation spillage from reactors in Chernobyl. These incidents are what average citizens of the world think of when they think of nuclear power. Those average citizens fail to realize the biggest impact nuclear energy has had on their lives, and they do not even know it. Nuclear power is no longer just an energy source or weapon of mass destruction, it is a medicine that saves thousands of lives daily. Many treatments in high income countries who can afford the isotopes, which are atoms of the same element with a different number of neutrons usually created through nuclear processes, involve the use of them for both identification and eradication of diseases that once were thought to be impossible to get rid of. Thanks to isotopes such as Molybdenum-99 and Iodine-131, diseases ranging from arthritis to tumors can be found and eradicated in months. Although it is fantastic that countries such as the United States has access to these types of medicines and radiotherapy, the United States is dependent on foreign countries such as Australia for these important isotopes. In modern day medicine, isotopes imported from foreign countries is a necessity for the United States.

Isotopes such as Molybdenum-99, Iodine-131, and Technetium-99 are some of the most common isotopes used in modern medicine. Molybdenum-99 is used primarily to create Technetium-99 for medical purposes. According to the World Nuclear Association, "The most common radioisotope used in diagnosis is technetium-99 (Tc-99), with some 40 million procedures per year, accounting for about 80% of all nuclear medicine procedures and 85% of diagnostic scans in nuclear medicine worldwide." Radioisotopes are used for diagnosis of diseases due to their special properties. Some isotopes are able to hold tracers that can bind to a patient's cells during a positron emission tomography scan. Positron emission tomography scans are used to get an accurate third dimensional model of a person's organs and where a tumor may be located. The way the scan works is isotopes with tracers are absorbed very quickly by unhealthy cells in a tumor. The tracers begin to quickly decay and emit small particles called positrons. These positrons react with electrons causing each to be eliminated and photons to be emitted. The positron emission tomography scan detects these photons and is able to use them to make a 3D rendering of the targeted organ. The use of Technetium-99 in scanning is especially important in brain scans. A person's brain is extremely fragile, so it is risky to try to find a tumor in the brain. Technetium-99 bypasses this danger as no exploration is required and the tumor is easily located. Iodine-131 is an isotope used more for curing problems than diagnosing. The most prominent use of Iodine-131 is in the curing of thyroid cancer. According to Kiran Bashir, "About half of the iodine in your body is absorbed by the thyroid gland." Iodine-131 follows the normal Iodine into a person's thyroid gland. The isotope then attacks any remaining thyroid cancer or tumor cells that remain after a removal surgery. In developed countries, procedures like these happen daily. "In the USA there are over 20 million nuclear medicine procedures per year, and in Europe about 10 million, with 2 million of these being therapeutic. In Australia there are

about 560,000 per year, 470,000 of these using reactor isotopes. The use of radiopharmaceuticals in diagnosis is growing at over 10% per year," according to the World Nuclear Association. Many people around the world rely on nuclear energy and radioisotopes for curing what once were deadly diseases.

Although many people require the use of radioisotopes in the United States, most of the radioisotopes are created in foreign countries. According to the National Nuclear Security Organization, "The majority of Mo-99 supplied to U.S. patients is currently provided by foreign producers located in Australia (ANSTO), Belgium (IRE), the Netherlands (Curium), and South Africa (NTP Radioisotopes)." The United States' dependence on Molybdenum-99 from foreign suppliers is extremely precarious. Molybdenum-99 has a half-life of 66 hours which is an extremely short half-life making the shipping of the isotope extremely dangerous as any delays may cause extreme problems. Droughts or wildfires, such as the ones in Australia, have caused shipping to be paused or in danger which directly affects people in the United States. Delays in Molybdenum-99 can lead to depletions which may lead to increased deaths in hospitals as there is no safe way of locating tumors in brains. Although the fires in Australia happened two years ago and seems to have happened long ago, events happening today may affect the Molybdenum-99 supply. Years ago, Russia stated that it wanted to gain a better position in the Molybdenum-99 supply in the world market. According to the International Panel on Fissile Materials in regard to Molybdenum-99, "Russia's production capacity is closer to the 12% of the global capacity and 25% of the global demand." The amount of Molybdenum-99 created by Russia is especially important with Russia's invasion of Ukraine. Russia, in many of the western world's eyes, has antagonized itself in its unreasonable invasion of Ukraine. Countries in NATO such as the United Nations and the United States have placed sanctions and actively oppose Russia's

actions. The actions taken by the United States could lead to a halt in the selling of Molybdenum-99 from Russia to the United States which is especially important given how close the United States is from Russia meaning less Molybdenum-99 would be needed to be produced to outdo its half-life. Regardless of if Russia or Ukraine wins the war, relations between the United States and Russia will be dire especially if Russia decides to invade other countries in eastern Europe which has the potential of leading to World War III.

The importance of medical isotopes and the United States' dependence on overseas suppliers can be extremely dangerous to the citizens and economy of the United States. Although it may seem intimidating given the current events in the world, the United States has already begun working on making isotopes domestically. The United States' government has provided over $37 million dollars to Northstar Medical Technologies to begin the production of Molybdenum-99, and in 2021, Northstar Medical Technologies got approval from the FDA to begin manufacturing and selling of its products. SHINE Medical Technologies, Inc. has also begun the process of domestically making radioisotopes in the United States. Soon, the U.S. may no longer need to be reliant on foreign supplies of isotopes meaning disasters outside of the U.S. will not affect those inside it regarding radioisotope treatments. Radioisotopes are extremely important to the health of people around the world, so by having the U.S. make more domestically, more people can be saved.

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