Nuclear Medicine: Diagnosis versus Treatment

Within the past 100 years, breakthroughs in technology have revolutionized the world, carrying people from the steam engine to space shuttles and from the simple telegram to instant Skype-sessions. Breakthroughs in medicine have also dropped mortality rates in many industrialized nations, such as the advent of vaccinations. There are other medical innovations, such as the introduction of nuclear medicine, to provide diagnostic information about the functioning of a person's specific organs. Not only can nuclear medicine be used to for diagnostic purposes, but they are also commonly used to treat some medical conditions, especially cancer, by using radiation to weaken or destroy particular targeted cells (Radioisotopes). With tens of millions of nuclear medicine procedures performed each year, the demand for radioisotopes is rapidly increasing. Nuclear medicine has given millions of individuals the hope of fortune because they offer a powerful diagnostic tool, allowing medical treatment of many cancers and other diseases.

The history of nuclear medicine dates back to the 1950s, when physicians were using it with an endocrine emphasis to treat thyroid diseases (Radioisotopes). Today, of the thirty million people who are hospitalized each year in the United States, over one-third are treated with nuclear medicine. Over 10,000 hospitals worldwide use radioisotopes in medicine, and about 90% of the procedures are for diagnosis. More than 10 million nuclear-medicine procedures are performed on patients and more than 100 million nuclear-medicine tests are performed each year in the United States alone (Guide). The radioactive materials used in these tests are generally called radionuclides, meaning a form of an element that is radioactive. There are three primary reasons for why radionuclides have become powerful tools for diagnosing medical disorders. First, many chemical elements tend to concentrate in one part of the body or another (Science). As an example, nearly all of the iodine that humans consume in their diets goes to the thyroid gland. There, it is used to produce hormones that control the rate at which the body functions. Second, the radioactive form of an element behaves biologically in exactly the same way that a nonradioactive form of an element behaves (Science). When a person ingests the element iodine, for example, it makes no difference whether the iodine occurs in a radioactive or nonradioactive form. In either case, it tends to concentrate in the thyroid gland. Third, any radioactive material spontaneously decays, breaking down into some other form with the emission of radiation (Science). That radiation can be detected by simple well-known means. When radioactive iodine enters the body, its progress through the body can be followed with a Geiger counter or some other detection instrument. Such instruments pick up the radiation given off by the radionuclide and make a sound, cause a light to flash, or record the radiation in some other way. With the growth of the field, nuclear medicine will continue to be used to make a quick, accurate diagnosis of the patient's illness and to treat diseased organs, or tumors.

Using radioactive tracers in its diagnostic techniques, nuclear medicine emits gamma rays from within the body. These generally short-lived tracers can be given by injection, inhalation, or orally. A more recent development in nuclear medicine is Positron Emission Tomography (PET), which is a more precise and sophisticated technique using isotopes produced in a cyclotron (Radioisotopes). A positron-emitting radionuclide is introduced, usually by injection, and accumulates in the target tissue. As it decays it emits a positron, which promptly combines with a nearby electron resulting in the simultaneous emission of two identifiable gamma rays in opposite directions. These are detected by a PET camera and give a very precise indication of their origin (Radioisotopes). Furthermore, new procedures can combine PET with computed X-ray tomography (CT) scans to enable a 30% better diagnosis than with a traditional gamma alone. It is a very powerful and significant tool which provides unique information on a wide variety of diseases from dementia to cardiovascular disease and cancer. In addition, the positioning of the radiation source within the body makes the fundamental difference between nuclear medicine imaging and other imaging techniques such as x-rays. Organ malfunction can be indicated if the isotope is either partially taken up in the organ (cold spot), or taken up in excess (hot spot). If a series of images is taken over a period of time, an unusual pattern or rate of isotope movement could indicate malfunction in the organ (Radioisotopes). A distinct advantage of nuclear imaging over x-ray techniques is that both bone and soft tissue can be imaged very successfully. This has led to its common use in developed countries where the probability of anyone having such a test is about one in two, and steadily rising.

Beyond diagnosing medical disorders, nuclear medicine has developed into an effective method for treating these disorders. Radiation has a tendency to kill cells. Under many circumstances, that tendency can have a dangerous side effect: anyone exposed to high levels of radiation may become ill and can even die. But the cell-killing potential of radiation also has its advantages. A major difference between cancer cells and normal cells, for example, is that the former grow much more rapidly than the latter (Science). For this reason, radiation can be used to destroy the cells responsible for a patient's cancer. Cancer treatment with beams of massive ions directly from an accelerator has gained increasing utilization in the last decade. A patient with cancer lies on a bed surrounded by a large machine that contains a sample of cobalt-60. The machine is then rotated in such a way around the patient's body that the radiation released by the sample is focused directly on the cancer. Unlike gamma rays, which distribute their energy equally in healthy as well as cancerous cells, massive particles such as protons or alpha particles will deposit the bulk of their energy just before they stop (Guide). If the energy is well-chosen, most of the energy will be dumped into the tumor and not into the surrounding healthy tissue.

Using three dimensional water degrader columns, the shape of the tumor can be mapped out and selectively irradiated. If the treatment is successful, the cancer may be destroyed, producing only modest harm to the patient's healthy cells. That "modest harm" may occur in the form of nausea, vomiting, loss of hair, and other symptoms of radiation sickness that accompany radiation treatment. Even so, the radiation risk is very low compared to the potential benefits of nuclear medicine.

While no one can predict the future, it appears clear that nuclear medicine will increasingly improve the diagnosis and treatment of cancer and other diseases. Nuclear medicine provides society with a new and effective diagnostic procedure to detect the spread of diseases, specific treatments administered on an outpatient basis, and an extremely promising alternative for diagnosing and treating diseases by targeting infected cells. The investment in medical research and potential radioisotope will increase and expand the availability of treatments, saving money, and improving the lives of humans.

Works Cited

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