Prostate cancer is the second most commonly diagnosed cancer among men in the United States, after skin cancer. According to the American Cancer Society, approximately 268,490 new cases of prostate cancer will be diagnosed in 2022 in the United States.

Imaging plays an important role in diagnosing and staging prostate cancer and monitoring patients for recurrent disease. (For more information on imaging, see the Molecular Imaging and Prostate Cancer Fact Sheet). Radiopharmaceutical therapies have long been used to alleviate pain in patients with metastatic prostate cancer, predominantly in patients with metastatic disease to bones. New therapeutic agents for these patients are under development.

What is radiopharmaceutical therapy, and how does it work?

Radiopharmaceutical therapy (also called molecular radiotherapy) involves targeting cancer cells with a radioactive drug (radiopharmaceutical). Radiopharmaceuticals typically consist of a radioactive atom (also known as a radionuclide) combined with a cell-targeting molecule that seeks cancer cells. When the radiopharmaceutical binds to the target on the tumor cells, it brings the radiation directly to the tumor cells, no matter where they are located in the body, and treats the cancer.

Radiopharmaceutical therapy specifically targets cancer cells, limiting damage to healthy tissue. When injected into the patient’s bloodstream, the radiopharmaceutical travels to and delivers radiation directly to or near disease sites, limiting radiation exposure to healthy tissue. This type of therapy offers promise as a vehicle for personalized cancer treatment because it can be tailored to the molecular properties of a specific tumor.

Radiopharmaceutical therapy is currently used to treat metastatic prostate cancer, thyroid cancer, and well-differentiated neuroendocrine tumors. Researchers are developing and testing new radiopharmaceutical therapies to treat additional cancers.

About prostate cancer

The prostate gland, located just below the bladder and in front of the rectum, is part of the male reproductive system. It is about the size of a walnut and surrounds the urethra (the tube that empties urine from the bladder). The prostate gland makes fluid that is part of the semen.

Prostate cancer occurs when certain cells within the prostate gland grow in an uncontrolled, abnormal manner. Some tumors grow slowly while others grow at a more rapid pace.

Prostate cancer that spreads outside the prostate gland may initially grow into nearby tissues or lymph nodes. When prostate cancer spreads (i.e., metastasizes) to distant sites within the body, it most commonly involves the bones of the pelvis, spine, and ribs. When cancer spreads into the bone, it may cause pain, fractures, and other complications.

There are many treatment options for men with prostate cancer, including surgery to remove the prostate gland, radiation therapy, chemotherapy, antihormonal therapy, and immunotherapy. Male sex hormones (called androgens) that circulate in the bloodstream can cause prostate cancer to grow. A common form of prostate cancer treatment reduces the level of androgens or blocks them from working. This treatment can be seen as a chemical castration.

Despite such hormonal treatments, some prostate cancers continue to grow. This state is referred to as castration-resistant prostate cancer (CRPC). CRPC is often associated with cancers that have spread to lymph nodes, bones, and, less commonly, the lungs and liver. This state is referred to as metastatic
castration-resistant prostate cancer (mCRPC). Treatment for men with mCRPC is often aimed at controlling disease spread.

**Nuclear medicine therapies for metastatic prostate cancer**

The following ligand-targeted therapy is currently in use to treat men with mCRPC and is aimed at controlling disease spread:

- Lutetium-177 PSMA-617 (Pluvicto)

The following molecular radiotherapies are currently used to relieve pain and/or treat metastatic castration-resistant prostate cancer that has spread to the bone:

- Strontium-89 chloride (Metastron)
- Samarium-153 lexidronam (Quadramet)
- Radium-223 dichloride (Xofigo)

**Ligand-targeted therapy**

**Lutetium-177 PSMA-617** is the newest radiopharmaceutical to be approved by the U.S. Food and Drug Administration and is indicated for patients diagnosed with **castration-resistant metastatic prostate cancer who have previously been treated with androgen-blocking treatment and taxanes chemotherapy. Patients must also have a positive PSMA PET/CT scan.** (For more information on imaging, see the Molecular Imaging and Prostate Cancer Fact Sheet.)

Lutetium-177 PSMA-617 is a type of therapy known as PSMA (prostate-specific membrane antigen) targeted therapy. PSMA receptors are present on prostate cancer cells to a much greater extent than normal cells. Therefore, Lutetium-177 PSMA-617 preferentially delivers radiation to prostate cancer cells with a high expression of PSMA receptors. When the radioactive ligand binds to the PSMA on the tumor cells, it brings the radiation directly to the tumor cells.

Men undergoing ligand-targeted radiotherapy often receive 6 injections every 6 weeks. Side effects of the therapy most commonly include fatigue, dry mouth, and a decrease in blood counts.

**Bone palliative targeted molecular radiotherapies**

Both strontium-89 and samarium-153 lexidronam are radiopharmaceutical therapies that target areas of increased bone turnover and are directly injected into the bloodstream. Since the FDA approval of radium-223 dichloride, the use of both strontium-89 chloride and samarium-153 lexidronam has significantly decreased.

**Radium-223** treats men with prostate cancer with predominantly **bony metastatic disease.** Radium-223 concentrates at locations where there is a higher concentration of calcium. Bone metastatic lesions from prostate cancer usually present with higher bone matrix production and therefore attract more calcium than healthy bone. Once the Radium-223 reaches the target in the bone, it will deliver radiation to that area. Unlike strontium-89 and samarium-153, which emit beta particles, radium-223 emits alpha particles. Alpha particles deposit a higher amount of energy over a shorter distance than beta particles. In addition to providing pain relief, studies have shown that Radium-223 can also extend overall survival in patients.

Men undergoing radiopharmaceutical radiotherapy often receive 6 injections every 4 weeks. Research has shown that this course of therapy is also effective in relieving pain. Side effects of the therapy include decrease in blood counts.
Are radiopharmaceutical therapies covered by insurance?

Medicare and most insurance companies cover the cost of radiopharmaceutical therapies. Check with your insurance company for specific information on your plan.

Are radiopharmaceutical therapies safe?

Medical procedures have side effects and risks; the same is true for radiopharmaceutical therapies. If given in the right way for the right patients at the right time, these therapies are considered safe, with the benefits outweighing the potential risks.

RELATED CONTENT

- Fact Sheet: Molecular Imaging and Ovarian Cancer
- Fact Sheet: Molecular Imaging and Neuroendocrine Tumors
- Fact Sheet: What is Peptide Receptor Radionuclide Therapy (PRRT)?
- Fact Sheet: What is Radiation Dosimetry?
- Fact Sheet: What is Nuclear Medicine and Molecular Imaging?

About SNMMI

The Society of Nuclear Medicine (SNMMI) is an international and medical organization dedicated to raising public awareness about nuclear and molecular imaging and therapy and how they can help provide patients with the best health care possible. With more than 15,000 members, SNMMI has been a leader in unifying and optimizing nuclear medicine and molecular imaging since 1954.

The material presented in this pamphlet is for information only and is not intended as a substitute for discussions between you and your physician. Be sure to consult with your physician or the nuclear medicine department where the treatment will be performed if you want more information about this or other nuclear medicine procedures.