ACR–ACNM–ARS–SNMMI PRACTICE PARAMETER FOR THE PERFORMANCE OF PROSTATE-SPECIFIC MEMBRANE ANTIGEN (PSMA) THERAPY

The American College of Radiology, with more than 40,000 members, is the principal organization of radiologists, radiation oncologists, and clinical medical physicists in the United States. The College is a nonprofit professional society whose primary purposes are to advance the science of radiology, improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists, radiation oncologists, medical physicists, and persons practicing in allied professional fields.

The American College of Radiology will periodically define new practice parameters and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice parameter and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review and approval. The practice parameters and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice parameter and technical standard by those entities not providing these services is not authorized.

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care[1]. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the practitioner considering all the circumstances presented. Thus, an approach that differs from the guidance in this document, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in this document when, in the reasonable judgment of the practitioner, such course of action is indicated by variables such as the condition of the patient, limitations of available resources, or advances in knowledge or technology after publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document may consider documenting in the patient record information sufficient to explain the approach taken.

The practice of medicine involves the science, and the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to the guidance in this document will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The purpose of this document is to assist practitioners in achieving this objective.

---

1 *Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, 831 N.W.2d 826 (Iowa 2013) Iowa Supreme Court refuses to find that the "ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures (Revised 2008)" sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.*

I. INTRODUCTION

This practice parameter was developed collaboratively by the American College of Radiology (ACR), the American College of Nuclear Medicine (ACNM), the American Radium Society (ARS), and the Society of Nuclear Medicine and Molecular Imaging (SNMMI).

This practice parameter is intended to guide appropriately trained and licensed physicians performing therapy with lutetium-177 (Lu-177) vipivotide tetaxetan (Lu-177 prostate-specific membrane antigen -617). Application of

this parameter should be in accordance with the ACR–AAPM–ACNM–SNMMI–SPR Technical Standard for Therapeutic Procedures Using Radiopharmaceuticals [1], insofar as that standard relates to the handling of radiopharmaceuticals, radiation safety, and radiation protection of patients, personnel, and the public. There must also be compliance with applicable laws and regulations. Lu-177 PSMA-617 therapy requires close cross-disciplinary cooperation and communication between the physicians who are responsible for the clinical management of the patient, those who administer radiopharmaceutical therapy, and those who monitor for and manage the treatment-related side effects. Adherence to this parameter should help to maximize the efficacious use of these procedures, maintain safe conditions, and ensure compliance with applicable regulations.

Metastatic castration-resistant prostate cancer (mCRPC) is a disease that originates in the prostate but has disseminated by hematogenous spread to other parts of the body and no longer responds to therapies that target testosterone hormone production or signaling pathways. Presently mCRPC is not typically curable, but it can be treated to control disease, slow progression, and extend survival. Multiple therapies have been developed in recent years, which demonstrate such capacity in patients with this disease. Although the pace of mCRPC progression can be highly variable, for many patients this is measured in multiple years, a natural history of disease that confers the opportunity for patients to sequentially receive multiple different forms of treatment during the course of their disease. With continued development of additional therapies that show clinical efficacy, there emerges a hope that even if mCRPC cannot be cured it may one day be managed as a chronic condition with multiple lines of effective treatments engaged over time. In this setting, it becomes increasingly important to leverage tumor histopathology, genomics, radiography, and circulating biomarkers to optimize and personalize the selection, sequencing, and combination of therapeutic options for patient with mCRPC.

PSMA is a transmembrane protein with glutamate carboxypeptidase enzymatic activity, and it is expressed on epithelial cells of the prostate and on most prostatic adenocarcinoma cells. Outside of the prostate, PSMA is also expressed on other normal tissues, including epithelia of the salivary glands, kidneys, and small intestine, but typically at a much lower level of expression compared to that observed on prostate cancer cells. Radiolabeled antibodies or small molecules that target PSMA have been shown to have high sensitivity and specificity for detecting prostate cancer. One such targeting agent is PSMA-617, a small molecule composed of glutamate-urea-lysine PSMA-binding component, a linker region, and a DOTA chelator that can complex 177-Lu [2] . Following intravenous (IV) administration, 177-Lu-PSMA-617 circulates in blood and is rapidly distributed to the gastrointestinal tract, liver, lungs, kidneys, heart wall, bone marrow, and salivary glands [3]. In approximately 60%– 70% of instances, 177-Lu-PSMA-617 exhibits binding to proteins in blood plasma. Excretion occurs rapidly in an initial phase mediated primarily by renal clearance of unbound 177-Lu-PSMA-617 with 50% and 70% excreted from blood into urine by 4 and 12 hours after injection, respectively [4] . Bound 177-Lu-PSMA-617 exhibits considerably longer residence in tumor, normal tissue, and plasma proteins, leading to a whole-body half-life of ~42 hours [5]. Lu-177 PSMA-617 is an effective therapy for patients with mCRPC, having been compared to physician-selected standard of care treatment in the randomized, phase 3 VISION trial [6]. From circulation in the blood, 177-Lu-PSMA-617 binds selectively to PSMA, resulting in preferential uptake and retention in mCRPC tumors throughout the body. As 177-Lu undergoes radioactive decay, this tumor selectivity enables theranostic capabilities for tumor-specific imaging of gamma-ray emissions and therapeutic delivery of radiation, primary from Beta (ß-) emissions. The beta particle emission from Lu-177 has a maximum energy (Q-value) of 0.5 MeV, a range in soft tissues of 2 mm, and a half-life of 6.7 days . The gamma ray emissions from 177-Lu are low energy at 208 keV (11% abundance) and 113 keV (6.4% abundance), and these enable quantitative single-photon emission CT (SPECT) imaging and patient-specific dosimetry.

The goal of therapy with Lu-177 PSMA-617 is to reduce disease burden, slow disease progression, and extend life, while minimizing untoward side effects and complications. Lu-177 PSMA-617 is an effective therapy for patients with mCRPC, having been compared to physician-selected standard of care treatment in the randomized, phase 3 VISION trial. This study enrolled patients with PSMA-positive mCRPC who had been treated with androgen receptor pathway inhibition and taxane-based chemotherapy. At a median follow-up of 20.9 months, the VISION trial showed that Lu-177 PSMA-617 extends both radiographic progression-free survival (8.7 months in the 177-Lu-PSMA-617 group versus 3.4 months in the control group, P<.001) and overall survival (15.3 months in the 177-Lu-PSMA-617 group versus 11.3 months in the control group, P<.001) . Of the patients with mCRPC who were screened and imaged with 68-Ga-PSMA-11 PET/CT as part of a selection for possible treatment on this trial, only 4.9% did not have at least one PSMA-positive metastatic lesion, and 8.7% had at least one

PSMA-negative tumor, whereas the majority (86.6%) met imaging criteria for treatment. Beyond an overall survival benefit, the study demonstrated that Lu-177 PSMA-617 lengthened the median time to any skeletal symptomatic events (eg, bone fracture) and reduced deterioration in the scores on two patient-reported health-related quality of life assessments, the Functional Assessment of Cancer Therapy–Prostate and the Brief Pain Inventory–Short Form.

Side effects associated with Lu-177 PSMA-617 can be categorized as acute, subacute, or delayed. It is highly advisable that a multidisciplinary team, including those familiar with managing radiation-related toxicities, coordinate the care of a patient being considered for treatment with Lu-177 PSMA-617.

General: Nearly all patients receiving Lu-177 PSMA-617 on the VISION trial experienced a side effect, and 52.7% experienced a grade =3 adverse event. The most common reported side effects included fatigue, dry mouth, nausea, anemia, back pain, and arthralgia. In most cases, these symptoms are self-limiting and rarely require more than supportive therapy. Adverse events led to dose reduction or discontinuation of treatment in only 1.9% and 7% of patients, respectively.

Hematologic: Bone marrow and blood includes rapidly hematopoietic progenitor cells and differentiated blood cells that can be highly radiosensitive. Radiation emitted from Lu-177 PSMA-617 can therefore lead to anemia, thrombocytopenia, lymphopenia, and/or leukopenia in 31.8%, 17.2%, 14.2%, and 12.5%, respectively. However, most of these are minor effects, and grade ≥3 anemia, thrombocytopenia, lymphopenia, and/or leukopenia are observed in just 12.9%, 7.9%, 7.8%, and 2.5% of patients. Rarely, with other 177-Lu treatments, it has been observed that 1% to 4% of patients may develop leukemias and myelodysplastic syndrome (MDS) [7, 8]. MDS can lead to a fatal outcome in patients heavily pretreated with myelosuppressive therapies before receiving other forms of Lu-177 radiopharmaceuticals; however, it remains unclear whether and at what rate this late effect of radiation may be observed in patients who have received Lu-177 PSMA-617.

Salivary Glands: Lu-177 PSMA-617 is taken up in salivary glands due to expression of PSMA in the epithelial cells of these structures. Consequently, dry mouth is among the most common adverse effects observed following Lu-177 PSMA-617 treatment, with 38.8% of patients reporting this on the VISION trial [9].

Gastrointestinal: Abdominal discomfort, decreased appetite, nausea, and/or vomiting can occur within hours to days of radiotherapy treatments, including Lu-177 PSMA-617. In addition, the frequency and consistency of bowel movements can be affected with diarrhea or constipation both reported following Lu-177 PSMA-617. However, these adverse gastrointestinal effects are generally mild and rates of grade ≥3 nausea, decreased appetite, diarrhea, or constipation occurred in <2% of patients.

Nephrotoxicity: Lu-177 PSMA-617 is excreted by the kidneys through glomerular filtration, and there is limited reabsorption in the proximal tubules, with plasma clearance approximating passive renal clearance and with no effect observed from amino acid infusion on the rate of Lu-177 PSMA-617 clearance. Renal toxicity resulting in grade 3 or 4 kidney injury occurred in 3% of patients during the VISION trial. In a retrospective Australian study, the renal outcome during a longer follow-up time after treatment (median time 8 months) with 177-Lu-PSMA-617 demonstrated a mild nephrotoxic risk of 4.5%.

Risk of Infertility: The recommended cumulative activity of 1200 mCi (44.4 GBq) Lu-177 PSMA-617 can result in radiation absorbed dose to the testis within a range in which temporary or permanent infertility may ensue, such as seen following pelvic external-beam radiotherapy.

Facilities and their responsible staff should consult with their radiation safety officer (RSO) to ensure that there are policies and procedures specific to Lu-177 PSMA-617 that address 1) required instrumentation, calibration, and calibration frequency and 2) ordering and receiving, recordkeeping, safe use, and waste disposal in compliance with the applicable laws and regulations as described in ACR–AAPM Radiation Safety Officer Resources [10].

II. INDICATIONS

177-Lu PSMA-617 is indicated for the treatment of adult patients with PSMA-positive mCRPC who have been

treated with androgen receptor pathway inhibition and taxane-based chemotherapy.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

The qualifications and responsibilities of physicians and other personnel performing these therapeutic procedures should be in accordance with the ACR–AAPM–ACNM–SNMMI–SPR Technical Standard for Therapeutic Procedures Using Radiopharmaceuticals [1] and/or the ACR–ARS Practice Parameter for Radiation Oncology [11].

In addition, training and experience must be in compliance with the applicable laws and regulations.

IV. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for a Lu-177 PSMA-617 treatment should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the procedure or diagnosis would be helpful and may at times be needed to allow for the proper performance of the procedure.

The request for the procedure must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. (ACR Resolution 35, adopted in 2006 - revised in 2016, Resolution 12-b)

IV. SPECIFICATIONS OF THE EXAMINATION

A. Pre-Treatment Evaluation

The treating physician's initial evaluation of the patient must include review of the patient's history, physical examination, pertinent diagnostic studies, existing laboratory reports (with laboratories planned 7-10 days before treatment preferably), and complete history of all available records of previous pertinent therapies, including, but not limited to, androgen receptor pathway inhibitors, taxane-based chemotherapy, and current therapies.

1. Patient selection for PSMA targeted therapy: Efficacy of Lu-177 PSMA is currently approved in the setting of mCRPC [6] CRPC is defined by two consecutive prostate-specific antigen (PSA) progressions (at least 2 weeks apart) to a 25% increase over nadir or appearance of new lesions on imaging, despite hormonal treatment leading to serum testosterone levels <50 ng/dL (<1.7 nmol/L) [12]. When considered outside the approved indication, the patients should always be recruited to a research clinical trial. Lu-177 PSMA localizes to PSMA which is overexpressed on the cell surface of up to 85% of prostate adenocarcinoma cases. Hence, it is of paramount importance to confirm that the mCRPC being treated has sufficient PSMA expression determined by any of the PET Ga-68 or F-18 approved PSMA radiotracers on PET imaging [13, 14, 15]. Concurrent 18F FDG PET imaging is not mandatory for all patients, but maybe helpful in cases with concern for PSMA negativity or for patients who experience biochemical progression on Lu-177 PSMA therapy [16].

2. Contraindications: There are no absolute contraindications. Relative contraindications include ECOG > 3, life expectancy < 3 months, presence of untreated/ unstable brain metastases or spinal epidural disease, acute hydronephrosis, acute infections, urinary incontinence, severe cardiovascular or psychiatric comorbidities, decreased renal (GFR < 30 mL/min, creatinine > two-fold ULN) or hepatic function (liver enzymes > fivefold ULN). Patients with severe myelosuppression (white blood cell count <2.5/nL; absolute neutrophil count <1.5 nL; platelets <75/nlL should only be treated if the benefits outweigh the risks [17].

3. Discontinuation of other therapies: If the patient is being treated with large-field external beam radiotherapy, chemotherapy, or treatment with radioactive bone-seekers, they should be discontinued for at least 4 weeks before to Lu-177 PSMA infusion. Limited data are available on the safety of concurrent external beam radiation and Lu-177 PSMA therapy given the potential for additive toxicity.

4. Concurrent therapies: Androgen deprivation therapy (luteinizing hormone-releasing hormone analogs/antagonists and first-generation antiandrogens) and novel androgen-axis drugs (eg, abiraterone, enzalutamide), can be continued during PSMA-–radioligand therapy after multidisciplinary discussion with the oncology teams. Other agents like analgesics, bisphosphonates or denosumab and focused radiation therapy are permitted.

5. Laboratory considerations: In anticipation of possible side effects, each patient should have a complete blood count with differentials and metabolic panel including renal and hepatic function tests. Such monitoring should be performed before each infusion and as needed for hematologic monitoring in between treatments. Dose reduction to 160 mCi (5.9 GBq) and/or increasing the interval between radiopharmaceutical administrations can be considered based upon severity of adverse reactions [3]. Discontinuation of therapy is recommended for recurrent grade 3 toxicity. Along with the aforementioned laboratories, serum testosterone and PSA levels should also be obtained.

6. Quality Management: To use radiopharmaceuticals as unsealed sources for therapy, including Lu-177 PSMA, a "quality management" program must be in place as required by applicable state and federal regulations. (An Agreement State is any state with which the Nuclear Regulatory Commission or the US Atomic Energy Commission has entered into an effective agreement under subsection 274.b of the Atomic Energy Act of 1954 as amended, 73 Stat, 689). Key elements of such a program include written directives, duplicative procedures for identifying patients, careful record keeping to ensure prescribed administered activity, minimization of the possibility of infiltration for radiopharmaceuticals that are administered IV, procedures for minimizing radiation exposure or radiopharmaceutical contamination of personnel, family members of patients, and the public (eg, alerts regarding possible current or future pregnancy), procedures for containment of radioactivity; and an audit mechanism to ensure compliance with the program.

7. Informed Consent: Informed consent must be obtained and documented. See the ACR–ARS Practice Parameter on Informed Consent – Radiation Oncology [18].

8. Treatment: The procedure and follow-up should be performed according to an established system of procedural steps unique for Lu-177 PSMA [6, 17].

9. Precautions: For patients with female partners of reproductive potential, an effective contraception should be used during treatment and continued until 3-4 months following the last treatment dose. Sexual activity should be avoided following therapy for 7 days. Patients should be advised to sleep in a separate bedroom from household contacts for 3 days, from children for 7 days, or from pregnant women for 15 days. Patients should limit close contact (less than 3 feet) with household contacts for 2 days or with children and pregnant women for 7 days [3].

10. Radiation Precautions: Radiation precautions and patient release criteria may be regulated federally by the NRC in many states or by the state (with regulations that are closely patterned on the federal regulations and may be more restrictive). The RSO or medical physicist for the local facility can provide information on the applicable regulations. Details on the federal regulations can be obtained at the NRC website (nrc.gov).

Under the guidelines of federal code 10 of the Code of Federal Regulations (CFR) 35.75 (United States Nuclear Regulatory Commission. NRC policy on release of iodine-131 therapy patients under 10 CFR 35.75 to locations other than private residences . Consolidated guidance about materials licenses: program-specific guidance about medical use licenses (NUREG-1556, Volume 9, Revisions 2, Page 8-73 and Appendix) [19] a patient may be released to the public if the total effective dose equivalent to any other individual (including any caregiver or family member) who is exposed to the patient is not likely to exceed 5 mSv (0.5 rem). If the total effective dose equivalent is likely to exceed 1 mSv (0.1 rem) to any individual, instructions (including written instructions) must be provided to the patient on actions to limit radiation exposure to others by using the "as low as reasonably achievable" (ALARA) principle. Some states may have specific rules and regulations regarding release of patients with significant residual activity. The NRC noted that release criteria for PSMA Lu-177 therapies for metastatic castrate resistant prostate cancer [20] are the same as for DOTA Lu-177 therapies used for neuroendocrine tumors [20], and that applicable licensing provisions are contained in Title 10 of the CFR (10 CFR) Part 35, Subpart E, "Unsealed Byproduct Material – Written Directive Required."

The dose limits specified by the National Council on Radiation Protection and Measurements (NCRP) differ somewhat from the NRC regulations (National Council on Radiation Protection and Measurements. NCRP No. 155 [21], management of radionuclide therapy patients. Because the fetus and children are more sensitive to radiation injury than adults, the NCRP specifies that children and pregnant women, whether or not they are members of the patient's household, should be limited to 1 mSv (0.1 rem). Any individual who has no familial connection to the patient and whose presence offers no emotional benefit should also be limited to 1 mSv, which is also the NRC dose limit to a member of the public.

Many radiation meters measure exposure rates in milliroentgens per hour (mR/h). For purposes of radiation protection and for low linear energy transfer radiation (including beta particles and most x-rays and gamma rays), the authors of this document accept the approximation that 1 mR, 0.01 mSv, and 1 mrem are equivalent. Thus, an exposure rate of 7 mR/h at 1 m is an adequate approximation to the dose rate, 0.07 mSv/h (7.0 mrem/h) at 1 m.

Specific Considerations During Lu-177 PSMA Therapy and Patient Release:
According to radiation exposure calculations based on whole-body clearance data, patients may need to be kept in radiation isolation for up to 2 hours following the administration of the typical dose of 200 mCi (7.4 GBq) Lu-177 PSMA therapy. Postinfusion survey by physics or other radiation safety is performed to determine an acceptable maximum exposure rate that conforms to the 10 CFR 35.75 requirement of <5 mSv exposure anticipated to other individuals. An established protocol for documenting this survey result should be used and available. Until the patient has been released, the patient must be kept in an area with suitable radiation shielding to protect others from unnecessary exposure. An administration of 200 mCi Lu-177 PSMA typically results in exposure levels on the order of 2 mR/h at 1 m immediately after administration, declining to 1 mR/h after 24 hours, allowing outpatient treatment in most cases with appropriate training, protocols, infrastructure, and patient counseling. The procedures and practical example guidance for instruction of patients upon discharge have been reviewed in published literature [22]. For further information, see Appendix A.

Modeling per the NUREG-1556 assumption of 0.25 occupancy factor estimates 1.8 mSv exposure dose to other individuals, thus requiring written instructions be given to the patient on ALARA principles. During therapy, involvement of trained radiation safety personnel qualified in safe management of unsealed sources, waste, accidental contamination, and counseling of patients is important. The patient and, as relevant, caregivers should be compliant with all radiation safety precautions and instructions. Education should occur before treatment, preferably at the time of consultation so that the patient and caregivers can plan ahead. The specific instructions and considerations for admission or other special accommodations will vary from institution to institution, but key features are summarized below.

Urinary Contamination:
During the initial patient interview, the patients should be assessed for urinary continence because urine is the most common potential source of contamination. Continence pads or underwear should be recommended if there is a positive history of urine leakage. Some states and local governments may have specific rules and regulations regarding disposal of contaminated material [23]. Please consult with your RSO for patient instruction. During therapy, a dedicated toilet is preferred, and although lead shielding is not needed because of the short range of beta emission, disposable lining of the floors and toilet/sink surfaces is recommended to contain radioactive urine or other contamination. If severe urinary incontinence is present, condom or foley catheterization can be performed prior to administration. Other simple measures used to minimize urinary contamination upon discharge include:

- Use of private room with its own bathroom
- Washing of hands for 20 seconds after each use of the restroom
- Instructing the patient to urinate while seated
- Flushing 2 to 3 times with the toilet lid closed
- Rinsing of sinks and showers after use
- Cleanup of urinary spills with damp toilet paper that can be flushed down the toilet (to minimize

accumulation of waste product trash requiring long-term storage).

Release to Health Care Facility/Admission to Hospital Considerations:
If confinement in a health care facility is needed, it is not usually necessary to store body effluents, such as urine, stool, or vomitus. In general, for patients who have been released to the public, precautions for the patient should be according to ALARA principles and universal precautions. A discussion should be had in such cases with a facility or hospital's radiation safety department and/or involved parties (clinical leadership) to determine any additional precautions that will be taken for care workers. Furthermore, should a patient receiving Lu-177 PSMA require admission to a hospital or transfer to an emergency department, it is highly recommended that the radiation safety department be informed and administering team contact the receiving personnel for a "sign-out."

Although not explicitly required, examples of "extra" precautions include the following. For effluent disposal where acceptable under state or federal regulations, the toilet can be flushed two or three times after each use to ensure sufficient dilution of radioactivity. Food trays, linens, and all other contaminated products may be stored in the patient's room until monitored and cleared by radiation safety staff. The patient must stay in the room except in a medical or nonmedical (eg, fire) emergency, and access by personnel and visitors can be limited. All trash and residual nondisposable items can be monitored after the patient's release and stored until radiation levels reach the statutory level defined for safe disposal or reuse. In some jurisdictions, items in decay storage must reside there for 10 half-lives (67 days for Lu-177) or until radiation levels are indistinguishable from background. Once all known contamination is removed from the room, the room must be surveyed to verify that the radiation levels and removable contamination are sufficiently low to permit its general use. The room may not be used until this survey is performed and safe level documented. Individual institution's radiation safety procedures may vary somewhat.

If the admitting physician is different from the physician who administers the radiopharmaceutical, there must be a mechanism to prevent premature discharge or release of the patient from confinement.

Waste Disposal:
As above, trash and nondisposable items contaminated by patient fluids must be stored and monitored until their radiation levels reach safe disposal limits, which may vary between institutions and jurisdictions, with one prominent guideline being 10 half-lives (67 days for Lu-177).

Distance of Caregivers and Considerations for Travel:
There is no specific regulation on required distance of caregivers following discharge. However, to meet guidance from NUREG-1556's use of a 0.25 occupancy factor for estimating exposure of public allowing safe discharge of patients after administration, it is assumed that exposed persons will maintain a distance of 1 m (3 ft) for at least 3 days and not sleep in the same bed as the patient for 7 days. There is a further assumption of following ALARA principles to minimize exposure to potential contamination, such as may occur during use of the same toilet facilities.

Prolonged use of personal or public transportation (bus, train, etc.) in the company of others for more than one hour is discouraged for the first 3 days following therapy. Although 10 CFR, part 35.75, does not expressly prohibit release of a radioactive patient to a location other than a private residence such as a hotel, the NRC strongly discourages this practice because it can result in radiation exposure to members of the public for which the licensee may not be able to assess full compliance with the code.

Nonetheless, when travel is unavoidable in the first 3 days after therapy, the patient should be instructed to discuss the matter with treating personnel.

Furthermore, although patients are recommended to travel immediately home, it is acknowledged that some patients may need to reside in a hotel or other public facility. Again, precautions to maximize distance from other members of the public are recommended (>1 m at a minimum) in the 3 days after Lu-177 PSMA administration.

IV. SPECIFICATIONS OF THE EXAMINATION

B. Treatment Procedures for Infusion of Lu-177 PSMA

1. Preparation:
   Lu-177 PSMA is a radiopharmaceutical that requires effective radiation shielding before handling. The vial containing the radiopharmaceutical is delivered in a lead shielded container. It is highly advised that the personnel assigned to prepare or infuse the radiopharmaceutical wear double waterproof gloves. Radiopharmaceuticals should be used by or under the supervision of healthcare providers who are qualified by specific training and experience in the safe use and handling of radiopharmaceuticals, and whose experience and training have been approved by the appropriate governmental agency authorized to license the use of radiopharmaceuticals. The activity in the syringe is measured in a dose calibrator (well counter) before and after administration.

2. Dosage:
   The recommended dosage is 200 mCi (7.4 GBq) Lu-177 PSMA IV every 6 weeks for up to 6 doses, or until disease progression, or unacceptable toxicity [3]. (The safety profile and therapeutic benefit of Lu-177 PSMA therapy beyond 6 doses is unknown.)
   Hydration: Oral hydration is encouraged when possible. Otherwise, IV infusion of 250–500 mL of 0.9% normal saline at a rate of 250 mL/hr can also be performed, if not otherwise contraindicated. Patients should be advised to continue hydration following treatment for at least 1–2 weeks.

   Prophylactic antiemetic therapy with ondansetron is permitted but not mandatory. Additionally, treatment with a short course of oral steroids such as dexamethasone may be considered (~2 mg administered orally twice daily for 5-7 days after injection) to limit post-treatment nausea, anorexia, and fatigue and to reduce risk of swelling in the setting of bulky osseous disease with or without epidural component.

3. Infusion Methods:
   Before infusion, measure the source activity to confirm prescribed activity. Parenteral access can be established through a peripheral IV line, a peripherally inserted central catheter, or via port-a-cath. Before therapy administration, verify the patency of the access line with a minimum flush of 10 mL of 0.9% sodium chloride solution. The therapy infusion may take anywhere from one–30 minutes, depending on the method of administration chosen. Lu-177 PSMA-617 can be administered to the patient either directly from the original manufacturer vial or after transferring the solution to a syringe.

   When infusing from the vial, two methods can be used: gravity infusion (with or without an IV pump) or peristaltic pump infusion. If using a syringe, the dose can be administered either via manual push by hand with a syringe shield or with the assistance of a shielded syringe pump. Regardless of the method an institution chooses to implement, staff involved in operating or administering the dose will require appropriate training and must ensure compliance with radiation safety regulations [24]. Please follow the manufacturer-specific administration instructions for additional details [25]. After the Lu-177 PSMA-617 infusion is complete and the access line is removed, assay the IV tubing, vial, or syringe to determine the residual activity. The residual activity should then be used to calculate the final administered dose amount. Although Lu-177 PSMA-617 is currently the only FDA-approved radioligand therapy in mCRPC, there is active research involving other theranostic agents.
   Using different techniques, Lu-177 PSMA can be delivered in a vial under positive pressure or in a syringe. Each institution can choose the most suitable technique of radiopharmaceutical administration.

With any method, after the infusion, remove the IV access, measure the remaining activity in the setup, including the vial, and subtract this from the preinfusion activity to determine the net activity administered.

Lu-177 PSMA is delivered in a vial under positive pressure. It can be administered via gravity method, infusion pump method, or automated syringe pump injector or via manual push [26]. Each institution can choose the best technique of radiopharmaceutical administration.

Gravity (dilution) Method (with or without an automatic pump):

This method involves administering normal saline into the vial, diluting the solution, and creating gradient pressure to deliver the solution from the vial to the patient with minimal manipulation. Because the vial remains within its shipped lead container during administration and requires no manipulation, radiation exposure is minimized.

Patient and tubing preparation:

1. Prepare a radioactive container/jar (sharps safe) and measure its background activity.
2. Insert IV with extension line and prime with sterile 0.9% sodium chloride solution. Ensure there are no bubbles in the lines and IV is clumped.
3. Hang a 500 –1,000 mL sterile 0.9% sodium chloride solution on an infusion bag hang holder and connect administration set tubing. Connect a 2.5-cm-long, 20-gauge needle (short needle) into the tubing. Ensure the passage of saline without leaking.
4. If an automatic pump is used: Connect the saline administrating line to the automatic pump.

Vial Preparation:

1. Sterilize the top of the Lu-177 PSMA vial using an alcohol swab and let it dry.
2. Insert the 20-gauge needle (short needle) into the Lu-177 PSMA vial, ensuring that the beveled tip inside the vial does not touch the solution at any time during the infusion.
3. Keep the IV tubing clamp closed until the entire setup is completed and ready for infusion.
4. Insert a second 9-cm-long, 18-gauge (long needle) needle into the Lu-177 PSMA vial, ensuring that the beveled tip of this long needle touches and is secured to the bottom of the vial during the entire infusion.
5. Remove the inner needle trocar to a radioactive waste jar.
6. Fasten a connecting tube prefilled/primed with sterile 0.9% sodium chloride to the hub of the long needle, ensuring that there are no air bubbles inside the plastic tubing.
7. Check the IV access for Lu-177 PSMA to ensure patency; once confirmed, fasten the male Lauer lock of the connecting tube to the IV access, keeping clamp closed.
8. Do not remove the needles to reposition once the seal is punctured, because this may cause air leaks and prevent dose delivery by this method.

Delivery:
Open the clamp from the vial (long needle) in the IV connecting tube.
No Pump: Using the saline bag administrator rate regulator, regulate the flow of the sodium chloride solution via the short needle into the Lu-177 PSMA vial at a slow visualized rate. The rate may manually be increased if no air leak from the vail (stable air-fluid level) was noticed.
Automatic pump: Set the pump at a lower initial infusion rate for 5 minutes, followed by a higher rate for 25 minutes (the rate can vary per institution). If adopted from the Lutathera perfusion protocol, set the pump for 100 mL/h for 5 minutes, followed by 300 mL/h for an additional 25 minutes.
The total infusion duration is about 30 minutes or until the measured radioactivity is stable for at least five minutes.
During infusion, ensure that there is no air leak, that the solution level in the Lu-177 PSMA vial remains constant, and that the vial does not fill up completely.
Do not administer Lu-177 PSMA as an IV bolus.

Disassmble (may vary between sites):

1. Used the pre-prepared radioactive waste jar/container and measure background activity
2. Clamp the saline line.
3. Clamp the connecting line from the vial.
4. With scissors, cut the nonradioactive line near the short needle.
5. Remove the IV Line from the patient
6. Place the vial (still connected to the long and the short needles) into the radioactive waste jar.

7. Measure the remaining activity in the radioactive container to obtain the net activity administered.

Pump Method:

This method uses a pump to deliver the solution from the vial to the patient without dilution. In this method also minimizes radiation exposure.

Infusion with peristaltic Pump Method:
Short and long needles are also used for the infusion pump method. The tubing connecting the long needle should be primed with normal saline solution before attachment to an infusion pump. The other end of this tubing is attached to the patient's IV access.

A 3-way stopcock is connected to the hub of the short needle before it is inserted into the vial with a filter attached to the vent tip. Again, the tip of the short needle should stay above the fluid level, whereas the tip of the long needle is at the bottom of the vial. The infusion pump controls the rate of the Lu-177 PSMA solution in the vial, which is usually programmed to deliver 0.8 to 0.9 mL/min for a total infusion time of 25 to 30 minutes.

Syringe methods:

This method involves drawing the Lu-177 PSMA solution from the vial into a sterile lead-shielded syringe, which can be administered using a syringe pump injector. This process exposes the individual drawing the solution to radiation risk. To reduce pressure resistance during solution drawing, a vented filtered short needle can be used. It has been announced that doses will soon be manufactured in syringes instead of vials for clinical use if the institution prefers.

Automated Syringe Pump Injector Method:
A connecting tube prefilled with sterile 0.9% sodium chloride solution is used to link the syringe containing the radiopharmaceutical to the patient's IV access.

Program pump to deliver the contents of the syringe over 30 minutes, for example, 30 mL at a rate of 60 mL/h. Once the infusion is complete, flush the connecting tube with 25 mL of sterile 0.9% sodium chloride to ensure any remaining radiopharmaceutical is delivered to the patient.

Carefully handle the setup safely to avoid spillage and minimize radiation exposure, using tongs if necessary.

Manual Syringe Method
A 3-way stopcock is connected to the patient's primed IV line. A 10-mL syringe of 0.9% sterile sodium chloride is connected to the second hub of the 3-way stopcock, and the lead-shielded Lu-177 PSMA solution syringe is connected to the third hub minimizing residuals.

IV. SPECIFICATIONS OF THE EXAMINATION

C. Post-Therapy Management

All personnel involved with Lu-177 PSMA therapy should perform a survey of their hands and clothing/shoes for any contamination, and appropriate measures should be performed if such contamination is discovered. The room used for infusion should be surveyed for contamination before releasing the room to another patient. All medical waste associated with the radioligand therapy should be stored as required by radiation safety procedures, making sure that they are separated from other wastes associated with short-acting radiopharmaceuticals.

Care of the patient after Lu-177 PSMA therapy follows established institutional protocol for care of patient after radionuclide therapy with special consideration to ALARA principles. Patients should be kept in isolation for approximately 0.5– 2 hours to monitor side effects, ensure sufficient hydration, and complete first urination before release. The patients should be encouraged to continue hydration (4-8 glasses per day for 3 days) and

void frequently after release.

Post-therapy SPECT imaging may be obtained to rule out extravasation, confirm physiological tracer biodistribution/excretion and also to assess treatment response [27]. The imaging can be performed as early as 4 hours after treatment. If desired, planar ± SPECT imaging is recommended at multiple time points for the purposes of dosimetry. Personalized dosimetry may be used to assess and estimate potential risk to organs for the individual patient, as data collection for correlative studies seeking to establish maximum organ dose thresholds or lesion treatment efficacy thresholds, or for dose reporting in case of future radiation treatments [28].

Interventions have been investigated to reduce risks of or manage toxicities if Lu-177 PSMA therapy. To reduce the risk of xerostomia, for example, administration of oral vitamin C (ascorbic acid), was associated with a decrease in accumulation of the radiopharmaceutical agent in the salivary glands [9, 29].

V. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Parameter for Communication of Diagnostic Imaging Findings [30].

A summary of the patient's history, pathologic findings, imaging results and laboratory findings should be included in the report to document the indication and tolerability for treatment with Lu-177 PSMA. The report should include the radiopharmaceutical used, the administered activity, the site and route of administration, safety precautions for other staff involved in the patient's care, and any associated incident encountered during therapy. If dosimetry is performed, salient organ absorbed dose values, both in directly calculated dose and in equivalent dose, should be reported, and, if available, a dose map in DICOM format with the associated CT.

VI. EQUIPMENT SPECIFICATIONS

Equipment performance monitoring should be in accordance with the ACR–AAPM Technical Standard for Nuclear Medical Physics Performance Monitoring of Gamma Cameras [31].

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, non-physician radiology providers, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, "as low as reasonably achievable" (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

Facilities and their responsible staff should consult with the radiation safety officer to ensure that there are policies and procedures for the safe handling and administration of radiopharmaceuticals in accordance with ALARA principles. These policies and procedures must comply with all applicable radiation safety regulations and conditions of licensure imposed by the Nuclear Regulatory Commission (NRC) and by applicable state, local, or other relevant regulatory agencies and accrediting bodies, as appropriate. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol, using body habitus or other customized method when such guidance is available.

Nationally developed guidelines, such as the ACR's Appropriateness Criteria®, should be used to help choose the most appropriate imaging procedures to prevent unnecessary radiation exposure.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org). These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director's National Evaluation of X-ray Trends; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *ACR Position Statement on Quality Control and Improvement, Safety, Infection Control and Patient Education* on the ACR website (https://www.acr.org/Advocacy/Position-Statements/Quality-Control-and-Improvement).

ACKNOWLEDGEMENTS

This practice parameter was revised according to the process described under the heading *Process for Developing ACR Practice Parameters and Technical Standards* on the ACR website (https://www.acr.org/clinical-resources/clinical-tools-and-reference/practice-parameters-and-technical-standards) by the Committee on Practice Parameters and Technical Standards - Nuclear Medicine and Molecular Imaging of the ACR Commission on Nuclear Medicine and Molecular Imaging and the Committee on Practice Parameters – collaboration with the ACNM, ARS and SNMMI.

Writing Committee – members represent their societies in the initial and final revision of this practice parameter

ACR
Morris, Zachary MD, Co-Chair
Surasi, Devaki Shilpa MD, Co-Chair
Karagulle Kendi, A. Tuba MD
Wong, Terence Z MD, PhD

SNMMI
Calais, Jeremie MD, MSc
Marcus, Charles MD
Savir-Baruch, Bital MD

ARS
Folkert, Michael MD, PhD
Hassanzadeh, Comron MD, MPH

ACNM
Osmany, Saabry MD
Zukotynski, Katherine MD, PhD

Committee on Practice Parameters – Nuclear Medicine and Molecular Imaging
(ACR Committee responsible for sponsoring the draft through the process)

Ghesani, Munir V MD, Chair
Aboian, Mariam MD, PhD
Bartel, Twyla B DO, MBA
Gerard, Perry S MD
Marcus, Charles MD
Peacock, Justin G MD, PhD
Surasi, Devaki Shilpa MD
Wong, Terence Z MD, PhD

Subramaniam, Rathan M MBA, MD, MPH, PhD, Chair
Akin, Esma A MD
Dibble, Elizabeth H MD
Karagulle Kendi, A. Tuba MD
Mercier, Gustavo A MD, PhD
Solnes, Lilja B MBA, MD
Trout, Andrew T MD
Zukotynski, Katherine MD, PhD

Committee on Practice Parameters and Technical Standards
(ACR Committee responsible for sponsoring the draft through the process)

Caplin, Drew M MD, Chair

Committee on Practice Parameters – Radiation Oncology
(ACR Committee responsible for sponsoring the draft through the process)

Schechter, Naomi MD, Chair
Chao, Samuel MD
Frank, Steven J MD
Garsa, Adam MD
Morris, Zachary MD
Reilly, Michael PhD

Berkowitz, Aviva MD
Davis, Brian J MD, PhD
Freedman, Laura MD
Lo, Simon S. ChB, MB
Rabatic, Bryan MD
Saeed, Hina MD

Sio, Terence Tai-Weng MD, MS

Wallner, Paul DO

Larson, David B MBA, MD, Chair, Commission on Quality and Safety
Rohren, Eric MD, PhD, Chair, Commission on Nuclear Medicine & Molecular Imaging
Small, William MD, Chair, Commission on Radiation Oncology

Comments Reconciliation Committee

Moriarity, Andrew MD - CSC, Chair	Rodgers, Daniel MD - CSC, Co-Chair
Bartel, Twyla B DO, MBA	Calais, Jeremie MD, MSc
Caplin, Drew M MD	Chao, Samuel MD
Folkert, Michael MD, PhD	Ghesani, Munir V MD
Hassanzadeh, Comron MD, MPH	Karagulle Kendi, A. Tuba MD
Larson, David B MBA, MD	Marcus, Charles MD
Morris, Zachary MD	Osmany, Saabry MD
Rohren, Eric MD, PhD	Savir-Baruch, Bital MD
Schechter, Naomi MD	Small, William MD
Subramaniam, Rathan M MBA, MD, MPH, PhD	Surasi, Devaki Shilpa MD
Wong, Terence Z MD, PhD	Zukotynski, Katherine MD, PhD

REFERENCES

1. American College of Radiology. ACR-AAPM-ACNM-SNMMI Technical Standard for Therapeutic Procedures Using Radiopharmaceuticals. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=153+&releaseId=2
2. Benešová M, Bauder-Wüst U, Schäfer M, et al. Linker Modification Strategies To Control the Prostate-Specific Membrane Antigen (PSMA)-Targeting and Pharmacokinetic Properties of DOTA-Conjugated PSMA Inhibitors. J Med Chem. 2016 Mar 10;59(5):1761-75.
3. Pluvicto, 2022. https://www.novartis.com/us-en/sites/novartis_us/files/pluvicto.pdf.
4. Kurth J, Krause BJ, Schwarzenböck SM, Stegger L, Schäfers M, Rahbar K. External radiation exposure, excretion, and effective half-life in 177Lu-PSMA-targeted therapies. EJNMMI Res. 2018 Apr 12;8(1):32.
5. Schuchardt C, Zhang J, Kulkarni HR, Chen X, Muller D, Baum RP. Prostate-Specific Membrane Antigen Radioligand Therapy Using 177Lu-PSMA I&T and 177Lu-PSMA-617 in Patients with Metastatic Castration-Resistant Prostate Cancer: Comparison of Safety, Biodistribution, and Dosimetry. Journal of Nuclear Medicine. 63(8):1199-1207, 2022 08.
6. Sartor O, de Bono J, Chi KN, et al. Lutetium-177-PSMA-617 for Metastatic Castration-Resistant Prostate Cancer. New England Journal of Medicine. 385(12):1091-1103, 2021 09 16.
7. Sonbol MB, Halfdanarson TR, Hilal T. Assessment of Therapy-Related Myeloid Neoplasms in Patients With Neuroendocrine Tumors After Peptide Receptor Radionuclide Therapy: A Systematic Review. JAMA Oncol. 2020 Jul 01;6(7):1086-1092.
8. Pritzl SL, Kusne Y, Halfdanarson TR, et al. Spectrum of therapy-related clonal cytopenias and neoplasms after exposure to Lutetium-177-Dotatate. Leuk Res. 2024 Jan;136():S0145-2126(23)00699-9.
9. Muniz M, Loprinzi CL, Orme JJ, et al. Salivary toxicity from PSMA-targeted radiopharmaceuticals: What we have learned and where we are going. Cancer Treat Rev. 2024 Jun;127():S0305-7372(24)00076-8.
10. American College of Radiology. ACR-AAPM radiation safety officer resources. Available at: https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Radiology-Safety/ACR-AAPM-Radiation-Safety-Resources.pdf.
11. American College of Radiology. ACR-ARS Practice Parameter for Radiation Oncology. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=200+&releaseId=2
12. Scher HI, Morris MJ, Stadler WM, et al. Trial Design and Objectives for Castration-Resistant Prostate Cancer: Updated Recommendations From the Prostate Cancer Clinical Trials Working Group 3. J Clin Oncol. 2016 Apr 20;34(12):1402-18.
13. Mannweiler S, Amersdorfer P, Trajanoski S, Terrett JA, King D, Mehes G. Heterogeneity of prostate-specific membrane antigen (PSMA) expression in prostate carcinoma with distant metastasis. Pathol Oncol Res. 2009 Jun;15(2):167-72.

14. Sweat SD, Pacelli A, Murphy GP, Bostwick DG. Prostate-specific membrane antigen expression is greatest in prostate adenocarcinoma and lymph node metastases. Urology. 1998 Oct;52(4):637-40.
15. Fendler WP, Eiber M, Beheshti M, et al. PSMA PET/CT: joint EANM procedure guideline/SNMMI procedure standard for prostate cancer imaging 2.0. Eur J Nucl Med Mol Imaging. 2023 Apr;50(5):1466-1486.
16. Rosar F, Burgard C, David S, et al. Dual FDG/PSMA PET imaging to predict lesion-based progression of mCRPC during PSMA-RLT. Sci Rep. 2024 May 17;14(1):11271.
17. Kratochwil C, Fendler WP, Eiber M, et al. Joint EANM/SNMMI procedure guideline for the use of 177Lu-labeled PSMA-targeted radioligand-therapy (177Lu-PSMA-RLT). European Journal of Nuclear Medicine & Molecular Imaging. 50(9):2830-2845, 2023 07.
18. American College of Radiology. ACR-ARS Practice Parameter on Informed Consent- Radiation Oncology. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=141+&releaseId=2
19. NRC, 2011. https://www.nrc.gov/docs/ML1036/ML103620153.pdf.
20. NRC, 2018. https://www.nrc.gov/docs/ML1813/ML18136A824.pdf.
21. NCRP, 2015. https://ncrponline.org/publications/reports/ncrp-reports-155/.
22. Zoberi JE, Garcia-Ramirez J, Luechtefeld D, et al. Logistical, technical, and radiation safety aspects of establishing a radiopharmaceutical therapy program: A case in Lutetium-177 prostate-specific membrane antigen (PSMA) therapy. Journal of Applied Clinical Medical Physics. 24(4):e13899, 2023 Apr.
23. Graves SA. Radiation Safety Considerations of Household Waste Disposal After Release of Patients Who Have Received [177Lu]Lu-PSMA-617. Journal of Nuclear Medicine. 64(10):1567-1569, 2023 10.
24. https://www.usp.org/small-molecules/general-chapter-825.
25. https://www.novartis.com/us-en/sites/novartis_us/files/pluvicto.pdf.
26. Jeffers CD, Lawhn-Heath C, Butterfield RI, Hoffman JM, Scott PJH. SNMMI Clinical Trials Network Research Series for Technologists: Clinical Research Primer- Use of Imaging Agents in Therapeutic Drug Development and Approval. J Nucl Med Technol. 2022 Jun 14;():jnmt.122.264372.
27. Swiha M, Gafita A, Nguyen A, Emmett L. Treatment Response Imaging in Prostate Cancer. PET Clin. 2024 Jul;19(3):S1556-8598(24)00024-5.
28. Peters SMB, Mink MCT, Privé BM, et al. Optimization of the radiation dosimetry protocol in Lutetium-177-PSMA therapy: toward clinical implementation. EJNMMI Res. 2023 Jan 24;13(1):6.
29. Pepin A, Lee V, O'Brien S, Mulugeta P, Taunk NK. Management of Dry Eye Toxicity After Treatment With 177Lu-PSMA-617 Radioligand Therapy. Pract Radiat Oncol. 2024;14(4):S1879-8500(24)00079-1.
30. American College of Radiology. ACR Practice Parameter for Communication of Diagnostic Imaging Findings. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=74+&releaseId=2
31. American College of Radiology. ACR–AAPM Technical Standard for Nuclear Medical Physics Performance Monitoring of Gamma Cameras. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=196+&releaseId=2

Appendix A

Post Treatment Instructions to Patient Following Lu-177 PSMA Therapy

Name of Patient: _____ Medical Record Number: _____
Last name, First name

Date of Treatment: _____ Isotope: Lu-177 Activity: _____

Before this date: _____, please show this form to every physician, healthcare worker or emergency personnel that provide you care.

Special Precautions

1. Limit close contact (less than 3 feet) with household contacts for 2 days or with children and pregnant women for 7 days.
2. Sleep in a separate bedroom from household contacts for 3 days, from children for 7 days, or from pregnant women for 15 days.
3. For patients with female partners of reproductive potential, an effective contraception should be used

during treatment and continued until 3-4 months following the last treatment dose.
4. Sexual activity should be avoided following therapy for 7 days.
5. Take particular care when urinating for 3 days. Toilets must be used in a seated position, even for men. Use private bathroom or flush 2 to 3 times and clean any spills with disposable gloves and damp cloth after each use. Wash hands thoroughly. The radiation leaves your body mainly from your urine.
6. Wash dishware and utensils and bathroom accessories separately for 3 days.
7. Do not travel by public transportation (bus, train, plane) for more than 1 hour for 3 days. If you are planning to travel while radiation safety precautions are in effect, please inform Nuclear Medicine or Radiation Facility personnel at (area code) ____-_____.

**For flights, travelers may call TSA Cares toll free at 1-855-787-2227 prior to traveling with questions about screening policies, procedures, and what to expect at the security checkpoint. For more information, visit https://www.tsa.gov/travel/special-procedures.

1. No prolonged car trip (more than 1 hour) with others for 3 days.
2. Drink plenty of fluid (4-8 glasses) per day for 3 days.

If you are admitted to the ER or hospitalized while radiation safety precautions are in effect, inform the hospital staff to notify the above contact person immediately. During off-hours, contact Nuclear Medicine or Radiation Facility via the operator at _____.

Instructions for Radioactive Trash Generated by patient

Please be aware that the following items that may be contaminated with urine cannot be disposed into regular trash:

1. Toilet papers, tissue
2. Towels, linens, sheets
3. Any other items that are contaminated with urine, blood, and wound or drainage secretions for the first 3 days post treatment

Towels, linens and sheets can be washed separately and reused.
Toilet paper and tissue need to be flushed down the toilet.

Some states and local governments may have specific rules and regulations regarding disposal of contaminated material, please consult with your RSO for patient instruction.

Any other contaminated items that cannot be washed or flushed down the toilet need to be kept for at least 70 days or brought to the Nuclear Medicine Facility to be stored.

I have read the above precautions and instructions and have spoken with the Nuclear Medicine or Radiation Facility personnel and agree to comply.

Patient (print name): _____

Signature: _____ Date/time: _____

Witness (print name) _____

Signature: _____ Date/time: _____

Authorized User or Supervised Designee (print name) _____
Adopted 2025 (Resolution 30)

Signature: _____ Date/time: _____

*Practice parameters and technical standards are published annually with an effective date of October 1 in the year in which amended, revised, or approved by the ACR Council. For practice parameters and technical standards published before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

Development Chronology for this Practice Parameter

2025 (Resolution 30)