Guidance on ^{177}Lu-DOTATATE Peptide Receptor Radionuclide Therapy from the Experience of a Single Nuclear Medicine Division

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^{177}Lu-DOTATATE is a radiolabeled somatostatin analog that has been approved by the U.S. Food and Drug Administration (FDA) for the treatment of somatostatin receptor–positive gastroenteropancreatic neuroendocrine tumors in adults. Radionuclide therapies have been administered for many years within nuclear medicine departments in North America. However, in comparison to other radiotherapies, ^{177}Lu-DOTATATE peptide receptor radionuclide therapy involves more planning, coordination, concomitant medication administration (antiemetic medications and amino acids), and direct patient care. To date, various methods have been used in multiple centers during the NETTER-1 trial and the provision of patient care. As participants in the phase 3 NETTER-1 trial and the subsequent expanded-access program for the administration of ^{177}Lu-DOTATATE studies, as well as recently starting postapproval clinical care, we have administered 61 ^{177}Lu-DOTATATE therapies at the time of this manuscript submission (13 in the NETTER-1 trial, 39 in the expanded-access program, and 9 clinically) at the Dana-Farber Cancer Institute and here share our procedures, personnel training, and workflow to help other centers establish programs for this FDA-approved ^{177}Lu-DOTATATE peptide receptor radionuclide therapy.

Key Words: radionuclide therapy; peptide receptor radionuclide therapy (PRRT); nuclear medicine; ^{177}Lu-DOTATATE; neuroendocrine tumor

J Nucl Med Technol 2018; 46:237–244
DOI: 10.2967/jnmt.118.209148

Neuroendocrine tumors commonly express somatostatin receptor subtype 2, which can be used for both imaging and treatment. Although peptide receptor radionuclide therapy (PRRT) has been used in other countries for approximately 20 y (*1*), ^{177}Lu-DOTATATE became the first agent of its kind approved by the U.S. Food and Drug Administration (FDA) (in January 2018) for the treatment of somatostatin receptor–positive gastroenteropancreatic neuroendocrine tumors (*2,3*). In the phase 3 NETTER-1 trial, patients with somatostatin receptor–positive midgut neuroendocrine tumors whose disease had progressed on standard-dose somatostatin analog therapy showed better progression-free survival when treated with 4 administrations of ^{177}Lu-DOTATATE 8 weeks (wk) apart along with the standard of care, 30 mg of the long-acting somatostatin analog octreotide per month, than when treated with monthly high-dose octreotide therapy (*4*). ^{177}Lu-DOTATATE has also been shown effective in nonrandomized studies including patients with other gastrointestinal and pancreatic neuroendocrine tumors (*1*). On the basis of our experience in the NETTER-1 clinical trial, the subsequent expanded-access program, and postapproval clinical care at Dana-Farber Cancer Institute, delivery of ^{177}Lu-DOTATATE PRRT to patients with gastroenteropancreatic neuroendocrine tumors requires more planning, coordination, concomitant medication administration, and direct supervised patient care than do most other radionuclide therapies administered in nuclear medicine departments.

^{177}LU-DOTATATE PRRT IN BRIEF

The treatment generally consists of a 7.4 GBq (200 mCi) intravenous infusion of ^{177}Lu-DOTATATE given every 8 wk

Received Apr. 6, 2018; revision accepted Jun. 18, 2018.
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Published online Aug. 3, 2018.

for a total of 4 administrations. This 8-wk interval has varied among investigators at other centers. Should a patient experience an adverse reaction during the initial infusion, the severity and timing of the reaction can be used to guide a delay or dose reduction for the subsequent infusions. We have seen reactions requiring that the next infusion be delayed, but none that would lead to a reduced dose. Given that ^{177}Lu-DOTATATE binds to somatostatin receptors, therapy with long-acting somatostatin analogs should be stopped at least 4 wk before ^{177}Lu-DOTATATE administration, but therapy with short-acting somatostatin analogs can continue, if needed for symptom control, until 24 hours (h) before ^{177}Lu-DOTATATE administration (*2–4*). We readminister the long-acting somatostatin analog octreotide between 4 and 24 h after each ^{177}Lu-DOTATATE infusion, but usually on the same day so that the patient does not have to return the next day.

Given the preferential renal excretion of ^{177}Lu-DOTATATE, amino acids consisting of 18–24 grams (g) each of lysine and arginine are coinfused before and during the ^{177}Lu-DOTATATE to help decrease renal retention and lower the radiation dose to the kidneys (*2*). Prophylaxis for amino acid–related nausea and vomiting includes antiemetic medication given at least 30 minutes (min) before the start of the amino acid infusion (*2*) and as needed throughout the treatment.

ROLES OF MULTIDISCIPLINARY TEAM MEMBERS

Administration of ^{177}Lu-DOTATATE PRRT involves multiple departments (imaging, medical oncology, pharmacy, and radiation safety) and multiple individuals within each

TABLE 1
Staff Roles, Responsibilities, and Required Training

Staff member	Role or responsibility	Required training
Medical oncology member	Communicates with nuclear medicine team on eligible patients	Workflow training
	Enters orders in electronic health record for ^{177}Lu-DOTATATE procedure and required medications	Eligibility training
	Evaluates patients within week before each ^{177}Lu-DOTATATE treatment and monitors for adverse events afterward	
Pharmacist	Provides antiemetics, amino acids, and posttreatment long-acting somatostatin analog on treatment day	Workflow training
Radiation safety officer	Provides ^{177}Lu radiation safety training to nuclear medicine staff	Workflow training
	Prepares treatment room and restroom with contamination control measures; provides radiologic survey support as needed	
	Collects residual or unused doses and associated contaminated materials and manages inventory of those items for ultimate disposal	
	Reviews each record of therapeutic administration	
	Develops and maintains basis for release of patients after treatment	
Nuclear medicine nurse	Checks electronic medical record on day before treatment to ensure medication orders have been entered correctly and sends them to pharmacy on treatment day	Workflow and radiation safety, including patient care and waste disposal
	Places intravenous catheter in patient (can also be done by nuclear medicine technologist)	Medication management and Alaris pump
	Administers antiemetics, amino acids, and long-acting somatostatin analog	
	Monitors for adverse events during amino acid infusion, checks blood pressure and pulse just before and after ^{177}Lu-DOTATATE infusion, and ensures that patient voids before and hourly after infusion	
Nuclear medicine physician	Gets informed consent from patients and reviews radiation safety instructions with patient	Workflow and radiation safety
	Assays ^{177}Lu-DOTATATE dose in dose calibrator, assesses intravenous line patency, performs time-out before infusion, and gives infusion	Graseby pump
	Assesses status and discharges patient from nuclear medicine department	
Nuclear medicine technologist	Orders, receives, inspects, and prepares ^{177}Lu-DOTATATE dose for administration; prepares patient for treatment (can also be done by nurse)	Workflow and radiation safety, including dose preparation and waste disposal
	Surveys restroom floor and path to treatment area with Geiger counter; contacts radiation safety officer and restricts access to contaminated areas if found	Graseby pump and ^{177}Lu-DOTATATE dose preparation
	Prints patient dose administration card; measures exposure 1 m from patient, and confirms that level is below that established by radiation safety officer once all administrations are complete	

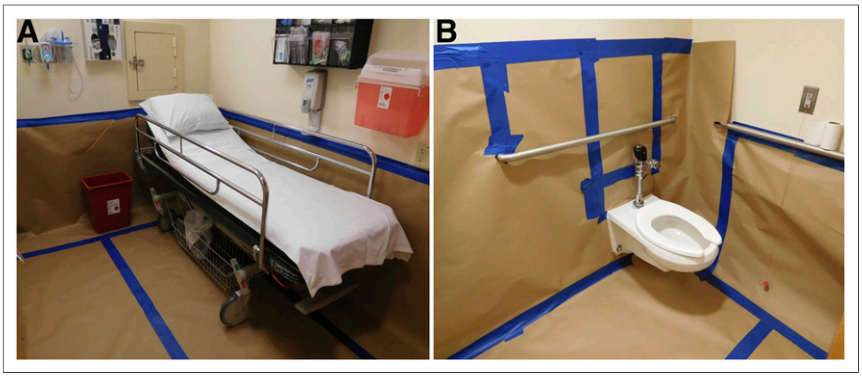


FIGURE 1. Prepared dedicated treatment room (A) and restroom (B).

department (medical oncologists, nurses and nurse practitioners, nuclear medicine physicians and technologists, pharmacists, and the radiation safety officer). Each member of the team is assigned specific roles and responsibilities to streamline the process and optimize delivery of care. The required training and resources are tailored to these roles and responsibilities (Table 1). Since the time that the FDA approved ^{177}Lu-DOTATATE PRRT, we have established a multidisciplinary tumor board that meets bimonthly to determine patient eligibility, which includes demonstration of a somatostatin receptor–positive tumor on imaging such as ^{68}Ga-DOTATATE PET/CT. We have also established a required consultation between a nuclear medicine physician and the patient before the therapy is scheduled. The date for this appointment is set once a patient has been deemed eligible for ^{177}Lu-DOTATATE PRRT.

ORDERING AND RECEIPT OF ^{177}LU-DOTATATE DOSE

At least 2 wk before the date on which the ^{177}Lu-DOTATATE PRRT is scheduled, the nuclear medicine division orders the dose from the manufacturer (Advanced Accelerator Applications). Within 24 h of receiving the order, the manufacturer confirms that the dose will be available at the requested time on the scheduled date.

Approximately 2 days (d) before the treatment, the manufacturer delivers a batch-release document stating the batch number; shipment date and time; calibration date, time, and activity; expiration date and time; and volume for the ^{177}Lu-DOTATATE dose. The day before the treatment, a nuclear medicine technologist receives the dose and visually checks that it is free of particles.

PREPARATION OF TREATMENT ROOM AND RESTROOM

The day before a treatment, the floor and lower walls of a lead-lined treatment room and restroom in the nuclear medicine division are lined with plastic-backed kraft paper (Fig. 1). Chux pads are placed over the patient stretcher or chair and then covered by a bedsheet. A large sharps waste bucket is placed in the treatment room for any waste that might contain ^{177}Lu (alcohol wipes, gauze, emesis basins, intravenous supplies). Several pairs of scrubs are also set aside for the patient to use if needed.

INFUSION OF AMINO ACIDS

An antiemetic (oral or intravenous, depending on patient's insurance) is given at least 30 min before the amino acid infusion.

Our pharmacy usually provides 2 L of amino acids in the form of either Aminosyn II (10%; Hospira, Inc.) or Clinisol (15%; Baxter Healthcare Corp.). We dilute the Clinisol to 2.2 L.

We perform infusions via an Alaris pump (Becton Dickinson [BD]). The rate and time of infusion can be adjusted as needed per the amino acid content. According to the prescribing information for the amino acids, the infusion starts 30 min before the ^{177}Lu-DOTATATE infusion (*2*). To minimize nausea and vomiting but provide the same amount of amino acids, we reduce the rate from 500 to 320 mL/h but we start the infusion earlier—50 min before the ^{177}Lu-DOTATATE infusion for Aminosyn II and 60 min before the ^{177}Lu-DOTATATE infusion for Clinisol. Although this change lengthens the total duration of the amino acid infusion from 4 h to more than 6 h, fewer emetic events occur. In May 2018, the National Comprehensive Cancer Network added ^{177}Lu-DOTATATE PRRT principles to its guidelines on neuroendocrine and adrenal tumors, with the option of administering either compounded or commercial amino acids and of starting the infusion at a lower rate and increasing it every 10 min (*3*).

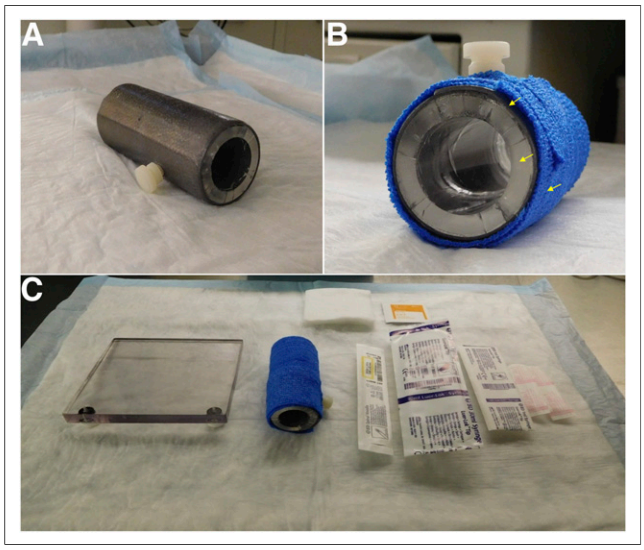


FIGURE 2. (A and B) In-house–fabricated 30-mL syringe shield (with outer-to-inner arrows indicating adhesive bandage, lead layer, and acrylic layer). (C) Supplies to draw dose (wedge, syringe shield, gauze, alcohol wipes, 30-mL and 1-mL syringes, 3.5-in [8.9-cm] spinal needle and 20-gauge needles, and chux pad).

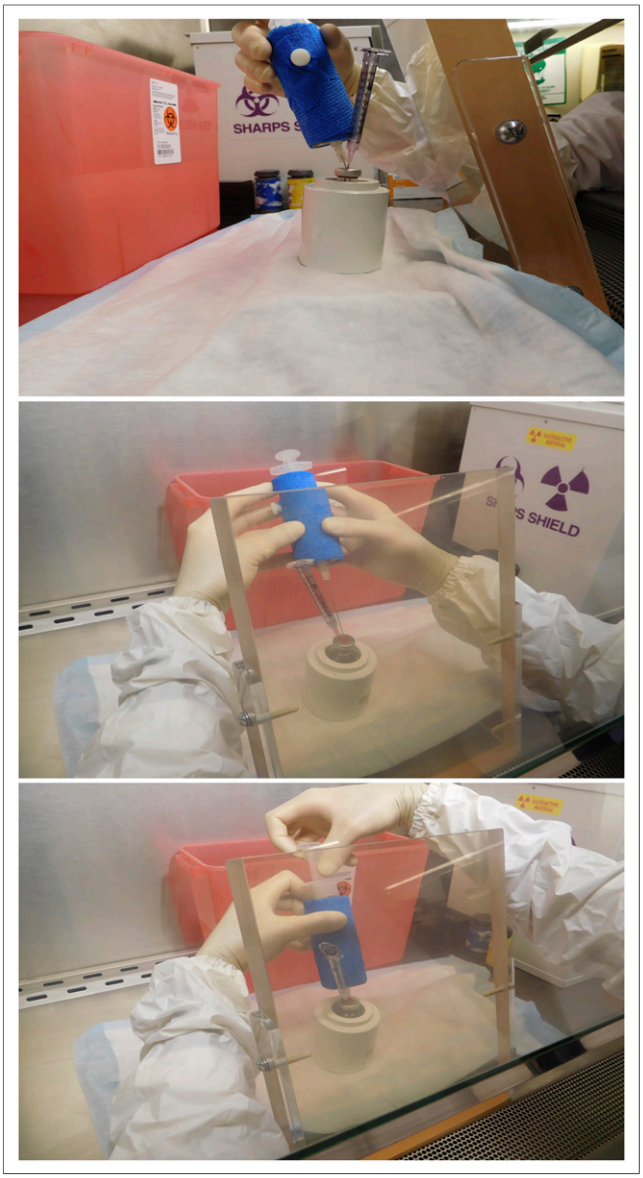


FIGURE 3. Dose preparation: insertion of vent needle and spinal needle for drawing up dose, with vial tilted on wedge, behind L-block in biologic safety cabinet, and with dedicated ^{177}Lu waste bucket in back.

PREPARATION OF ^{177}LU-DOTATATE DOSE

There are multiple options for preparing the ^{177}Lu-DOTATATE dose. One option is to drip or infuse saline into the vial either by gravity or with an infusion pump; as the saline enters the vial, the ^{177}Lu-DOTATATE exits the vial into the patient's intravenous tubing. However, since this method requires close monitoring and may have vial-pressure problems and leakage, we choose a different option, withdrawal of the dose into a syringe followed by administration via a shielded Graseby pump (Smiths Medical) (Figs. 2–4). So far, we have not had any problems administering the therapy with this method.

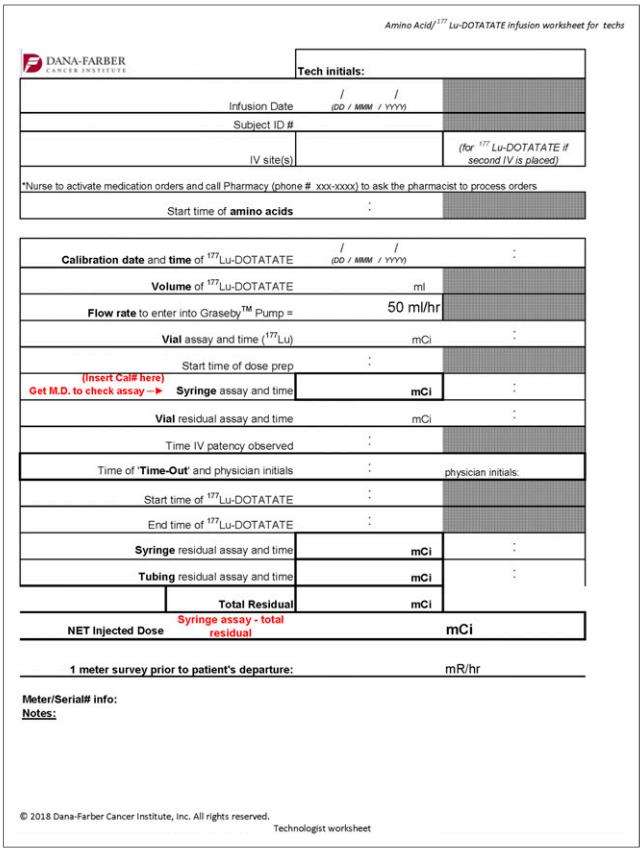
The dose is received from the manufacturer at an approximate volume of 25 mL in a 30-mL vial. Two nuclear medicine technologists work together, with one preparing the dose and the other completing an infusion worksheet (Fig. 5) to ensure that each step is followed in proper order. It is recommended that the technologist preparing the dose wear scrubs and a lab coat, along with 2 pairs of gloves and wrist gaiters to cover the gap between gloves and lab coat sleeves, for protection from drips or splashes as the syringe needle is withdrawn from the vial septum. When we train technologists to perform ^{177}Lu-DOTATATE PRRT, the procedures are simulated by drawing and loading a dose of saline solution into the Graseby pump. For this purpose, a graded-Z 30-mL syringe shield was built in-house using an acrylic shield wrapped with lead to reduce exposure from both beta and gamma emissions, and covered with a CoFlex (Andover) adhesive bandage to prevent contact with the lead surface (Fig. 2). The needed supplies are listed in Table 2. A technologist checklist for dose preparation is provided in Table 3.

INFUSION OF ^{177}LU-DOTATATE

The patient empties their bladder, vital signs are checked by the nurse, and immediately before the infusion the nuclear medicine physician checks the patency of the intravenous line and performs a time-out procedure with the patient (when the physician asks the patient to state his or her name and date of birth along with the reason he or she is in the nuclear medicine department, ensuring it is the right patient and the right procedure, and the patient is aware of what procedure is being done). The technologist connects the ^{177}Lu-DOTATATE microbore tubing to the Alaris port closest to the patient's intravenous line, the physician starts the ^{177}Lu-DOTATATE infusion, and the technologist records the start time. When the infusion is completed, within approximately 30 min the technologist records the stop time, fills the syringe with saline, and infuses a bolus saline flush at 400 mL/h via the Graseby pump. Once this flush is complete, the technologist disconnects the microbore tubing and returns the cart to the hot lab to measure residual radioactivity.

Two nuclear medicine technologists unload the pump and assay the residual radioactivity in the syringe while wearing

FIGURE 4. Dose administration supplies: Alaris pump with amino acids, saline bag, shielded Graseby pump, and ^{177}Lu-DOTATATE on chux pad–covered cart.



Amino Acid/^{177}Lu-DOTATATE infusion worksheet for techs

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	Tech initials:	
Infusion Date	/ / (DD / MMM / YYYY)	
Subject ID #		
IV site(s)		(for ^{177}Lu-DOTATATE if second IV is placed)

*Nurse to activate medication orders and call Pharmacy (phone # xxx-xxxx) to ask the pharmacist to process orders

Start time of **amino acids**	:	
Calibration date and **time** of ^{177}Lu-DOTATATE	/ / (DD / MMM / YYYY)	:
Volume of ^{177}Lu-DOTATATE	ml	
Flow rate to enter into Graseby™ Pump =	50 ml/hr	
Vial assay and time (^{177}Lu)	mCi	:
Start time of dose prep	:	
(Insert Cal# here) Get M.D. to check assay → ► **Syringe** assay and time	**mCi**	:
Vial residual assay and time	mCi	:
Time IV patency observed	:	
Time of '**Time-Out**' and physician initials	:	physician initials:
Start time of ^{177}Lu-DOTATATE	:	
End time of ^{177}Lu-DOTATATE	:	
Syringe residual assay and time	**mCi**	:
Tubing residual assay and time	**mCi**	:
Total Residual	**mCi**	
NET Injected Dose Syringe assay - total residual	**mCi**	
1 meter survey prior to patient's departure:	mR/hr	

Meter/Serial# info:
Notes:

Technologist worksheet

FIGURE 5. Amino acid/^{177}Lu-DOTATATE infusion worksheet for technologists.

2 pairs of gloves in addition to routine personal protective equipment. One technologist covers the pump with chux pads to avoid potential radioactive contamination, removes the dose syringe from the 3-way stopcock, replaces the original needle onto the syringe, and assays the residual radioactivity in the syringe using the dose calibrator with the appropriate plastic sleeve and channel setting for ^{177}Lu. The other technologist fills out the infusion worksheet. The residual activity is subtracted from the first syringe assay to determine the net injected dose. We measured residual activity in the syringe, microbore tubing, and 3-way stopcock during the NETTER-1 trial and the expanded-access program and found it to be negligible. We therefore now measure the syringe residual activity only after the ^{177}Lu-DOTATATE PRRT.

Besides the infusion worksheet for technologists, we also created an infusion worksheet for nurses (Fig. 6). It includes the pharmacy phone number for convenience in activating and releasing drug orders. The nurses note the start time of the amino acid infusion to estimate when the technologists will be bringing the ^{177}Lu-DOTATATE dose to the patient room for administration. The nurses also document every bathroom visit to ensure that the patient voids at least hourly after ^{177}Lu-DOTATATE administration. It is helpful for the nurses to have an area outside but contiguous to the treatment room (such as a hallway) to document vital signs, medication administrations, and adverse events on the worksheet, which is saved and referenced during subsequent treatments. The worksheet for nurses has been reformatted for clinical use by replacing the trial subject number with the patient's name and medical record number, and the worksheet for technologists has been incorporated into our Quality Management Program worksheet for clinical use.

FURTHER RECOMMENDATIONS

As with all novel therapeutic agents, the transition of ^{177}Lu-DOTATATE PRRT from clinical trials to routine clinical care must be planned. The experience we acquired during the NETTER-1 trial and the expanded-access program helped us design standard operating procedures for routine delivery of ^{177}Lu-DOTATATE PRRT once it had been approved by the FDA. Besides our addition of a multidisciplinary tumor board and a patient–nuclear medicine physician consultation, we found that follow-up procedures similar to those of the NETTER-1 trial need to be in place to monitor efficacy and toxicity and to allow individualized decisions on post-PRRT somatostatin analog therapy to be made.

Safe delivery of ^{177}Lu-DOTATATE PRRT can be ensured by coordinated preparation among departments, including such considerations as patient consent, team communication, handling of radioactive materials, departmental resources and workflow, and emergency preparedness.

Patient Consent

In the NETTER-1 trial, a member of the medical oncology team obtained informed consent from the patients, and a nuclear medicine technologist instructed the patients on radiation safety. After FDA approval of ^{177}Lu-DOTATATE PRRT, we recommended that a potential candidate for treatment be evaluated by a multidisciplinary tumor board, including a consultation with a nuclear medicine physician. The goals of the consultation are to confirm that the therapy is appropriate for the patient, review its risks and benefits, answer any questions, obtain written informed consent, and review posttreatment radiation safety issues such as radiation risks, myelosuppression, secondary myelodysplastic syndrome, acute leukemia, renal toxicity, hepatic toxicity, neuroendocrine hormonal crises, embryofetal toxicity, lactation, and infertility (*2,3*). This consultation is included in the clinical notes of the patient's electronic health record and can be billed separately from the therapeutic procedure.

Team Communication

We recommend keeping the contact information updated for each team member and telling the patient in advance about the schedule and events of the treatment day. We also believe that it is helpful to designate a point-of-contact person in the nuclear medicine department to coordinate among the members of the multidisciplinary team (*5,6*).

Handling of Radioactive Materials

Additional preparation measures for radioactive materials are needed, including calibration of the dose calibrator for ^{177}Lu and inclusion of ^{177}Lu in the radioactive materials

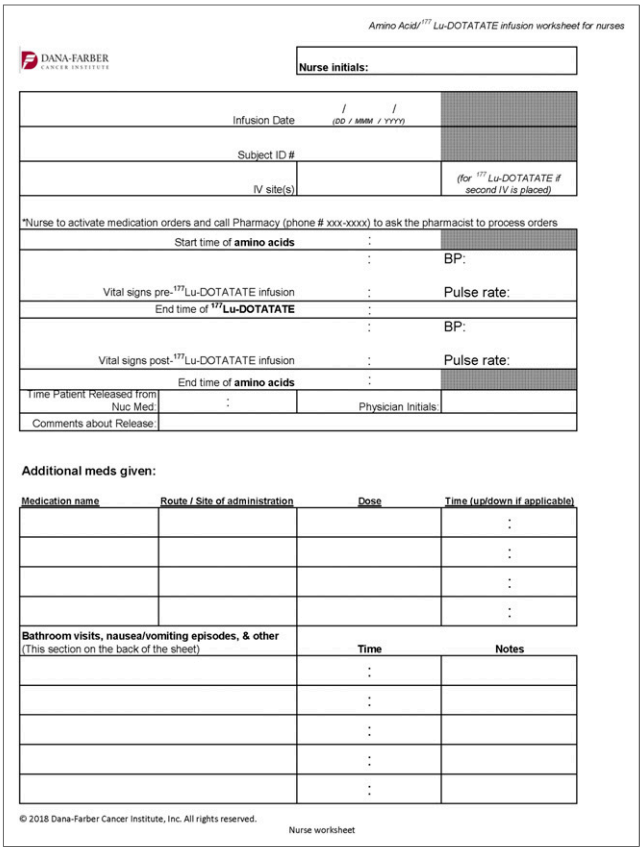
TABLE 2
Supplies to Prepare and Administer ^{177}Lu-DOTATATE Dose

Supply	Purpose
A designated treatment room and restroom	To prevent radiation exposure to other people
Plastic-backed kraft paper and masking tape	To line walls and floor of treatment room and bathroom
Scrubs for patient; scrubs, lab coat, impermeable gloves, wrist gaiters, goggles or face shield, personal dosimetry badge, and radiation detection device for technologist	To monitor radiation exposure and provide personal protection
Hot lab with L-block shield within biosafety cabinet	To prevent radiation exposure when preparing dose
Large waste bucket for sharps	To collect used sharps and any waste that might contain ^{177}Lu
Workstation	To document medication administration and vital signs
250-mL saline bag with extension tubing	To flush dose syringe
3-way stopcock	To connect dose tubing and saline tubing
22- to 20-gauge intravenous catheter system, tourniquet, chlorohexidine, Tegaderm (3M), and CoFlex adhesive bandage	To establish intravenous line
Microbore extension tubing	To attach dose syringe to intravenous line
10-mL prefilled saline syringe	To flush and check patency of intravenous line
30-mL vial of saline	To train staff through simulations
1-mL syringe, 20-gauge needle	To vent dose vial
Gauze	To raise vial inside shielded pig and to clean area
Chux pads	To clean and protect area
Tongs, tweezers, and alcohol wipes	To pick up and clean vial
30-mL lead-lined acrylic syringe shield	To prevent radiation exposure when dose is drawn
Wedge	To tilt vial when dose is drawn
30-mL syringe; 20-gauge spinal needle 2.5–3.5 in (6.3–8.9 cm) long	To draw dose
Pump and tubing	To infuse dose, as well as antiemetics and amino acids

license. Addition of ^{68}Ga to the license may also be helpful because ^{68}Ga-DOTATATE is approved by the FDA (*7*) and is routinely used to assess patient eligibility for ^{177}Lu-DOTATATE PRRT (*3*). Most nuclear medicine divisions store radioactive waste until the radioactivity decays, but adequate storage space must be confirmed because the waste can quickly add up if

TABLE 3
Technologist Checklist for ^{177}Lu-DOTATATE Preparation

Tech initials	Step
	Protect cart with chux pads
	Hang 250-mL saline bag; prime tubing with saline
	Connect tubing to 3-way stopcock; prime 3-way stopcock with saline
	Prime microbore tubing with saline; connect microbore tubing to 3-way stopcock
	Load tubing into Graseby pump
	Set rate on Graseby pump (50 mL/h); clear volume; change dose calibrator setting, sleeve, and plunger to those for ^{177}Lu
	Label syringe with patient's name, date of birth, medical record number, drug, dose, and date
	Assay vial (place gauze in bottom of pig while vial is still in dose calibrator), and record result and time; if less than 6.66 GBq or 180 mCi (7.4 GBq or 200 mCi − 10%), contact nuclear medicine physician before proceeding
	Draw entire dose from vial into 30-mL syringe
	Vent dose vial by attaching 20-gauge needle to 1-mL syringe (plunger removed) and inserting at tilted angle just enough to puncture vial
	Draw dose by attaching 3.5-in (8.9-cm) spinal needle to 30-mL shielded syringe, inserting into vial (tilted on wedge) until reaching its bottom, and slowly withdrawing entire volume; if withdrawal is difficult, slightly loosen thumbscrew of shield (2.5-in [6.3-cm] needle can be used but will not reach bottom)
	Before removing syringe, use tongs to raise vial and assess whether entire volume has been withdrawn
	Slowly pull syringe straight up and out of vial
	Pull back plunger to ensure that no liquid remains in hub of needle
	Discard spinal needle into sharps waste bucket; attach regular needle
	Remove air from syringe
	Assay residual activity in vial, and record result and time
	Assay syringe dose, and record result and time (nuclear medicine physician to confirm)
	Connect syringe dose to 3-way stopcock and load into Graseby pump
	After infusion, assay residual activity in syringe and needle



Amino Acid/^{177} Lu-DOTATATE infusion worksheet for nurses

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Nurse initials:

Infusion Date	/ / (DD / MMM / YYYY)	
Subject ID #		
IV site(s)		(for ^{177} Lu-DOTATATE if second IV is placed)

*Nurse to activate medication orders and call Pharmacy (phone # xxx-xxxx) to ask the pharmacist to process orders

Start time of **amino acids**	:	
Vital signs pre-^{177}Lu-DOTATATE infusion	:	BP: Pulse rate:
End time of **^{177}Lu-DOTATATE**	:	
Vital signs post-^{177}Lu-DOTATATE infusion	:	BP: Pulse rate:
End time of **amino acids**	:	
Time Patient Released from Nuc Med:	:	Physician Initials:
Comments about Release:		

Additional meds given:

Medication name	Route / Site of administration	Dose	Time (up/down if applicable)
			:
			:
			:
			:

Bathroom visits, nausea/vomiting episodes, & other (This section on the back of the sheet)	Time	Notes
	:	
	:	
	:	
	:	
	:	

Nurse worksheet

FIGURE 6. Amino acid/^{177}Lu-DOTATATE infusion worksheet for nurses.

patients vomit or void on bulky materials. Because ^{177}Lu-DOTATATE has an intrinsic contaminant, ^{177m}Lu, that has a half-life of about 160 d as opposed to 6.647 d for ^{177}Lu, most of our waste has ultimately been classified as low-level radioactive waste, including some of the kraft paper used for prophylactic protection of floor areas, adding significant bulk to the disposed volume. Retention of waste for decay-in-storage procedures was not possible without license amendment. To minimize the resultant high costs of waste disposal, we recommend avoiding the mixing of such waste with waste contaminated by shorter-lived (half-life, $<$120 d) materials.

Our process to reduce radiation exposure to technologists and nurses includes the ALARA (as low as reasonably achievable) principle, focusing on time, distance, and shielding. All technologists are trained in the PRRT procedure and deliver it on a routine rotated schedule. Treatment simulation with saline is provided for training until the technologist feels comfortable with the procedure. The dedicated treatment room is near the dedicated restroom, minimizing the distance of exposure for the technologist, and a powered recliner allows patients to adjust their position without the help of the technologist. Care in handling radioactive material is essential to minimize the risk of skin contamination or the impact on departmental operations, should contamination occur outside the protected patient area.

Shielding includes the lead-lined treatment room and restroom, as well as the graded-Z syringe shield, shielded infusion pump, and leaded plastic L-block.

Departmental Resources and Workflow

We designate a nuclear medicine technologist and a radiology nurse to the patient for the entire day, noting the need for a second technologist to assist with dose preparation and a second nurse to relieve the first nurse for breaks and to verify medications. In addition to the number of staff, the type of training needed for everyone involved has to be defined (Table 1) (*5*).

The timing of the sequence of treatment events must also be considered. Currently, we need to order the ^{177}Lu-DOTATATE dose at least 2 wk in advance. We recommend that the dose be scheduled to arrive the day before the treatment and that the

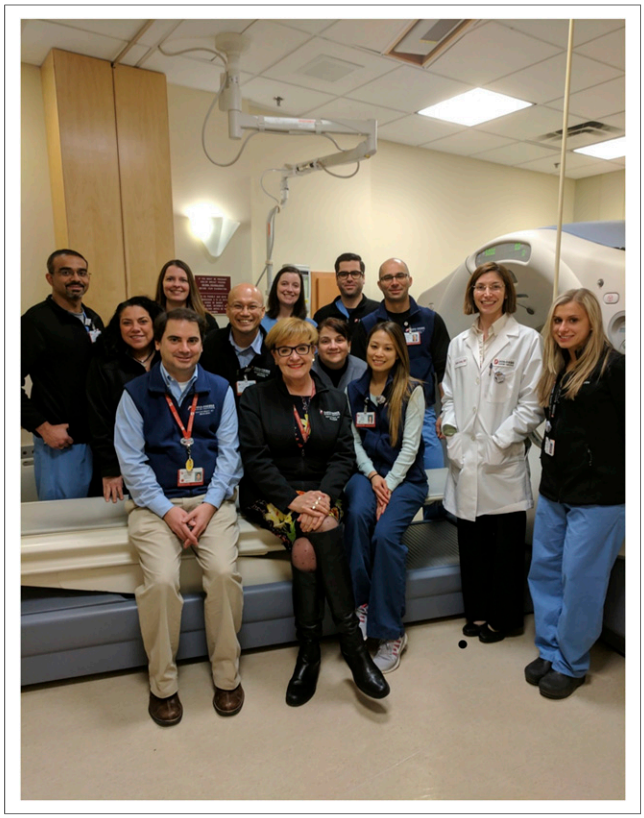

FIGURE 7. Dana-Farber Cancer Institute nuclear medicine team. (Back row, left to right) Umesh Mukkuzhi, MS, CNMT, RT(N)(CT), Amanda Abbott, MS, CNMT, RT(N)(CT), PET, Lauren Gilbert, CNMT, RT(N)(CT), and Timothy Belisle, CNMT, RT(N)(CT). (Middle row, left to right) Michele Iacobucci, Yuji Kuzuhara, MHA, RT(N)(MR)(CT), CNMT, Jennifer Manganella, CNMT, RT(N)(CT), and Justin Tremont, CNMT, RT(N)(CT), PET. (Front row, left to right) Christopher Sakellis, MD, Annick D. Van den Abbeele, MD, FACR, Eileen Vo, RT(N), Heather Jacene, MD, and Marta Adamkiewicz, CNMT, RT(N). (Not pictured) Theresa Carroll, RT(N)(CT), Oswaldo Delgado, CNMT, Johnny Madrid, CNMT, NMTCB(CT), James Wellemeyer, RT(N), Aida Arthur, RN, Marianne Castano, MS, RN, Marion Fallon, RN, Leslie Hajjar, RN, Betsy Mele, RN, and Mary Jane Murphy, RN.

patient arrive early (7:00 AM) on the treatment day to help prevent potential delays. Standard release criteria, including a 1-m survey with a Geiger counter, are followed at the end of the amino acid infusion. The nuclear medicine physicians assess the well-being of all patients before discharge and confirm that they will comply with the radiation safety precautions. Thus far, all patients have been treated as outpatients.

The physical location of the treatment area also needs to be determined. In the NETTER-1 trial, sites had options such as starting the patient in the medical oncology unit for the antiemetics and amino acid infusion, then transporting the patient to the nuclear medicine department for the ^{177}Lu-DOTATATE infusion, and finally returning the patient to the medical oncology unit to complete the amino acid infusion. We keep the patient in the nuclear medicine division from start to finish, to avoid transporting a patient who may not be feeling well and the additional personnel that it requires. Also, if radioactive contamination were to occur, we would rather it be in the nuclear medicine department, where we are prepared to contain it, instead of in the medical oncology unit or during patient transport. We recommend a location in which a designated treatment room and nearby restroom can be reserved for the treatment day, since patients may be drowsy from the antiemetics and may need help walking to the restroom every hour after the ^{177}Lu-DOTATATE infusion.

Emergency Preparedness

Emergency preparedness is advisable, in view of the shortage of intravenous saline products and amino acids that occurred in September 2017 when Hurricane Maria damaged production sites in Puerto Rico (*8,9*). We recommend ensuring in advance that the required amino acids and saline solutions can be procured before scheduling patients for treatment.

CONCLUSION

The recent FDA approval of ^{177}Lu-DOTATATE PRRT requires the introduction of new departmental workflows and procedures—a task that, although challenging, can be successfully implemented with proper planning.

DISCLOSURE

Jennifer Chan is a member of consulting or advisory boards for Ipsen, Novartis, and Advanced Accelerator Applications. Heather Jacene receives research support from Siemens Healthcare and GTx, Inc.; is a consultant for Fusion Pharmaceuticals; receives honoraria from the American Society of Clinical Oncology, Astellas, and Bayer Healthcare; and receives royalties from Cambridge Publishers. No other potential conflict of interest relevant to this article was reported.

ACKNOWLEDGMENTS

We thank our patients, who inspire us to continue to improve the quality of their care and bring them the latest in diagnostic and therapeutic procedures, and we thank our multidisciplinary team, through whose dedication and collaboration we were able to safely and efficiently establish this novel treatment. We give special thanks to our clinical nurse specialists, Anne Elperin and Susanne Conley, for providing or arranging nursing training, and to our pharmacists, Caroline Harvey and Dr. Rebecca Cheung, for procuring the required amino acids and providing all concomitant medications. The members of the nuclear medicine team are shown in Figure 7.

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