

PET-CT FDG Oncology and Brain Imaging

Special Instructions to technologists:

For PET-CTs on cancer patients, ask the patient whether they have recently undergone chemotherapy or radiation therapy, and if so, date of last therapy, planned timing for next therapy, and any upcoming physician appointments. If patient has had any kind of chemotherapy/immunotherapy in the last 10 days, colony stimulating factor within the last 2 weeks, or radiation in the last 2 months, consult with the radiologist about whether the PET-CT should be rescheduled (It is important to contact provider and let them know before rescheduling patient. If neither provider or nurse coordinator can be reached, please send provider a powerchart note about PET rescheduling and include date and time for next PET appointment). **Schedulers should refer to appendix A for instructions for PET rescheduling following therapy.**

For Oral diabetic medication and insulin instructions: please refer to **appendix B.**

Guidelines for when to withhold IV contrast: Calculate GFR prior to administering intravenous contrast. If GFR is more than 50 and no IV contrast allergy, okay to administer IV contrast. If GFR is between 40-50, contact the radiologist to check whether it is okay to administer IV contrast. If patient is not on dialysis and $GFR < 40$, do scan without IV contrast. OK to give IV contrast to patients with normal GFR and only one kidney. If patient refuses IV contrast, make a note about it and do PET-CT scan without IV contrast.

To be done at UNMH/OSIS only

Radiopharmaceutical: F-18 fluorodeoxyglucose (FDG)

Dose (Adult/Pediatric): Refer to Nuclear Medicine Dose Chart

Route of Administration: Intravenous. Instruct the patient to remain in a quiet state, resting comfortably, during the uptake phase (between administration of the radiopharmaceutical and imaging).

Patient Preparation: NPO (except for water and medications) for at least 4 hours prior to FDG administration.

All metal must be removed from the patient prior to scanning, including (but not limited to) glasses, bras, dentures, earrings, rings, and watches if arms are left down. For whole-body scans, pants with metal zippers may be pulled down to below the imaged region (typically knee level if scanning to thighs), or the patient may wear a gown.

If the scan is with intravenous contrast, the patient must fill out a contrast form, which must be reviewed by the technologist prior to the examination.

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For all brain PET-CTs, the patient should be in a quiet/darkened room during the uptake phase. The patient should stay awake with eyes open and rest comfortably, with as little muscular activity as possible.

For brain PET-CTs to evaluate seizures, the patient should be free of seizures for a minimum of 2 hours. Consult with the radiologist if the last seizure occurred less than 2 hours ago. Patient should also have EEG monitoring starting 1 hour prior to FDG-injection, and to be continued up until imaging time.

Equipment Setup: Time per bed position (minutes):

	OSIS PET-CT	UNMH PET-CT
Brain only	5	10
Head/neck	3	5
Whole body or eyes to thighs	1	3
Limited (pelvis, legs, etc)	1	3

PET-CT protocol:

Regions to be imaged:

- **FDG-1** = eyes to thighs, arms up; with oral and intravenous contrast
- **FDG-3** = two acquisitions (no oral contrast):
 - head/neck, skull base through upper mediastinum; arms down; with IV contrast only, AND
 - clavicles to thighs, arms up; with IV contrast only (no oral or water);

Note: divide IV contrast dose between the two portions of the exam
- **FDG-3D** with dedicated neck CT (no oral contrast): perform FDG-3 as above and reconstruct neck CT separately per CT protocol; send to separate accession number
- **Brain** = brain only; arms down; no oral contrast; no intravenous contrast unless specified by the radiologist
- **Limited** = region to image and intravenous/oral contrast as specified by radiologist
- **FDG-WB** = head to toe, arms down and close to body; with oral and IV contrast (generally used for multiple myeloma, melanoma, paraneoplastic syndrome, and pediatric patients (under 18 years old).
- **Treatment planning** = perform non-contrast CT in region of radiotherapy cradle; follow with PET-CT protocol as above, making sure that the radiotherapy planning CT and PET-CT are performed over the same region and with the patient in the same position.

Additional modifications may be made by the radiologist, e.g., to include extremities.

Consult with radiologist if there are any questions about whether additional

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regions need to be included, e.g., if the patient has obvious involvement of an area not included or mentions a particular concern the patient or their physician had.

Oral contrast:

Outpatients and inpatients:

FDG-1: routine protocol is water oral contrast during the uptake phase (and for 1 hour prior when possible)

FDG-3 (head/neck cancer patients): No oral contrast (no water, no Redicat, no Gastrografin)

Positive oral contrast (to be used in patients with ovarian, cervical and endometrial cancer)

Outpatient: 1 bottle of Redicat to consume after injection of FDG.

Inpatient: 7 mL Gastrografin in 8 oz water immediately and 30 minutes after injection.

Intravenous contrast (if requested by the radiologist):

100 mL, power injected, typically 3 mL/sec (slower if needed) unless otherwise specified (see above); follow pediatric CT protocols for intravenous contrast in children (< 18 years old).

For head/neck studies, 150 mL contrast is divided between the two portions of the examinations (75 mL for each). Follow pediatric CT protocols for intravenous contrast in children (< 18 years old).

Timing of CT scan delay with respect to IV contrast:

Neck CT: 90-second delay

Whole body CT: 75-second delay

Extremities (if imaged by themselves for, e.g., infection): 90-second delay

Please see separate CT imaging protocols for details of CT protocol settings, including for dedicated neck CT imaging performed at the time of the PET-CT.

Patient Positioning: Supine. Head first (unless limited examination of the legs/feet, then feet first)

If the extremities are imaged by themselves (either as a limited study or as part of a whole-body examination), a BB must be placed on the right leg or right arm in the imaged field of view.

Procedure: Imaging time post FDG-injection: One hour for all protocols EXCEPT minimum 45 minutes for brain PET-CTs*

1. Measure the patient's blood glucose level by glucometer. If it is 200 mg/dL or below, proceed. If it is above 200 mg/dL, refer to appendix C for outpatient appointments. For inpatient or infection PET patients, discuss with attending. Infection PET patients can typically be imaged even with blood glucose over

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- 200 mg/dL and NPO less than 4 hours, with approval of the radiologist.
2. Inject FDG, and flush with normal saline (10 mL for butterfly needles; 20 mL for angiocatheters, 40 mL or greater for indwelling catheters).
 3. If applicable, have patient drink oral (usually water) contrast during the uptake phase as above.
 4. Perform CT examination of region of interest, followed by PET.

Acquisition:

1. On chronicle, enter PET dose, time administered, and time per bed position
2. Load topogram
3. Set parameters for scan
4. Load → move → start
5. When CT is complete (approximately 25 secs), you will be prompted to move patient for PET scan (table moves all the way to the back of the gantry)
6. Options → PET monitor to view scan length if desired (applies to UNMH PET only; displays how long the entire PET scan will take).
7. When acquisition is complete, load fusion on Wizard before sending to PACS

After the examination, the patient should be encouraged to drink lots of fluids and void frequently to minimize bladder/pelvic organ radiation exposure (Image Wisely campaign, “Considerations Regarding Radiation Exposure in PET-CT”).

Processing:

Follow automatic processing workflow

Process CT in B 5 31 algorithm

Process PET into attenuation corrected and non attenuation corrected PET files

Generate PET-CT fused axial data set

Use “Microdelta Hot Metal” color scheme

For whole-body images, the liver should be PINK (not bright orange, not dim purple)

Items Required For Complete Study:

- Enter protocol, protocoling physician, FDG dose, blood glucose, injection site, height, weight, lab values and contrast amounts/rates in comments section on PACS
- Processing and transfer of all images to PACS and/or Leonardo as appropriate
 - Topogram (to PACS)
 - Fused axial images (to PACS)
 - CT, PET Corrected, and PET Uncorrected to PACS, Portal, and Syngo Via.
 - Please send MIPS to PACS.
- Complete the examination in RIS

***For oncology PET imaging, EANM guidelines (2015) recommend 55-75 min delay from injection (within 10 min from previous exam timing).**

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References:

ACR–SPR PRACTICE PARAMETER FOR PERFORMING FDG-PET/CT IN ONCOLOGY (2016)
Accessed 9.2018. <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/FDG-PET-CT.pdf>

EANM Guidelines (FDG PET/CT: EANM procedure guidelines for tumour imaging: version 2.0) Accessed 9.2018. http://snmmi.files.cms-plus.com/FileDownloads/ProcedureStandards/2015_GL_PET_CT_TumorImaging_V2.pdf

¹⁸F-FDG PET and PET/CT Patient Preparation: A Review of the Literature. J. Nucl. Med. Technol. March 1, 2014 vol. 42 no. 1 5-13. <http://tech.snmmjournals.org/content/42/1/5.long>

PET PROS Elements of PET/CT Reporting. Accessed 9.2018. http://snmmi.files.cms-plus.com/docs/PET_PROS/ElementsofPETCTReporting.pdf

SNMMI Guidelines [SNMMI Procedure Standard for Tumor Imaging with 18F-FDG PET/CT 1.0 \(2006\)](#)
Outdated and replaced by EANM guidelines 2.0. Accessed 9.2018.

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Appendix A (for schedulers). Recommended delay for PET after therapy (from [EANM Guidelines v2](#)):

Treatment	Recommended Minimum Delay
Chemotherapy*	10 days (if possible)
Radiation Therapy	2 months
Surgery	Varies. 6 weeks for surgical field evaluation.
Stimulating Factor	Generally, at least 2 weeks

*Current plan to use similar timeframe for immunotherapy

Oral chemotherapy: for those patients who are on daily oral chemotherapy, if patients are taking oral chemotherapy continuously without a break, they are okay to be scheduled for PET-CT while on their oral chemotherapy. If patients take oral chemotherapy daily with a short break between courses, for example if they are taking oral chemo daily for a month with a 2 weeks break in between, they should be scheduled latest date possible in the 2 week break.

It is important for the schedulers to send the clinical provider a note through powerchart, if PET-CT cannot be performed on the date ordered by clinician for any of the above reasons. **Please use the following template:**

<p>PET requested date: PET scheduled date:</p> <p>In order to ensure good quality PET/CT results, we have incorporated the following EANM recommended delays following treatments: Chemotherapy – minimum of 10 days, if possible (this is also being used for immunotherapy). If patient receives weekly therapy, we generally try to schedule them immediately prior to next scheduled therapy. Radiation therapy – 2 months. Surgery – Variable; 6 weeks for surgical field evaluation. Colony stimulating factor – at least 2 weeks.</p> <p>In this patient’s case, doing the study after the recommended delay would put the study date AFTER the requested date. We realize that these guidelines may not be feasible in all situations, and we do not wish to unnecessarily delay decision making or treatment. If it is clinically important for this patient to receive PET imaging prior to the scheduled date, please let us know (via replying to this message). You can also call 272.2421 and leave a secure voice message. If you would like to speak with a nuclear radiologist, feel free to call the nuclear medicine reading room at 272-3113.</p> <p>Thank you for letting us participate in this patient’s care.</p>

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Appendix B: Diabetic Patients Instructions¹

- Home blood glucose checks should be performed in the days leading to the PET exam to ensure adequate blood glucose levels in the morning (less than 200 mg/dl).
- **Metformin** should be discontinued for two days after the study for all patients receiving IV contrast.
- Patients on **continuous insulin infusion/pump** should be scheduled early in the morning (by 8 AM) and eat breakfast after the PET study. The insulin pump is kept on the night/basal setting until after the PET study.
- If patient on **insulin pump** cannot be scheduled in morning, then patient needs to set his insulin pump on the night/basal setting for 4 hours before PET scan while also fasting during this period.
- Patients on **rapid acting (Humalog, Novolog, Apidra) or short acting/ regular insulin (Novolin R, Humulin R)** should take their normal amount of insulin along with breakfast by 6-7 AM. They should be scheduled at least 4 hours after having taken their short acting insulin, typically between 11 am and 1 pm.
- For patients who take **intermediate acting/ NPH (Novolin N, Humulin N) or long acting insulin (Lantus, Levemir)** in the morning: they should be scheduled first thing in the morning. They need to withhold their morning dose of intermediate or long acting insulin till after the scan. Those receiving evening/ bed-time intermediate or long-acting insulin should take their insulin in the evening and be scheduled first thing in morning after an overnight fast.

¹ adapted from Surasi et al. J Nucl Med Technol. 2014 Mar;42(1):5-13

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Appendix C: Process for PET/CT Outpatients with Elevated Blood Glucose Levels (CBG >200 mg/dl)

Scenario	Process
CBG >200 but ≤210	Ask patient to walk around and return in 30 mins to recheck. PET-CT can be performed if patient's BGL is below 200
CBG > 210, on medication for diabetes but did not take it	Reschedule for later on same day (if patient has medications with them, and there's a contingency dose timed late enough) or next available date, in the late morning or early afternoon. Ask patient to eat a light meal and take diabetes medication 4 hours prior to rescheduled PET-CT appointment.
CBG > 210, on medication for diabetes and took it	Discuss with patient whether his/her blood sugars tend to run more normal (<200) at a different time of day (e.g., fasting, first thing in the morning). If so, reschedule patient for a future date at that specified time. If not, contact ordering provider per instructions below.
CBG > 210, not on diabetes medication	Contact ordering provider per instructions below.

Communication/Rescheduling Plan:

- Ask patient for date of follow-up appointment with ordering provider/cancer doctor.
 - Also check PowerChart for pending appointments
 - For all rescheduled patients, attempt to reschedule the PET/CT before the treatment or clinic date.
- For diabetic patients not on medication, or who took their medication and blood sugar was still too high, ask patient whether they have a PCP, and if so, have them contact their PCP for assistance.
- Obtain reliable contact phone number for the patient
- Have the nuclear medicine front desk or supervisor call the ordering clinic/provider directly, AND send the provider a PowerChart message, with the following details:
 - Patient's blood sugar was too high for PET/CT (give number and that it must be ≤200)
 - Either patient is NOT on diabetes medication, or took their diabetes medications and blood sugar is still too high
 - Patient has a PCP (name) and was instructed to contact the PCP for assistance with managing blood sugar, OR patient does not have a PCP
 - Patient has a follow-up appointment or treatment/surgery/etc with the ordering provider scheduled for _____.
 - The patient's blood sugar must be managed before rescheduling PET/CT.
 - Patient's contact number is _____.
- If there are any questions or difficulties, contact the Nuclear Medicine attending radiologist for assistance.