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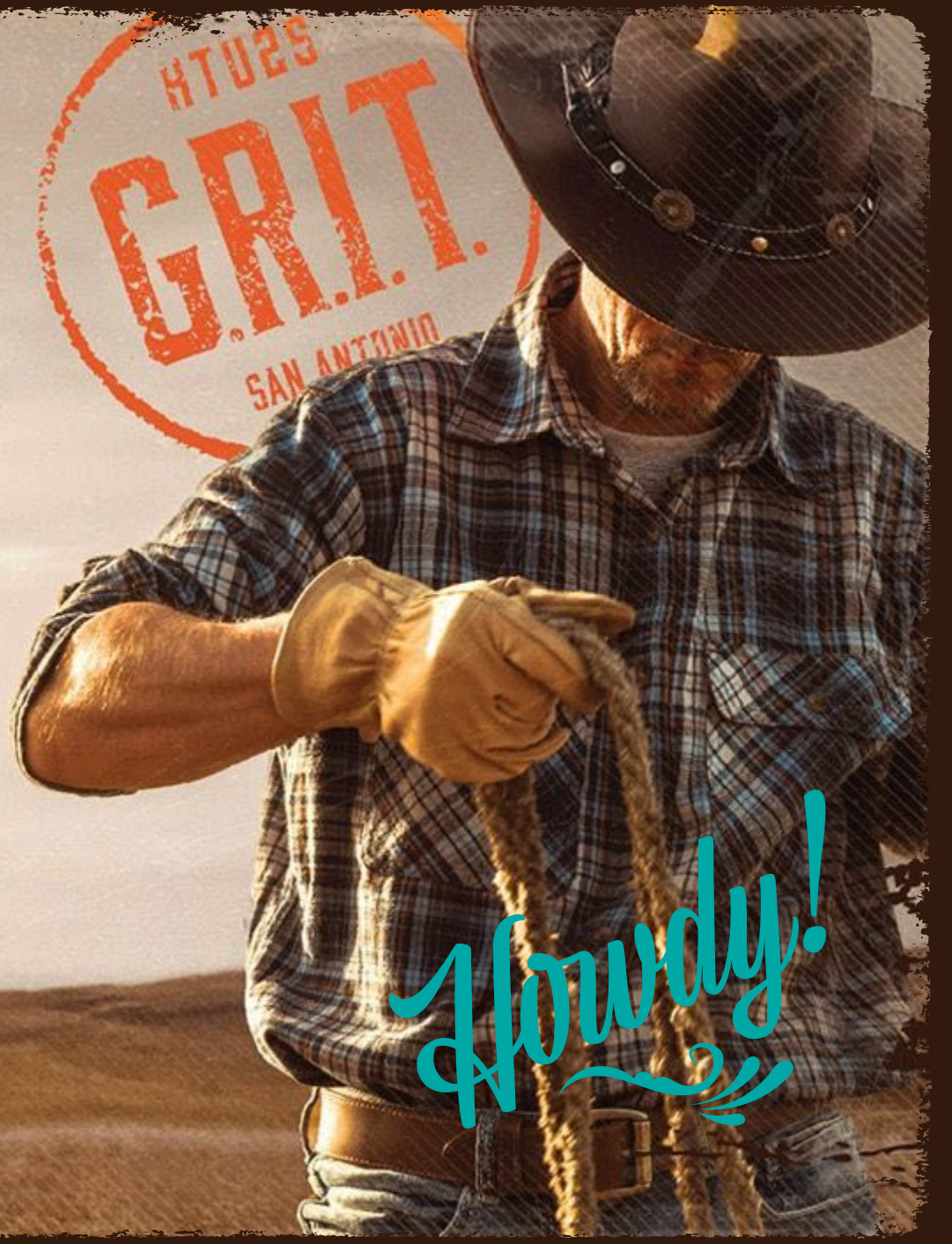
Can you see me? Contrast Agents, Dyes & Radiopharmaceuticals: A Crash Course for Busy Clinicians



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CE Deadline: 09/30/25

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Howdy!

Disclosures

The presenters have no real or perceived conflicts of interest related to this presentation

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Learning Objectives

At the end of this session, participants should be able to:

- Recall the differentiating factors between forms of radiographic- and gadolinium-based contrast agents and the use of dyes in the surgical space.
- Identify the radiographic agents, dyes and radiopharmaceuticals that Pharmacy may be tasked with procuring and managing, as well as accounting for the resulting supply expense.
- Recognize current and potential future use of emerging theranostics in practice.

BACKGROUND

Poll Question #1

What is your role/profession?

A. Nurse
B. Pharmacist
C. Physician
D. Technologist
E. Other clinical role
F. Other non-clinical role

Poll Question #2

What is your knowledge level with contrast, surgical dyes and theranostics?

A. I consider myself an expert

B. I know enough to be dangerous

C. I don’t know much and that’s why I am here

Background

Contrast

Growing utilization

- Iohexol ($384M) and iopamidol ($317M)
  - in the top 25 drugs of non-federal hospital spend in 2024
  - both with growth compared to 2024
- $6.84B spent on contrast agents in 2024
  - projected to grow to $14.8B by 2034

Dyes

- Many products on market and coming to market
- Some may require specific equipment to visualize
  - Diagnostic aids was the 9th highest category in spend for non-federal hospitals in 2024

Theranostics

- Next innovation in oncology therapy
- Global market projected to grow from $4.3B in 2024 to $12.7B in 2029

Sources: 1. Tichy E, Rim M, et al. National trends in prescription drug expenditures and projections for 2025. Am J Health Syst Pharm. 2025 Apr 23. https://doi.org/10.1093/ajhp/zxaf092; 2. “Contrast Media Market Trends, Dynamics and Strategic Opportunities,” Towards Healthcare. https://www.towardshealthcare.com/insights/contrast-media-market-sizing. Accessed 6/22/025; 3. “Theranostics Global Market Report 2024-2029 - Cancer Epidemics in Developing Countries and New Radiotheranostics Driving the Theranostics Market.” Businesswire. https://www.businesswire.com/news/home/20240820037125/en/Theranostics-Global-Market-Report-2024-2029---Cancer-Epidemics-in-Developing-Countries-and-New-Radiotheranostics-Driving-the-Theranostics-Market---ResearchAndMarkets.com. Accessed 6/22/2025

CONTRAST

Barium Sulfate Contrast

- Oral, Esophageal and Gastrointestinal use ONLY
- Inert, insoluble
- No anaphylactic concerns, but contraindicated in patients with:
  - Constipation/intestinal blockage
  - Perforated bowel
  - Recent gastrointestinal surgery

Source: MedlinePlus. (2016, July 15). Barium sulfate: MedlinePlus drug information. MedlinePlus - Health Information from the National Library of Medicine. https://medlineplus.gov/druginfo/meds/a606010.html

Ultrasound Contrast Agents

Structure:
- Microbubbles encased in phospholipid spheres

Common ultrasound contrast agents:
- Perflutren lipid microspheres
  - Lipid-based shell
- Perflutren lipid Type-A microspheres
  - Protein-based shell
- Sulfur Hexafluoride lipid Type-A microspheres
  - Protein-based shell

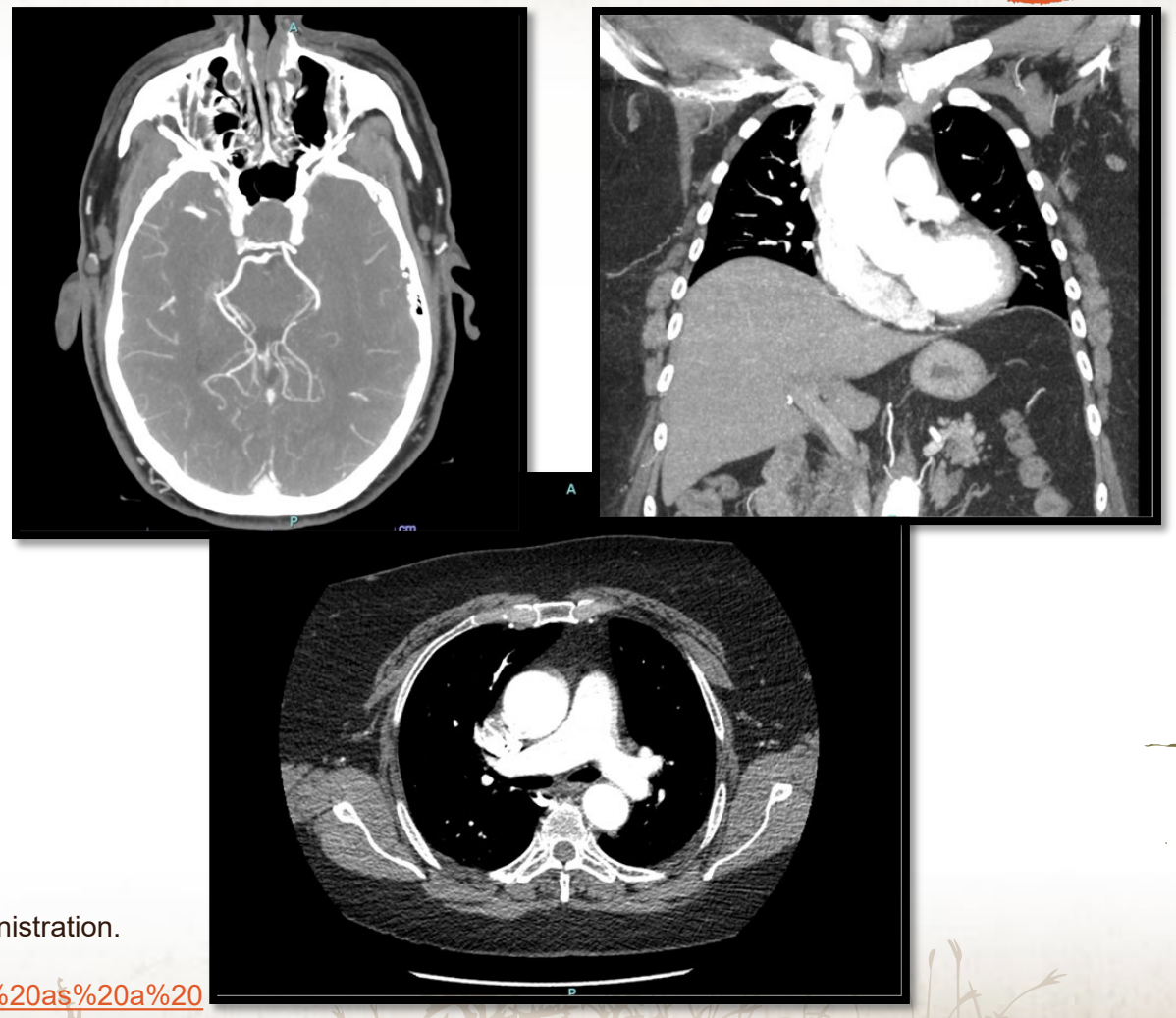
Clinical uses:
- Contrast enhancement of ultrasound exams
- Commonly used in echocardiography, with some niche utilization (vascular and organ studies in patients with severe end stage renal disease, iodine anaphylaxis, etc.)

Contraindications:
- Intra-cardiac shunts
- Intra-arterial injection
- Pulmonary hypertension
- Severe hepatic disease
- Hypersensitivity to the contrast or its components

Source: Chong, A., Haluska, B., & Wahi, S. (2013). Clinical application and laboratory protocols for performing contrast echocardiography. Indian Heart journal, 65(3), 337–346. https://doi.org/10.1016/j.ihj.2013.04.002

Intravascular Iodinated Contrast

- First used in the 1950s
- Most commonly used in Computed Tomography and procedural areas
  - Cardiac Cath Lab
  - Interventional Radiology/Fluoroscopy
  - Interventional Neurology
  - Vascular Surgery
- Main purpose is to visualize vasculature, organs, tissues and disease processes



Source: FDA. (2022, March 30). Iodinated contrast media (ICM). U.S. Food and Drug Administration. https://www.fda.gov/drugs/information-drug-class/iodinated-contrast-media-icm#:~:text=ICM%20are%20drugs%20containing%20iodine%20that%20are,by%20mouth%20as%20a%20drink%2C%20or%20rectally

Intravascular Iodinated Contrast

- Contrast-induced nephropathy remains a concern for all intravenous/intraarterial administered iodinated contrast
- Each facility should have a contrast administration policy; contact your Imaging Director for additional information

Ionic Monomer

- Earliest Iodinated Contrast
- High Osmolality
  - 5–8x blood
- Almost no current IV/IA use due to adverse reactions
- Diatrizoate

Non-ionic Monomer

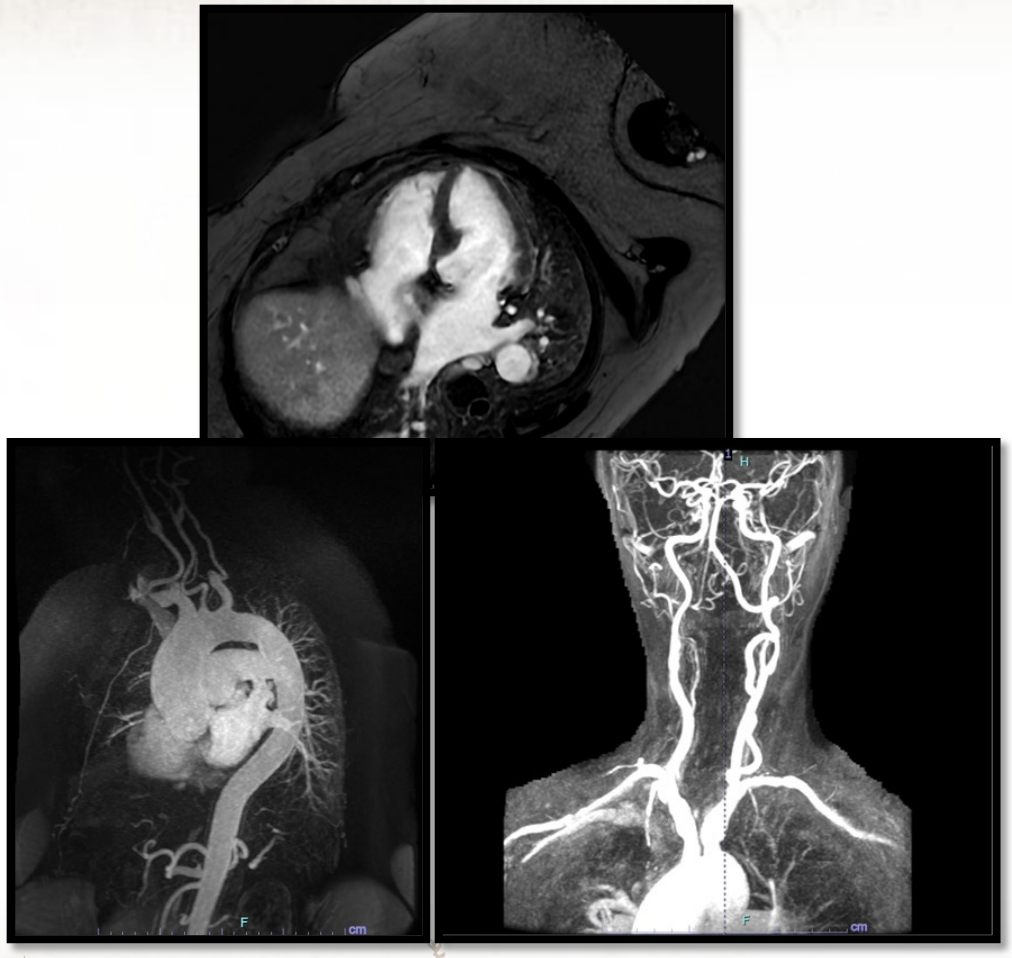
- Most contemporary contrasts
- Low Osmolality
  - 2–3x blood
- Fewer adverse reactions compared to Ionic Monomers
- Iohexol & Iopamidol

Non-ionic Dimer

- Newest class of iodinated contrast
- Iso-osmolality
- Fewest adverse reactions, but no clear imaging advantage
- Iodixanol

Source: Pasternak, J. J., & Williamson, E. E. (2012). Clinical pharmacology, uses, and adverse reactions of iodinated contrast agents: A primer for the non-radiologist. Mayo Clinic Proceedings, 87(4), 390-402. https://doi.org/10.1016/j.mayocp.2012.01.012

Gadolinium-based Contrast Agents (GBCAs)



- Intravenous administration
- Main adverse events
  - Anaphylaxis
  - Contrast-induced Nephropathy
  - Nephrogenic Systemic Fibrosis (NSF)
    - Rare; higher occurrence rates associated with certain GBCAs
- Like iodinated contrast, main purpose is to visualize vasculature, organs, tissues and disease processes

Source: Scarciglia, A., Papi, C., Romiti, C., Leone, A., Di Gregorio, E., & Ferrauto, G. (2025). Gadolinium-based contrast agents (GBCAs) for MRI: A benefit–risk balance analysis from a chemical, biomedical, and environmental point of view. Global Challenges, 9(3). https://doi.org/10.1002/gch2.202400269

GBCA Classification

- GBCAs possess a higher complexity than their iodinated and barium contrast cousins
- GBCAs are classified by both structure (below) and NSF risk (following slide)

Linear

- Less stable
- Higher gadolinium retention
- GBCAs
  - Gadopentetate
  - Gadobenate
  - Gadoxetate
  - Gadodiamide
  - Gadoversetamide

Macrocyclic

- More Stable
- Lower gadolinium retention
- GBCAs
  - Gadoterate
  - Gadoteridol
  - Gadobutrol
  - Gadopiclenol
  - Gadoquatrane (FDA approval expected 2026)

Source: Scarciglia, A., Papi, C., Romiti, C., Leone, A., Di Gregorio, E., & Ferrauto, G. (2025). Gadolinium-based contrast agents (GBCAs) for MRI: A benefit–risk balance analysis from a chemical, biomedical, and environmental point of view. Global Challenges, 9(3). https://doi.org/10.1002/gch2.202400269

GBCA Classification, *continued*

- American College of Radiology (ACR) further classified GBCAs according to the relative risk associated with NSF

Group I	Group II	Group III
• Associated with greatest number of NSF cases • GBCA: ▪ Gadodiamide ▪ Gadopentetate ▪ Gadoversetamide	• Associated with few, if any, unfounded cases • GBCA: ▪ Gadobenate ▪ Gadobutrol ▪ Gadoterate ▪ Gadoteridol ▪ Gadoexetate ▪ Gadopiclenol	• Limited data, but no reported cases of NSF • No GBCAs currently in this category

Source: American College of Radiology. (2024). ACR manual on contrast media. www.ACR.org. https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Contrast-Manual.

SURGICAL DYES

Surgical Dyes

- Surgical dyes are used to enable or enhance surgical procedures
  - Enable
    - Highlighting sentinel node
    - Visualize cranial vasculature
  - Enhance
    - Map tissue perfusion
    - Stain tumor cells
- A comprehensive understanding of the dyes used in your facility leads to a better experience for your surgeons and a safer experience for your patients

- **Indocyanine Green (ICG)**
- **Sodium Fluorescein**
- **Indigo Carmine (Bludigo)**
- **Isosulfan Blue**
- **Cytalux**
- **Cysview**
- **Gleolan**

Indocyanine Green (ICG)

- Mechanism of action
  - Binds to plasma proteins in the circulatory system
- Surgical Indications
  - Fluorescence imaging (vessels and tissue perfusion)
  - Visualization of Extrahepatic Biliary Ducts
  - Lymphatic Mapping of Cervical and Uterine Cancer
- Contraindications
  - Liver disease or allergy to iodides
- WAC (wholesale acquisition cost): $205
- IV Dosing Procedure and Timing
  - Use within 6 hours after reconstitution
  - After IV administration flush with 10 mL 0.9% NaCl via 3-way stopcock
  - Redosing available due to 3-4 minute half-life
- Florescence response
  - Vessel/Tissue: 5–15 seconds after injection
  - Biliary Ducts: 45 minutes after injection
  - Cervical/Uterine: 1 minute after interstitial injection
- Shortage status: Current and previous shortages (2016, 2017)

Sources: 1. “Drugs@FDA,” *U.S. Food & Drug Administration:* https://www.accessdata.fda.gov/drugsatfda_docs/label/2024/011525s039lbl.pdf Accessed 6/18/2025; 2.”ASHP Drug Shortages” https://www.ashp.org/drug-shortages. Accessed 7.10.2025

Sodium Fluorescein

- Mechanism of action
  - Binds to human serum albumin in the circulatory system
- Surgical Indications
  - Diagnostic fluorescein angiography and neuro-oncological surgery
- Contraindications
  - Known allergy
- WAC: $75 – $300

- Dosing Procedure and Timing
  - Oncology: IV dosing at induction (1 hour prior to dural opening)
  - Neuro Vascular: IV – 15 minutes, IA – 1 minute
  - Must wait 1 hour prior to redosing
- Precautions
  - Extravasation causes severe tissue damage
  - Ensure appropriate microscope filter available
- Shortage status: Previous shortages (2022, 2023)

Sources: 1. “Drugs@FDA,” *U.S. Food & Drug Administration:* https://www.accessdata.fda.gov/drugsatfda_docs/label/2025/022186Orig1s013lbl.pdf Accessed 6/18/2025; 2. Zhao, X., Belykh, E., Cavallo, C., Valli, D., Gandhi, S., Preul, M. C., Vajkoczy, P., Lawton, M. T., & Nakaji, P. (2019). Application of Fluorescein Fluorescence in Vascular Neurosurgery. Frontiers in surgery, 6, 52. https://doi.org/10.3389/fsurg.2019.00052; 3. Restelli, F., Bonomo, G., Monti, E., Broggi, G., Acerbi, F., & Broggi, M. (2022). Safeness of sodium fluorescein administration in neurosurgery: Case-report of an erroneous very high-dose administration and review of the literature. Brain & spine, 2, 101703. https://doi.org/10.1016/j.bas.2022.101703; 4. ”ASHP Drug Shortages” https://www.ashp.org/drug-shortages. Accessed 7.10.2025

Indigo Carmine (Bludigo)

- Mechanism of action
  - Excreted by the kidney through tubular secretion
- Surgical Indications
  - Visualization aid in the cystoscopic assessment of the integrity of the ureters in adults following urological and gynecological open, robotic or endoscopic surgical procedures
- Contraindications
  - Known allergy
- WAC: $360

- IV Dosing Procedure and Timing
  - Use immediately after opening ampule
  - 5 mL IV given over 1 minute
- Precautions
  - Cardiovascular and hypersensitivity reactions require blood pressure and heart rhythm monitoring
  - Interferes with blood oxygen saturation monitoring (SpO2) accuracy
- Visualization response
  - Visible at ureteral orifices 4–9 minutes after injection
- Shortage status: Previous shortages (2022, 2023)

Sources: 1. “Drugs@FDA,” U.S. Food & Drug Administration: https://www.accessdata.fda.gov/drugsatfda_docs/label/2022/216264s000lbl.pdf Accessed 6/18/2025; 2. ”ASHP Drug Shortages” https://www.ashp.org/drug-shortages. Accessed 7.10.2025

Isosulfan Blue

- Mechanism of action
  - Binds to serum proteins and is picked up by the lymphatic vessels
- Surgical Indications
  - Lymphatic mapping and sentinel lymph node biopsy
- Contraindications
  - Known allergy
- WAC: $1220

- Dosing Procedure
  - Administered subcutaneously
- Precautions
  - Interferes with blood oxygen saturation monitoring (SpO2) accuracy
  - Do not mix with local anesthetics in the same syringe
- Visualization response
  - Sentinel node is stained 15–45 minutes after injection
- Shortage status: None

Sources: 1. “Drugs@FDA,” U.S. Food & Drug Administration: https://www.accessdata.fda.gov/drugsatfda_docs/label/2007/018310s011lbl.pdf Accessed 6/18/2025; 2. ”ASHP Drug Shortages” https://www.ashp.org/drug-shortages. Accessed 7.10.2025

Specialty Dyes

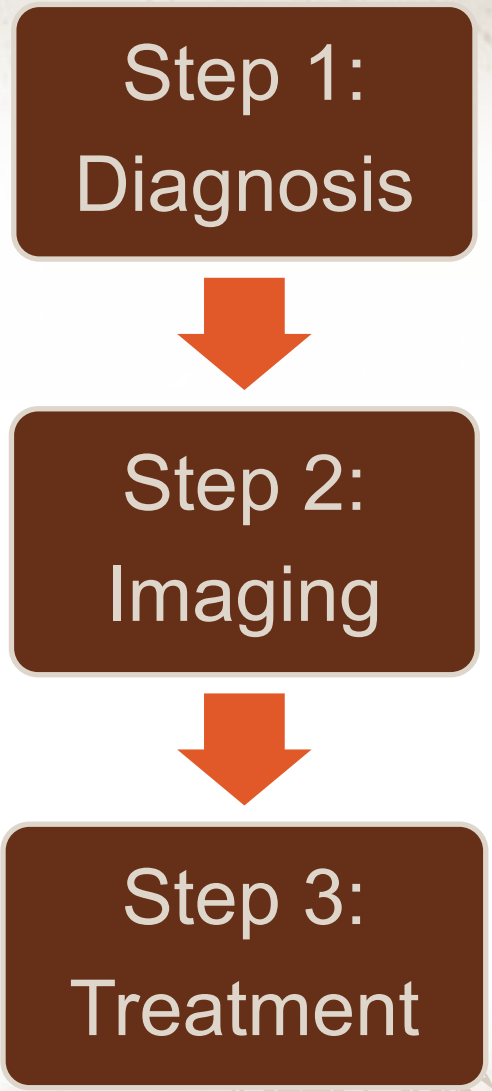
- **Cytalux**
  - Optical imaging agent for ovarian or lung cancer as an adjunct for intraoperative identification
  - IV administration over 60 minutes 1–9 hours prior to surgery
  - Requires specific near infrared imaging hardware
  - WAC: $4,500
- **Cysview**
  - Optical imaging agent indicated for use in the cystoscopic detection of non-muscle invasive papillary cancer of the bladder
  - Administer to bladder via intravesical catheter and retain for 1 hour
  - Requires Karl Storz D-Light C Photodynamic Diagnostic System
  - WAC: $1,600
- **Gleolan**
  - Optical imaging agent indicated in patients with glioma for visualization of malignant tissue during surgery
  - Oral administration 2–4 hours prior to anesthesia
  - Requires specific blue light emitting source and emission filters for microscope visualization
  - WAC: $3,100

Sources: Accessed 6/18/2025
1. "Drugs@FDA," U.S. Food & Drug Administration: https://www.accessdata.fda.gov/drugsatfda_docs/label/2020/214907s000lbl.pdf.
2. "Drugs@FDA," U.S. Food & Drug Administration: https://www.accessdata.fda.gov/drugsatfda_docs/label/2010/022555s000lbl.pdf.
3. "Drugs@FDA," U.S. Food & Drug Administration: https://www.accessdata.fda.gov/drugsatfda_docs/label/2017/208630s000lbl.pdf.

THERANOSTICS

What is Theranostics?

- Combining "therapy" and "diagnostics," theranostics is a precision medicine approach that uses both imaging *and* targeted therapies to diagnose and treat diseases, particularly cancer
- This involves using radiopharmaceuticals, or drugs containing radioactive material, to image disease as well as target and destroy unhealthy cells while sparing healthy tissues



Source: "What is Theranostics," *MD Anderson*: https://www.mdanderson.org/cancerwise/what-is-theranostics.h00-159701490.html. Accessed 6/19/2025.

Chemotherapy & Side Effects

- Chemotherapy is a systemic treatment primarily used to combat cancer
- Works by targeting and destroying rapidly dividing cells, which is a characteristic of cancer cells
- Can also affect healthy cells that divide quickly, leading to various side effects

- Nausea
- Vomiting
- Hair Loss
- Fatigue
- Fever
- Infection(s) Risk
- Nausea
- Vomiting
- Hair Loss
- Chemo brain
- Rashes
- Mouth/Throat Sores
- Appetite Changes
- Neuropathy
- Bleeding
- Bruising
- Constipation
- Diarrhea
- Blood Count Changes
- Secondary Cancer(s)

Source: "Chemotherapy," *Mayo Clinic*: https://www.mayoclinic.org/tests-procedures/chemotherapy/about/pac-20385033. Accessed 6/9/2025.

Radiotherapy & Side Effects

- Radiotherapies are targeted treatments that only bind to the effected tumors/cells, leaving all others alone
- Used mostly for palliative care and extending of life instead of treating cancer (Pluvicto may result in a complete response [CR])
- Side effects that typically last only a few days post treatment before resolving

- Radiation Exposure
- Nausea
- Vomiting
- Constipation
- Diarrhea
- Dry Eyes/Mouth
- Kidney/Liver Issues
- Decreased Appetite
- Joint Pain
- Infection(s) Risk
- Tumor Site Pain
- Blood Count Changes
- Secondary Cancer(s)

Sources: 1. “Is Right Now the Right Time for Lutathera?”, *Lutathera*: https://us.lutathera.com/sites/us_lutathera_com/files/documents/lutathera-patient-consideration-guide-digital.pdf. Accessed 6/9/2025; 2. “Is Pluvicto Next in your Prostate Cancer Journey?” *Pluvicto*: https://us.pluvicto.com/sites/us_pluvicto_com/files/documents/pluvicto-considering-brochure.pdf. Accessed 6/9/2025.

Current Theranostic Treated Cancers

- **Pheochromocytoma**

  Rare adrenal gland tumor(s)

- **Paraganglioma**

  Neuroendocrine tumor that forms near your carotid artery along nerve pathways in your head and neck and in other parts of your body

- **Neuroendocrine Cancer***

  Neuroendocrine tumors (NETs) are a group of uncommon tumors that start in your neuroendocrine cells. These cells combine the traits of nerve cells and hormone-producing endocrine cells

- **Metastatic Castrate Resistant Prostate Cancer (mCRPC)***

  Prostate cancer that keeps growing even when the amount of testosterone in the body is reduced to very low levels and has spread from the prostate to other parts of the body

**Diagnoses annotated with an asterisk will be focused on in this presentation*

Sources: Accessed 6/9/2025. 1. "Pheochromocytoma," *Mayo Clinic*: https://www.mayoclinic.org/diseases-conditions/pheochromocytoma/symptoms-causes/syc-20355367; 2. "Paraganglioma," *Cleveland Clinic*: https://my.clevelandclinic.org/health/diseases/22394-paraganglioma; 3. "Neuroendocrine Tumors," *Cleveland Clinic*: https://my.clevelandclinic.org/health/diseases/22006-neuroendocrine-tumors-net; 4. "Understanding Metastatic Castration-Resistant Prostate Cancer," *Very Well Health*: https://www.verywellhealth.com/metastatic-castration-resistant-prostate-cancer-11714251.

Diagnostic Imaging – Positron Emission Tomography (PET) Scan

- A non-invasive imaging test that uses a small amount of radioactive material called a radiotracer
- This tracer is injected into the body, where it accumulates in areas of high metabolic activity, such as tumors or inflamed tissues
- The PET scanner then detects the radiation emitted by the tracer, producing detailed images of the organs and tissues in real-time

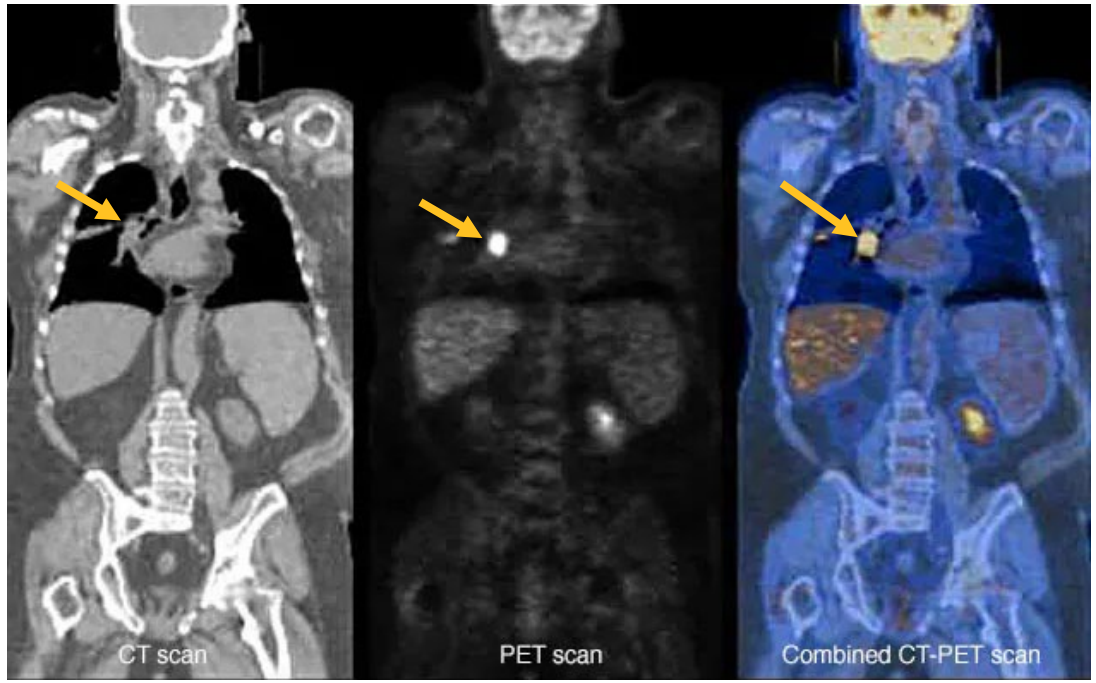


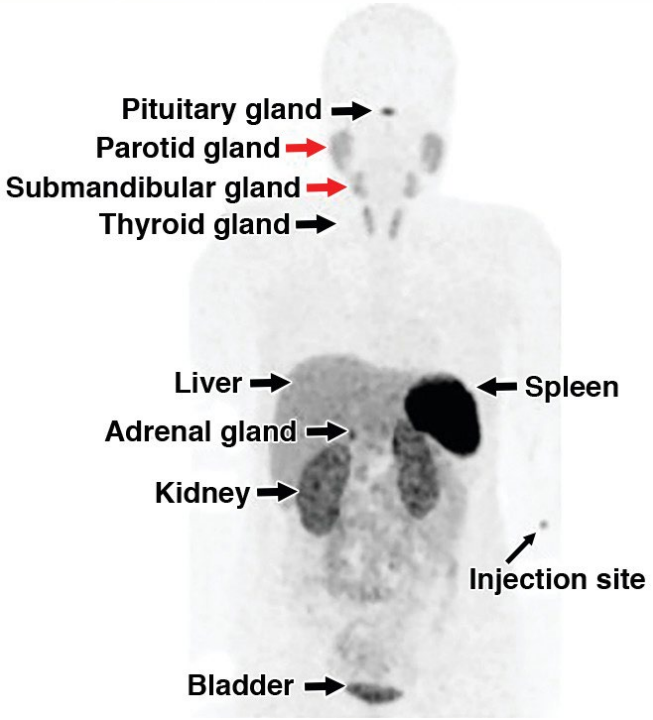
Image Source: "Positron emission tomography scan," *Mayo Clinic*: https://www.mayoclinic.org/tests-procedures/pet-scan/about/pac-20385078. Accessed 6/9/2025.

PET Scan Drugs

Many drugs are used in positron emission tomography (PET) imaging, but these are utilized specifically for neuroendocrine tumors (NETS) and metastatic castrate resistant prostate cancer (mCRPC)

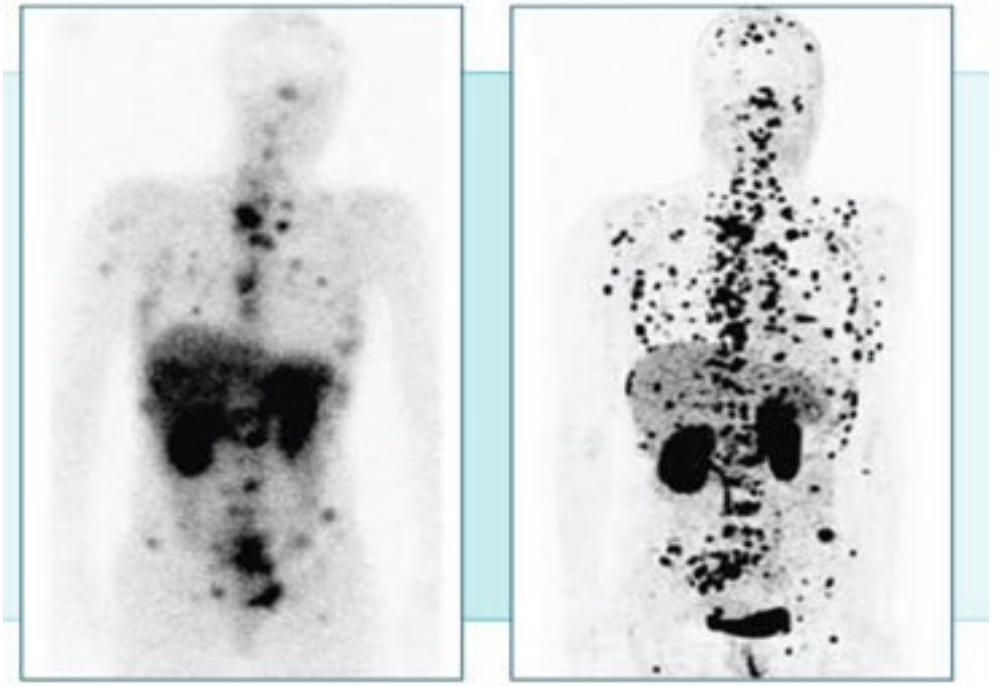
Positive NET PET Scan

Normal biodistribution of neuroendocrine imaging



Old "gold standard" imaging

New "gold standard" imaging



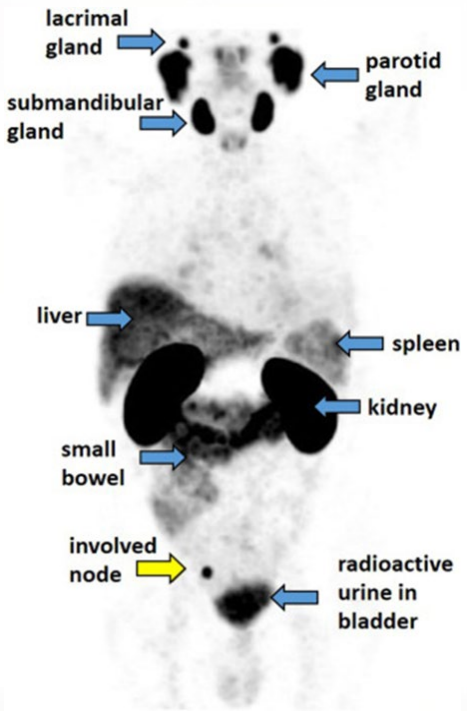
Octreoscan SPECT[4]

Copper Cu 64 dotatate PET[4]

Sources:
1. Image Credit: "Neuroendocrine Tumor Diagnosis and Management: ^{68}Ga-DOTATATE PET/CT," *American Journal of Roentgenology*: https://www.ajronline.org/doi/10.2214/AJR.18.19881. Accessed 6/19/2025.
2. "Recent advances in emerging radiopharmaceuticals and the challenges in radiochemistry and analytical chemistry," *ScienceDirect*: https://www.sciencedirect.com/science/article/pii/S0165993624005363. Accessed 6/9/2025.

Positive mCRPC PET & Nuclear Medicine Bone Scan

Normal biodistribution



Positron Emission Tomography Scan (metastatic)

Normal biodistribution

Nuclear Medicine Bone Scan (metastatic)

Sources/Image Credits: 1, "Positron Emission Tomography (PET)/Computed Tomography (CT) Imaging in Radiation Therapy Treatment Planning: A Review of PET Imaging Tracers and Methods to Incorporate PET/CT," *ScienceDirect*: https://www.sciencedirect.com/science/article/pii/S2452109423000416#fig0001. Accessed 6/9/2025; 2. "JENCC Offering New Cutting-Edge Scan To Better Diagnose Prostate Cancer," *Nylen Cancer Center*: https://www.nylencancercenter.com/news-and-events/jencc-offering-new-cutting-edge-scan-to-better-diagnose-prostate-cancer. Accessed 6/19/2025; 3. "Bone Scan," *Mayo Clinic*: https://www.mayoclinic.org/tests-procedures/bone-scan/about/pac-20393136. Accessed 6/19/2025

Patient Eligibility for Theranostic Treatment

- Cancer diagnosis consistent with radiotherapy treatment
- Receive positron emission tomography (PET) to determine if patient's tumor(s) will be responsive to treatment
- If the tumor(s) are receptive to the PET tracer and the scan is positive, it is indicative that the patient is likely eligible for treatment (pending other aspects like labs, etc.)
- Acceptance by a medical oncologist who specializes in specified cancer
- Case reviewed by Radiologist (scans, lab values, medical considerations that may interfere with treatment such as incontinence and ability to care for oneself)
- Insurance approval required (may vary facility to facility)
- Patient will receive call once insurance approves treatment to set up treatment schedule
- Patient receives treatment(s) and follow-up/interim care (Medical Oncologist appointments, scans, labs)

Radiotherapy Considerations (Patient)

Many radiation guidelines need to be followed 3 days post-infusion such as:

- **Toileting**
  - Use toilet in a seated position (all genders), wipe well, do not leave urine behind on skin (radiation burns), flush toilet 3x in public/shared spaces, change adult briefs more frequently when wet, catheter in place if urinary retention is an issue
- **Hydration**
  - Drink lots of fluids to flush system on unbound radiotracer to keep kidneys' function at or near baseline
- **Distance from others**
  - For 3 days, stay 3 feet away from any adults and 6 feet away from children, do not hold an infant/child for more than 30 minutes of close contact, sleep in a separate bed and avoid intimate contact
- **Washing**
  - Shower (no bathing) daily for 7 days after treatment using separate towels/washcloths, wash hands frequently throughout the day

Source: "Providing and Administering RLT," *Novartis*: https://www.rltinstitute.novartis.com/providing-and-administering-rlt/postadministration/patient-considerations/. Accessed 6/19/2025.

Radiotherapy Considerations (Patient), *continued*

- **Public Transportation**
  - Stay 3 feet away from others; if unable to do so, please do not take public transportation (trains, taxis [to include rideshares like Uber or Lyft], flights, etc.)
- **Driving Home**
  - Do not drive after treatment due to potential fatigue, sit in the back seat of the vehicle behind the passenger seat to create as much distance between you and the driver
- **Phone Number Resources**
  - Patient to be given phone number of Radiologist overseeing treatment (daytime and on-call phone number) and/or Radiation Safety Team for any questions or concerns post-treatment
  - Caregiver and/or loved-ones need to be given a Radiation Safety Team phone number to contact in case of unexpected death occurring within 60 days of treatment

Source: "Providing and Administering RLT," *Novartis*: https://www.rltinstitute.novartis.com/providing-and-administering-rlt/postadministration/patient-considerations/. Accessed 6/19/2025.

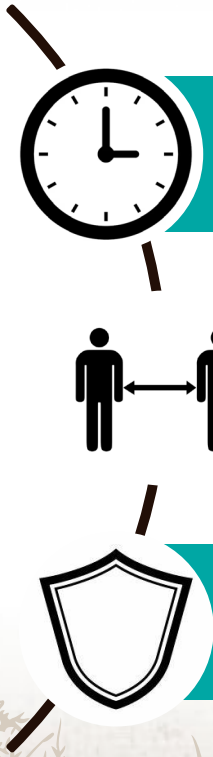
Radiotherapy Considerations (Patient), *continued*

- **Laundry**
  - Clothing, towels and bed sheets should be laundered separately for up to 3 days post treatment
- **Pregnancy, Sexual Intimacy and Breastfeeding**
  - Use birth control during treatment (applicable for patients or the partners of patients who can become pregnant) and for 6 months after your last treatment
  - Do not breastfeed during or for up to 6 months after your last treatment
- **Emergency Care**
  - Strongly urged to wear waterproof bracelet for 7 days post-treatment that acts as interim medical bracelet stating that patient has had a recent radioactive treatment and provide phone number of Radiologist overseeing treatment (daytime and on-call phone number) and/or Radiation Safety Team in case of emergency (for emergency medical services (EMS) and/or fire staff, emergency room and/or adjacent hospital staff)
  - Decision ultimately left up to patient for privacy concerns

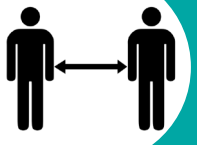
Source: "Providing and Administering RLT," *Novartis*: https://www.rltinstitute.novartis.com/providing-and-administering-rlt/postadministration/patient-considerations/. Accessed 6/19/2025.

Radiotherapy Considerations (Staff)

Both nursing and nuclear staff members should abide by the guidelines of “as low as reasonably achievable” (ALARA) when handling radioactivity or radioactive patients using the following guidelines to maintain minimal radiation exposure:



Time: How long to stay away from a radioactive source (drug, patient)



Distance: How far to stay away to decrease radiation exposure

Shielding: Use appropriate shielding for radiation type (alpha, beta, gamma)

Radiotherapy Considerations (Staff), *continued*

Additional Considerations

- All staff must wear a dosimeter body badge at chest/neckline to monitor radiation exposure to body (additional ring dosimeter for personnel administering the radioactive drug)
- No pregnant staff members administering or caring for radioactive patients
- PPE donned and doffed each time patient room is entered/exited
- Separate bathroom for radioactive patient use only and floors/toilet wrapped
- Geiger counter to monitor contamination on personnel or facility items (stretcher, chairs, floor, toilet, etc.)

- Radioactive Materials (RAM) license required for facility to administer radiopharmaceuticals in accordance with NRC regulations
- Authorized User (AU) training (nuclear medicine physician, radiation oncologist or radiologist)

Image Source: "A Comprehensive Guide to Administering Pluvicto," *Pluvicto*: https://www.pluvicto-hcp.com/sites/pluvicto_hcp_com/files/documents/pluvicto-administration-guide.pdf. Accessed 6/9/2025.

Assessment Question #1

Which of the following best describes a key clinical difference between traditional imaging contrast agents and surgical dyes?

A. Contrast agents are primarily used to stain tissues for visual identification during surgery, while surgical dyes are used for enhancing radiographic imaging

B. Contrast agents are typically administered orally, while surgical dyes are only injected intravenously

C. Surgical dyes are used for real-time, direct visual guidance during procedures, while traditional imaging contrast agents enhance imaging modalities like computed tomography or magnetic resonance imaging

D. Both contrast agents and surgical dyes are interchangeable and serve identical purposes in all clinical settings

Answer: Assessment Question #1

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Assessment Question #2

Which of the following dyes, commonly used in diagnostic procedures, has historically experienced shortages, requiring pharmacy to develop alternative procurement strategies and manage associated supply costs?

A. Cytalux
B. Indocyanine Green (ICG)
C. Cysview
D. Isosulfan Blue

Answer: Assessment Question #2

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Assessment Question #3

Which of the following is an example of current use of theranostics in practice?

A. The pairing of a diagnostic and a therapeutic radiopharmaceutical to target the same biomarker for both imaging and treatment

B. Use of 2 different radioactive treatments, administered sequentially to increase tumor killing

C. Use of a combination positron emission tomography (PET)/computed tomography (CT) scan to visualize a tumor and calculate dosimetry

D. Use of a combination of therapeutics to induce a synthetic lethality

Answer: Assessment Question #3

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