

Clinical Protocol: Tagged White Blood Cell Studies (In-111-WBCs, Tc-99m-HMPAO-WBCs)

Responsible Division: Division of Nuclear Medicine, Department of Radiology, UT Southwestern

POLICY BASIS FOR PROCEDURE

To establish a protocol for tagged white blood cell studies

DESCRIPTION OF STANDARD PROCEDURE

SCOPE

All Nuclear Medicine Technologists and Physicians must adhere to these guidelines.

PROCEDURE

Indications:

- Musculoskeletal infections such as disc space, joint space, prosthetic joint and other orthopedic hardware, osteomyelitis superimposed on existing bone pathology, osteomyelitis in diabetic patients, and differentiating osteomyelitis from bone infarction
- Fever of unknown origin (FUO)
- Detection and localization of an unknown source of sepsis (occult infection)
- Detection of an additional site of infection in patients with persistent or recurrent fever and a known site of infection
- Postoperative infections
- Cardiovascular infections (eg, prosthetic vascular graft, mycotic aneurysms)
- Differentiation of infection from tumor
- Mycobacterial infections (eg, tuberculosis)
- Opportunistic infections
- Pulmonary inflammation due to therapeutic or environmental agents
- Granulomatous diseases (eg, sarcoidosis)
- Interstitial nephritis
- Inflammatory bowel disease.

Examination Time:

- Initially: 30 minutes for withdrawal of 50 mL of blood.
- At 1 hour: 15 minutes for injection of the blood labeled with radiopharmaceutical, following written policy for the handling of radio-labeled blood products that will ensure all samples are positively identified as to source and that reinjection of these radiopharmaceuticals occurs only into the correct patient.
-
- In-111-WBCs:
 - Routine imaging at 24 hours (Range: 18- 30 hours)
 - Early (1 to 3 hours) imaging, when inflammatory bowel disease is suspected
 - Delayed images beyond the routine set of images may be needed up to 48 hrs

UT Southwestern Department of Radiology

- Tc-99m-HMPAO-WBCs: (Range: 30 mins to 24 hours)
Imaging at 2 -3 hours for extremities or abdominal infections.
Imaging at 6 hours for chest infections.

Patient Preparation

- Circulating white cell count of at least 5,000/ml is required by the radiopharmacy to achieve good labeling.

Equipment & Energy Windows:

- Gamma camera: Large field of view, preferably with dual heads.
- Collimator:
In-111-WBCs: Medium energy, parallel hole.
Tc-99m-HMPAO-WBCs: Low energy, high resolution, parallel hole.

Energy windows:

- In-111-WBCs:
One pulse height analyzer: 156 to 272 keV
Two pulse height analyzers: 20% windows centered at 171 and 245 keV
- Tc-99m-HMPAO-WBCs:
20% window centered at 140 keV

Radiopharmaceutical, Dose, & Technique of Administration:

Radiopharmaceutical:

- In-111-white blood cells
- Tc-99m-HMPAO-WBCs

Dose: (1)

- In-111-WBCs: 0.3 to 0.5 mCi (11.1 to 18.5 MBq).
- Tc-99m-HMPAO-WBCs: 5 to 10 mCi (185 to 370 MBq)
- Technique of administration:
 - Standard intravenous injection

Patient Position & Imaging Field:

- Patient position: Supine.
- Imaging field: Whole Body or Limited, depending on indication.

Acquisition Protocol:

Planar imaging:

- ANT and POST images are acquired of the torso, and of the extremities as indicated; occasionally other projections are obtained.

UT Southwestern Department of Radiology

- For moving acquisition: Use a camera/table motion of approximately 5-10 cm/min.
- Static acquisition protocol: Acquire images for approximately 5-10 minutes each.
- SPECT imaging (1) - use routinely for limited field of view studies and areas of uncertainty or as determined by the radiologist
- In – 111
Image acquisition parameters:
 - a) degrees of rotation: 360°
 - b) matrix: 64 x 64
 - c) number of images: 64
 - c) time per image: 25 - 30 seconds/ angular sampling (increase to 45 to 60 secs for extremities) .
- Tc-99m
Image acquisition parameters:
 - a) degrees of rotation: 360°
 - b) matrix: 128 x 128
 - c) number of images: 64
 - c) time per image: 30 seconds/ angular sampling
- Delayed imaging (may be needed to increase the certainty of diagnosis)

Data Processing:

SPECT image reconstruction:

1. The exact procedure for processing SPECT images depends on the computer software being used. This varies with the manufacturer and, in general, the manufacturer's protocol should be followed.
2. The reconstruction process in general terms is:
 - a) Correct the 64 planar images for uniformity (camera non-uniformity) using a high count, e.g. 30 million count, cobalt-57 flood acquisition.
 - b) Check the images for patient motion and apply a motion correction algorithm if indicated and if available.
 - c) If the entire field of view is not of interest, indicate the region that is of interest so that computer time is not expended reconstructing tomograms outside the region of interest.
 - d) Specify the filters to be used in the reconstruction process and the pixel thickness of the tomogram (usually 1 or 2 pixels).
 - e) Reconstruct transverse, sagittal, and coronal image.

Optional Maneuvers:

- Bone marrow imaging with Tc-99m-sulfur colloid: May be performed in conjunction with In-111-WBC studies for osteomyelitis to increase specificity (see section on Bone Marrow Study)
- Pethidine to reduce hepatobiliary excretion: When imaging inflammatory bowel disease with Tc-99m-HMPAO-WBCs, can give pethidine (an opiate) to constrict the sphincter of Oddi and reduce excretion of Tc-99m-WBC by products.
- Bone mineral imaging with Tc-99m-HDP/MDP: May be performed in conjunction with In-111-WBC studies for osteomyelitis to increase specificity.

Principle Radiation Emission and Dosimetry Data

In-111

Physical half-life = 2.83 days.

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-2	90.2	171.3
Gamma-3	94.0	245.3

Dosimetry - In-111-White Blood Cells (2)

Radiation Dosimetry: Adults

Radiopharmaceuticals	Administered activity MBq (mCi)	Organ receiving the largest radiation dose mGy/MBq (rad/mCi)	Effective dose equivalent mSv/MBq (rem/mCi)
¹¹¹ In-leukocytes ¹	10–18.5 iv (0.3–0.5)	5.5 Spleen (20)	0.59 (2.2)

¹ International Commission on Radiological Protection. *Radiation Dose to Patients from Radiopharmaceuticals*. ICRP Publication 53. London, UK: ICRP; 1988:256; normal liver.

Tc-99m

Physical half-life = 6.01 hours

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-2	89.07	140.5

Dosimetry - Tc-99m-WBC (3)

Radiation Dosimetry: Adults¹

Radiopharmaceuticals	Administered activity	Organ receiving the largest radiation dose	Effective dose equivalent
	MBq (mCi)	mGy/MBq (rad/mCi)	mSv/MBq (rem/mCi)
^{99m} Tc-exametazime (HMPAO) leukocytes ¹	185–370 iv (5–10)	0.15 Spleen (0.56)	0.017 (0.063)

¹ International Commission on Radiological Protection. *Radiation Dose to Patients from Radiopharmaceuticals*. ICRP Publication 53. London, UK: ICRP; 1988:232.

References:

1. ACR–SPR Practice Parameter For The Performance Of Scintigraphy For Inflammation And Infection – Revised 2014.
2. Society of Nuclear Medicine Procedure Guideline for ¹¹¹In-Leukocyte Scintigraphy for Suspected Infection/Inflammation – 2004
3. Society of Nuclear Medicine Procedure Guideline for ^{99m}Tc-Exametazime (HMPAO)-Labeled Leukocyte Scintigraphy for Suspected Infection/Inflammation – 2004

Approval: Rathan M Subramaniam, MD, PhD, MPH, Professor and Chief, Division of Nuclear Medicine, UT Southwestern. Date: 05/21/2017.