SAFE HANDLING OF TECHNETIUM-99M

FACT SHEET NO. 26-020-0220

General Information:

Technetium-99 metastable (Tc-99m) is a radionuclide widely administered to patients undergoing nuclear medicine imaging studies. Radiation from the TC-99m is emitted from the patient and detected (imaged) through special cameras such as Positron Emission Tomography (PET) or Single-photon Emission Computed Tomography (SPECT) cameras. These studies allow medical teams to identify abnormalities that may not be found through other imaging modalities such as Computed Tomography (CT) or Magnetic Resonance Imaging (MRI). Tc-99m has a short physical half-life of 6 hours and a biological half-life of 1 day and is, therefore, quickly eliminated from the body. Tc-99m is a pure gamma-ray emitter that emits a 140 keV photon suitable for detection and allows for highly precise alignment of imaging detectors. Characteristics of Tc-99m make it ideal for diagnostic medical imaging while keeping patient doses to a minimum.

How is Tc-99m regulated for use and possession?

The use and possession of radionuclides, such as Tc-99m, are regulated by the U.S. Nuclear Regulatory Commission (NRC). The NRC requires nuclear medicine facilities to be licensed to ensure radioactive materials are used safely to protect patients, workers, the public, and the environment. The NRC requirements for radiation protection and medical use of radioactive materials are listed in Title 10 of the U.S. Code of Federal Regulations (CFR), Parts 20 (Standards for Protection Against Radiation) and 35 (Access Authorization), respectively.

How is Tc-99m prepared for clinical use?

The parent radionuclide of Tc-99m, molybdenum-99 (Mo-99), is produced in a nuclear reactor or particle accelerator and packaged in an alumina column in a device called a technetium generator, or more commonly, a “Moly Cow.” Tc-99m is then separated from Mo-99 by passing a saline solution through the column. The saline solution removes Tc-99m and leaves behind Mo-99. The solution containing Tc-99m is then used to prepare radiopharmaceuticals. A technetium generator can be eluted several times per day for about a week before it needs to be replaced.

What are the risks to nuclear medicine pharmacists and technologists administering Tc-99m, and how can these risks be mitigated?

Radiation exposures of nuclear medicine pharmacists and technologists originate from dosage preparation, injection, and patient imaging. All radiation doses should be kept as low as reasonably achievable by using personal protective equipment when possible, minimizing exposure time, and/or maximizing the distance from the patient. Table 1 lists the average radiation doses received by a nuclear medicine technologist from different Tc-99m radiopharmaceuticals during dosage preparation, administration, and imaging.

A nuclear medicine technologist preparing a patient for imaging using a gamma camera (Photo: DVIDS stock)

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Table 1. Dose Received by Nuclear Medicine Technologists from Selected Routine Procedures

Procedure	Agent Administered	Activity (mCi)[a]	Dose from a Single Routine Procedure (mrad)[b]			
			Dosage Preparation	Administration	Imaging	Total
Bone	Tc-99m diphosphonate	15	0.02	0.01	0.54	0.57
Brain	Tc-99m pertechnetate	20	0.04	0.02	0.22	0.28
Infarct	Tc-99m pyrophosphate	15	0.01	0.01	0.02	0.04
Cerebral Blood Flow	Tc-99m pertechnetate	20	0.04	0.02	0.03	0.09
Liver	Tc-99m sulfur colloid	4	0.01	0.02	0.03	0.06
Thyroid	Tc-99m pertechnetate	2	0.02	0.01	0.04	0.07

[a] mCI: millicurie
[b] mrad: millirad
Adapted from: National Council on Radiation Protection and Measurements (NCRP). 1996. Report No. 124, *Sources and Magnitude of Occupational and Public Exposures from Nuclear Medicine Procedures*, Bethesda, MD.

The following precautions should be taken during the handling and disposal of Tc-99m:

- Prohibit eating, drinking, and smoking in areas where Tc-99m is handled or stored.
- Upon receipt of packages containing Tc-99m generators or unit doses of TC-99m, visually inspect the package(s) for damage and leaks, survey with a pancake probe, and perform removable contamination wipe tests. Immediately notify the Radiation Safety Officer when survey readings or wipe test counts exceed your local action levels.
- Tc-99m generators should be used only by pharmacists and technicians who have been properly trained in the safe use and handling of generators. Tc-99m generators should be stored in a locked room and access controlled when not in use.
- When handling Tc-99m, use appropriate protective equipment such as shielded storage containers, tungsten syringe shields, tongs or forceps; also wear proper dosimetry as required by your radiation protection program. In many cases, a standard lead equivalent (0.35 mm Pb) apron will reduce the Tc-99m dose rate to a technologist by about 50%.
- Wear disposable medical gloves while handling Tc-99m and injecting the patient. Wash your hands immediately after removing the gloves, and frisk the hands with a pancake probe to verify they are clean.
- In case of a spill involving Tc-99m, secure the area, warn others in the area, follow emergency procedures, and notify the Radiation Safety Officer immediately per your local radiation protection program procedures.
- Collect and isolate radioactive waste in clearly labeled and shielded containers. Dispose of radioactive waste according to your local procedures.
- **Where can I find more information?**
- Additional information regarding applying radiation safety standards in nuclear medicine can be found at: https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf
- Additional information regarding NRC regulations and radiation protection policies applicable to diagnostic nuclear medicine can be found at: https://www.nrc.gov/reading-rm/doc-collections/cfr/part035/full-text.html and https://www.nrc.gov/materials/miau/miau-reg-initiatives/guide_2002.pdf
- More information and details regarding occupational and public exposures from nuclear medicine procedures can be found in NCRP report No. 124, and can be obtained from: https://ncrponline.org/publications/reports/ncrp-reports-124/