

Practical Indication-Based Pediatric Nuclear Medicine Studies Update and Review

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KEYWORDS

• Radiopharmaceuticals • Pediatrics • Clinical applications • Scintigraphy

KEY POINTS

- Nuclear medicine studies provide complementary functional information to anatomic imaging modalities.
- Pediatric nuclear medicine examinations are technically challenging, requiring customization of study protocols to individual pediatric patients.
- Special emphasis on radiation dose optimization is required in pediatric practice.

INTRODUCTION

Nuclear medicine is an imaging specialty in which trace amounts of radiopharmaceuticals are used to examine different physiologic or pathologic processes in the body. Scintigraphic examinations provide useful functional information, which often complements anatomic information obtained from other radiological tests. Nuclear medicine examinations in children are often technically more difficult due to variation in body types, developmental stages, and disease conditions, as well as the need for sedation or anesthesia. Radiation dose optimization is an important concern, particularly in the pediatric population. This article reviews the current practice of diagnostic nuclear medicine in pediatrics. A discussion of radionuclide therapy and newer radiopharmaceutical agents that are predominantly investigational in the United States is beyond the scope of this article.

PEDIATRIC-SPECIFIC TECHNICAL CONSIDERATIONS

Radiopharmaceuticals

Most of the radiopharmaceuticals used in pediatric patients are labeled with technetium-99m (^{99m}Tc). Some other commonly used radionuclides include iodine-123 (^{123}I), xenon-133 (^{133}Xe), and fluorine-18 (^{18}F). In the past, there was no standardization of pediatric-administered radiopharmaceutical doses. However, in 2010, the North American consensus guidelines for administered radiopharmaceutical activities were developed for 11 radiopharmaceuticals, primarily based on patient weight.¹ These were updated in 2014 and have been harmonized with the European Association of Nuclear Medicine radiopharmaceutical pediatric dose card.² The commonly used radiopharmaceuticals and their dosages based on the North American consensus guidelines (if applicable) are listed in **Table 1**.

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Radiol Clin N Am ■ (2017) ■-■

<http://dx.doi.org/10.1016/j.rcl.2017.02.014>

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Table 1
Commonly used radiopharmaceuticals in pediatric nuclear medicine

Radiopharmaceutical	Typical Dose or Dose Range (MBq/kg, Unless Otherwise Specified), Typical Route of Administration	Indication
1. ^{99m}Tc -bicisate (ethyl cysteinate dimer [ECD])	7.4–11.1, intravenous (IV)	Brain perfusion
2. ^{99m}Tc -exametazime (hexamethylpropylene amine oxime [HMPAO])	7.4–11.1, IV	Brain perfusion
3. ^{18}F -fluorodeoxyglucose (FDG)	3.7 (brain), ^a IV 3.7–5.2 (body), ^a IV	Epilepsy imaging, myocardial viability imaging, oncology, infection or inflammation
4. ^{111}In -diethylenetriaminepentaacetic acid (DTPA)	1.85–74 MBq, intrathecal	Cerebrospinal fluid (CSF) imaging
5. ^{99m}Tc -DTPA	11.1–37 (CSF imaging) MBq, intrathecal 7.4 (brain death), IV 1.85 glomerular filtration rate (GFR), IV	CSF imaging, blood flow agent for brain death scintigraphy, GFR evaluation
6. ^{99m}Tc -sestamibi or ^{99m}Tc -tetrofosmin	9.25 (rest or stress only), IV 5.55 (rest) and 12.95 (stress) when performed on the same day, IV 11 (parathyroid scintigraphy), IV	Myocardial single-photon emission computed tomography (SPECT) perfusion, parathyroid scintigraphy
7. ^{13}N -ammonia	11.1, IV	Myocardial PET perfusion
8. ^{99m}Tc -macroaggregated albumin (MAA)	2.59 (if ^{99m}Tc -DTPA used for ventilation), ^a IV 1.11 (if ^{99m}Tc -DTPA not used for ventilation), ^a IV	Lung perfusion
9. ^{133}Xe	370–740 MBq, inhaled	Lung ventilation
10. ^{99m}Tc -sulfur colloid	11.1 MBq (salivagram), oral 7.4–37 MBq (esophageal transit), oral 9.25–37 MBq (oral liquid gastric emptying), ^a oral, naso-gastric or orogastric tube, gastrostomy tube 9.25–18.5 MBq (solid gastric emptying), ^a oral ≤37 MBq (per bladder filling cycle during cystography) ^a	Salivagram, esophageal transit, gastric emptying, cystography with augmented bladder
11. ^{99m}Tc -pertechnetate	1.85 (Meckel), ^a IV ≤37 MBq (per bladder filling cycle during cystography) ^a	Ectopic gastric mucosa, radionuclide cystogram, occasionally thyroid scintigraphy
12. ^{99m}Tc -labeled autologous red blood cells (RBC)	7.4, IV	Gastrointestinal (GI) bleeding scintigraphy
13. ^{99m}Tc -iminodiacetic acid (IDA)	1.85, ^a IV	Hepatobiliary scintigraphy
14. ^{99m}Tc -mercaptoacetyltryglycine (MAG-3)	3.7 (without flow), ^a IV 5.55 (with flow), ^a IV	Dynamic renal scintigraphy, diuretic renography, captopril renography

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