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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

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ACR–SPR–SNM PRACTICE GUIDELINE FOR THE PERFORMANCE OF ADULT AND PEDIATRIC RADIONUCLIDE CYSTOGRAPHY

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This guideline was revised collaboratively by the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Nuclear Medicine (SNM).

This guideline is intended to guide interpreting physicians in performing radionuclide cystography (RNC) in adult and pediatric patients. Properly performed imaging of the bladder with radiopharmaceuticals provides a sensitive means of detecting, following, and evaluating certain conditions of the bladder and ureters. As with all scintigraphic studies, correlation of findings with the results of other imaging and nonimaging procedures, as well as clinical information, is necessary for maximum diagnostic yield.

Application of this guideline should be in accordance with the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

(For pediatric considerations see sections VI and VII.)

II. DEFINITION

RNC involves filling the urinary bladder with a radiopharmaceutical, either by direct retrograde administration via catheter or by indirect, antegrade drainage of an intravenously administered radiopharmaceutical that is excreted by the kidneys, and subsequent imaging with a gamma camera.

III. GOAL

The goal of RNC is to enable the interpreting physician to detect and quantify physiologic and anatomic abnormalities of the genitourinary system by producing images of diagnostic quality.

IV. INDICATIONS

Clinical indications [1-3] for RNC include, but are not limited to:

1. Initial diagnosis of vesicoureteral reflux in female patients with urinary tract infection.
2. Diagnosis of familial reflux.
3. Follow-up of previously diagnosed vesicoureteral reflux to assess for spontaneous resolution.
4. Evaluation of vesicoureteral reflux after medical or surgical management.
5. Serial evaluation of bladder dysfunction for reflux.
6. Quantification of postvoid residual urine in the bladder.
7. Hydronephrosis.

For the pregnant or potentially pregnant patient, see the ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation.

V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

VI. RADIOPHARMACEUTICALS

If the direct (retrograde) technique (see below) is employed, technetium-99m as sodium pertechnetate, sulfur colloid, or stannous diethylenetriamine pentaacetic acid (DTPA) may be used. Sodium pertechnetate should not be used in individuals who have undergone bladder augmentation with gastric or intestinal tissue. An administered activity of 18.5 to 37 MBq (0.5 to 1.0 mCi) is introduced aseptically into the urinary bladder via a urethral catheter. Administered activities of 9.25 to 18.5 MBq (0.25 to 0.5 mCi) may be considered for infants and toddlers. The patient should void immediately before

catheterization if residual volume is measured by catheterization rather than by computer analysis of bladder activity [3]. Latex materials should not be used in patients known or prone to have latex allergy (e.g., patients with congenital spinal dysraphism).

If the indirect (antegrade) technique (see below) is employed, either technetium-99m DTPA or mercaptoacetyltriglycine (MAG-3[®]) must be used; technetium-99m MAG-3[®] is preferred. This test usually is performed as the final part of a conventional renal scan. Administered activity is the same as for renal scintigraphy (see the ACR-SPR Practice Guideline for the Performance of Adult and Pediatric Renal Scintigraphy), with which this technique can be combined. The advantages of the indirect technique are that it is noninvasive and it provides information about renal function. A disadvantage is a lower sensitivity than direct cystography, because a) the bladder may only be partially filled, b) reflux can be detected only during the voiding phase, and c) it may be difficult to differentiate between reflux and residual antegrade excretion [4-6]. Another disadvantage of indirect cystography is that it imparts a higher radiation dose to the patient than direct cystography. Indirect cystography should not be used if the patient is not toilet trained or has compromised renal function [4-7].

Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

VII. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for radionuclide cystography should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state's scope of practice requirements. (ACR Resolution 35, adopted in 2006)

A. Vesicoureteral Reflux

For infants and children refer also to the ACR–SPR Practice Guideline for the Performance of Voiding Cystourethrography in Children.

If the retrograde direct technique is used, the radiopharmaceutical is administered aseptically into the bladder via a urinary catheter and followed by an appropriate volume of sterile normal saline, until the bladder reaches capacity. Application of urethral anesthesia for male patients before catheterization may help decrease discomfort [8]. Alternatively, in adults, the radiopharmaceutical may be added to and mixed with 500 mL of sterile normal saline with appropriate shielding of the container. Warming the saline solution to room or body temperature and infusing at a slow rate may improve the comfort of the patient. The saline container typically is placed no more than 100 cm above the tabletop [2]. The pelvis and abdomen are imaged continuously in the posterior projection, with the patient lying supine. Digital data acquisition is recommended. If reflux occurs during filling of the bladder, the volume at which reflux occurred should be recorded. The end of the filling phase usually is indicated by a reduction or cessation of the infusate's rate of flow or by a bladder volume appropriate for the patient's age [3]. In children, bladder volume can be approximated either with the formula: (age in years + 2) x 30 mL = bladder volume [2] or with a reference table [9].

When the patient reaches maximum capacity and is instructed to void or when the patient begins to void spontaneously, imaging is continued until the bladder is empty. In patients able to cooperate, voiding images may be obtained with the patient upright. Postvoid posterior images of the bladder should be obtained in either the supine or upright position after bladder emptying is complete. If the patient cannot void upon request, emptying the bladder via the urinary catheter will reduce radiation exposure. In infants and children a cyclic (more than one filling and voiding) study may increase sensitivity. Repeat filling and voiding cycles are obtained with the catheter in place. The degree of reflux may be estimated using either a visual grading scale of 1 to 3 (mild, moderate, or marked) or a 1 to 5 scale analogous to that used for contrast cystography [3,7,10,11]. For visual analysis of digital images, contrast enhancement or other brightening mode or cine mode and a consistent image display technique should be used to maximize the sensitivity of the test and to detect the smallest amounts of reflux. Quantification of reflux during the bladder-filling phase and during the voiding phase also may be achieved using region-of-interest (ROI) analysis, with regions of interest placed over both the kidneys and the ureters.

Use of ROIs over the collecting systems and time activity curves may enhance the sensitivity of indirect

radionuclide cystography for detecting vesicoureteral reflux.

B. Residual Volume

For quantification of postvoid residual volumes, prevoid and postvoid images of the bladder should be acquired anteriorly or posteriorly. Regions of interest are drawn over the bladder on both sets of images. The volume of voided urine is recorded. Residual volume (RV) can be estimated by the following formulas [2]:

$$\text{RV (mL)} = \frac{(\text{voided vol [mL]}) \times (\text{postvoid bladder ROI count})}{(\text{initial bladder ROI count}) - (\text{postvoid bladder ROI count})}$$

Residual volume also may be calculated if the volume to which the bladder was filled is known. The equation then becomes:

$$\text{RV (mL)} = \frac{(\text{initial bladder vol [mL]}) \times (\text{postvoid bladder ROI count})}{\text{initial bladder ROI count}}$$

C. Instructions to Patient/Parent

The radiation exposure to the bladder lining and wall, although small and well within accepted diagnostic imaging levels, can be further reduced by a postexamination diuresis to eliminate residual radioactivity if the patient does not empty the bladder completely. Instruction to drink fluids by mouth for several hours following the examination should be given to the patient, parent, or caregiver.

VIII. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

The report should include the radiopharmaceutical used and the dose and route of administration, as well as any other pharmaceuticals administered, also with dose and route of administration.

IX. EQUIPMENT SPECIFICATIONS

A gamma camera with a low-energy all-purpose/general all-purpose (LEAP/GAP) or high-resolution collimator is recommended. If the clinical question relates to vesicoureteral reflux, the field of view must be large enough to include both the bladder and kidneys. For infants and small children, magnification may be used if a large-field-of-view camera head (400 mm) is employed.

Digital acquisition may be desirable and is necessary if quantification is performed. A 64 x 64 acquisition matrix is sufficient for detectors up to 400 mm in diameter. For larger detectors, a 128 x 128 matrix is needed. A framing rate of 10 to 30 seconds per frame is suggested. The collimator face and the entire imaging field must be protected from radionuclide contamination using plastic-backed absorbent pads or other similar material. Plans for collection, disposal, storage, or decontamination of radioactive urine and materials must be considered.

X. RADIATION SAFETY

Radiologists, imaging technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as “as low as reasonably achievable (ALARA).”

Facilities, in consultation with the radiation safety officer, should have in place and should adhere to policies and procedures for the safe handling and administration of radiopharmaceuticals, in accordance with ALARA, and must comply with all applicable radiation safety regulations and conditions of licensure imposed by the Nuclear Regulatory Commission (NRC) and by state, and/or other regulatory agencies. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol.

XI. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR web page (<http://www.acr.org/guidelines>).

Equipment performance monitoring should be in accordance with the ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Gamma Cameras.

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Suggested Reading (Additional articles that are not cited in the document but that the committee recommends for further reading on this topic)

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