

## Division of Nuclear Medicine Procedure / Protocol University Hospital and The American Center

KIDNEY FLOW / FUNCTION WITH DIURETIC  
UPDATED: FEBRUARY 2019

CPT CODE: 78708

**Indications:**

The scan is designed to differentiate dilated renal collecting systems (calyces, pelves, or ureters) from obstructed collecting systems. The site and side of the questioned obstruction must be provided prior to scheduling the study. Without it the test cannot be performed. The test might also be invalid if there is impaired renal function on the affected side, or if there is vesicoureteric reflux. In these patients, a decision must be made to increase furosemide or place an indwelling catheter.

**Patient Prep:**

Patients who had IV contrast CT or MRI will need to wait until the next day for a nuclear medicine renogram.

Pt does not have to be NPO unless required for sedation.

Pediatric patients pre-scan prep: Check In, IV and Foley placement, and pre-scan hydration prep takes place at the AFCH Diagnostic and Therapy Campground or Sedation Center.

Patient current height and weight is available in Health Link on the Doc Flowsheet tab.

**ADULT & PEDS > 11 YRS:** The patient should be well hydrated at the time of the study. This means 500 ml (16 oz) of fluid in the preceding 2 hours before start of exam. Have patient empty urinary bladder prior to start of exam. Provide IV access.

For patients **not** given oral hydration instructions, administer 250 ml normal saline IV over 30 minutes. Begin 15 minutes prior to radiopharmaceutical and continues for 15 minutes post-injection of radiopharmaceutical. Alternatively, oral hydration as described above can be use if time exists for the 2-hour oral prep.

**PEDIATRIC < 11 YRS:** For pediatric patients, IV hydration (normal saline) is required to be delivered at 10 ml/kg over 30 minutes. Begin 15 minutes prior to radiopharmaceutical and continue 15 minutes post injection of radiopharmaceutical. Then maintain IV infusion at rate of 8 ml/kg/hr. Hydration will be started 15 minutes prior to scheduled appointment time in Peds Day Treatment or Peds Sedate.

**Catheterization:**

Catheterization is recommended for following **adults**. Nuclear medicine physician should clarify with the referring provider in case of any confusion or discrepancy:

- With megaureter
  - With Vesicoureteric reflux
  - With neurogenic bladder
- \*See Nuclear Medicine SOG concerning urinary catheter placement.

Catheterization is required for **all children:**

- Less than 10 years old
- Who are Sedated
- With Vesicoureteral reflux
- With neurogenic bladder
- UPJ and obstructive issues
- Not “toilet-trained”

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### Foley Catheter Size\* (general guidelines):

- 0 months to 2 years 8 French Foley
- 3 years of age 8-10 French Foley
- 5 years of age 10 French Foley
- 6 years of age 12 French Foley
- 8 years of age 12 French Foley
- 12 years of age 12-14 French Foley
- Do not use a Feeding tube or 6 French Foley. They may not drain the bladder adequately and may alter the results or make the Lasix Renal Scan difficult to interpret.

### Sedation:

Sedation may be required for some infants or toddlers. Sedation is requested by the ordering physician via Peds Sedate Clinic. On rare occasions, General Anesthesia may be used in place of Peds Sedate Clinic due to scheduling constraints.

### Scheduling:

The test takes 90 minutes. Remind adult patients of the requirement to drink 2 glasses/cups of fluid, 2 hours prior to the exam, at time of scheduling.

For inpatients, ask whether or not the patient has a urinary catheter, if yes, verify if the output volume is being measured and/or being save.

### Radiopharmaceutical and Lasix Doses:

1. Adult: Prescribed 8 mCi  $\pm$  20% Tc-99m-MAG3. Adjust dose for patient weight per NMIS or weight table makes the range 4-12 mCi  $\pm$ 20%.
2. Pediatric dose adjusted <18 years based off adult dose.

### Furosemide

1. Neonates, infants and children (< 6 years): 1.0 mg/kg to a maximum of 40 mg of furosemide.
2. Children > 6 years and < 18 years: 0.5 mg/kg to a maximum of 40 mg of furosemide.
3. Adult (>/= 18 years): 40 mg of furosemide.

These doses will be increased if patient has renal impairment. The technologist on the day of the scan will verify/obtain the serum creatinine from the EMR. If a serum creatinine within the past 30 days is elevated per EMR stated normal ranges confirm with the NM Faculty or Resident of the day that the furosemide dose should be increased;

1. All pediatrics < 18 years: increase the furosemide dose to 40 mg
2. Adult (>/= 18 years): increase the furosemide dose to 80 mg.

If no serum creatinine is available from past 30 days, keep it to the standard/weight-based dose as explained above.

**Pediatrics:** Lasix administered at rate NOT to exceed 5 mg/min.

**Adults:** Lasix administered at rate NOT to exceed 10 mg/min.

*These rate limitations reduce the risk of ototoxicity.*

Furosemide will routinely be administered at 20 min post radiopharmaceutical injection when a urinary catheter is in place. When no catheter is in place, 1 minute after imaging resumes. See below for details.

### Imaging Device:

GE with LEHR collimator: MPS, Infinia or Optima.

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**Data Acquisition:** Use predefined protocol GatesRenalLasix or LasixRenal, depending on camera used.

**Acquisition Procedure:**

- A. Create patient.
- B. Acquisition protocol **with** urinary catheter: GatesRenalLasix or LasixRenal.
  - 1. Pre syringe: Acquire syringe in holder for 3 seconds, 128 x 128 matrix
  - 2. Preinj: Acquire one-minute pre-injection picture, 128 x 128 matrix
  - 3. RenalFlow: Renal Flow, 240 frames at 1 sec/frame followed by 46 frames at 1 min/frame, 128 x 128 matrix
  - 4. Post syringe: Acquire syringe and stopcock in holder for 3 seconds, 128 x 128 matrix
  - 5. Injsite: Acquire injection site image, a 15 second image, 128 x 128 matrix
  - 6. Post Tc: Post void image, 300 seconds, 128 x 128 matrix
  - 7. Collection Bag: Before emptying collection bag - 300 seconds, 128 x 128 matrix  
During the acquisition marker top, bottom, left and right.
- C. Acquisition protocol **without** urinary catheter: GatesRenalLasix or LasixRenal
  - 1. Pre syringe: Acquire syringe in holder for 3 seconds, 128 x 128 matrix
  - 2. Preinj: Acquire one-minute pre-injection picture, 128 x 128 matrix
  - 3. EARLYFLOW: Renal Flow, 240 frames at 1 sec/frame followed by 26 frames at 1 min/frame, 128 x 128 matrix
  - 4. LATEFLOW: 30 frames at 1 min/frame, 128 x 128 matrix
  - 5. Post syringe: Acquire syringe and stopcock in holder for 3 seconds, 128 x 128 matrix
  - 6. Injsite: Acquire injection site image, 15 second image, 128 x 128 matrix
  - 7. Post Tc: Post void image, 300 seconds, 128 x 128 matrix
  - 8. Collection Bag: Before emptying collection bag - 300 seconds, 128 x 128 matrix  
During the acquisition marker top, bottom, left and right.

**Imaging Procedure:**

Place the IV and then have the patient void prior or empty the urine collection bag prior to positioning.

All patients with any urine collection bag or other collection bag (kidney related): Empty urine collection bag prior to start. Check for urine output, the catheter may have to be manipulated to ensure drainage. At the end of the study take image of the collection bag then empty and then record urine output at end of study.

PEDIATRIC: Change child's wet diaper at the end of the study.

ADULTS: Ask patient to void before test and record time.

**Be sure to record patient's height & weight for processing.**

\*\* Prior to injection 99mTc-MAG3 inform the NM Faculty or Resident that there is or is not urine present (did the patient void or was there urine in the collection bag) they will either give the OK to inject furosemide at 20 minutes and/or give you additional instructions. \*\*

Lay the patient in the supine position with the gamma camera beneath the pallet. Insure the kidneys, ureters and bladder are in the field of view (FOV) for they are required regions of interest (ROI) for analysis. Position so kidneys are at top of FOV.

Rapidly inject Tc-99m MAG3 agent as a bolus, with a 10 cc saline flush. Start the computer at the time of injection, using predefined study.

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**Important, if you have clipped off the kidneys or clipped off the bladder with space above the kidneys**

- Stop and store the current acquisition at 4 minutes (initial 1 sec/frame acquisition)
- You will set up additional dynamic acquisition at 1 minute per frame for 46 minutes with urinary catheter or 26 minutes without urinary catheter.
- Reposition so the kidneys are at the top of FOV with as much bladder as possible for the rest of the images.

**Pediatrics:** Lasix administered at rate NOT to exceed 5 mg/min.

**Adults:** Lasix administered at rate NOT to exceed 10 mg/min.

*These rate limitations reduce the risk of ototoxicity.*

**Furosemide step with urinary catheter**

- Immediately prior to furosemide injection empty the urine collection bag.
- Give Furosemide at 20 minutes post 99mTcMAG3 injection. At 20 minutes from the start of the furosemide, stop and store images, however, the actual stop time must be a multiple of 5 minutes.
- Adjust catheter to assist bladder emptying as needed and take post void image.
- Empty and measure quantity of urine in the bag.

**Furosemide step without urinary catheter**

- Stop and store initial acquisition at 20 minutes post 99mTcMAG3 injection
- Get patient up to void and quickly get them back on table in as close to the same position, use markers as needed.
  - Note time of off and note the time back on table in terms of post 99mTcMAG3 injection.
  - You do not need to document quantity for this void.
- Start next acquisition
- Give Furosemide at 1 minute into this acquisition. Note the start time of furosemide injection in terms of post 99mTcMAG3 injection.
- At 20 minutes post furosemide, stop and store images, however, the actual stop time must be a multiple of 5 minutes.
- Get the patient up again to void; measure output. Get them back on table in as close to the same position and take post void image.

**\*\*\* ALL non-IV hydrated outpatients will receive one bottle of water upon leaving the section \*\*\***

**Variation:**

If requested this exam can be performed in an upright position being sure to secure the patient and chair for motion.

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### Processing Procedure:

When the patient does not have a urinary catheter, run COMBINEFLOW before GE Renal Analysis.  
This combines EARLYFLOW and LATEFLOW into RENALFLWT and truncates the data to a 5-minute reframed dataset.

**If there was patient motion during the scan, do Motion Correction on RENALFLWT.**

Process using GE Renal Analysis first  
Enter appropriate data in the dialog box  
**\* For pediatric pts: Set pediatric state to “Yes”**  
Draw ROIs for kidneys, bladder, and aorta

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Select proceed  
Screen-cap image that appears next. Renogram Processing Screen

- 
- Select Camera Based Clearance.
    - **Confirm or re-draw** injection site ROI
- 
- Select Review icon
    - Select Renogram QC
    - Select Function QC
      - **Screen-cap** Function QC screen
      - **Select Back**
- 
- Select Dynamic Image Review
    - On film record if pt had catheter
    - **Screen-cap** Dynamic Image Review screen
- 
- Select Renogram Review.
    - **Screen-cap** Renogram Review screen

### **Save and Exit protocol**

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Select **Renal Uptake** protocol from USER applications  
Enter data in dialog box  
Adjust brightness of display images  
Screen-cap uptake screen  
Exit

**NOTE - Adjusting display windows must be done in this order:**  
Set the current or all intensity option for the window leveling tool to “all”.  
Adjust the 5-min flow images and post-void image to desired brightness, same intensity setting.  
Set the current or all option to “Current” and adjust the 5 sec flow images to desired brightness

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### Optional Processing:

Upper and lower poles of right or left kidney per physician request to differentiate the drainage of a kidney's upper and lower poles. Reprocessing may also be needed to evaluate ureteral clearance.

Repeat processing steps using right kidney ROI as upper pole and left kidney ROI as lower pole. Be sure to **appropriately annotate** all save screens: Rt ROI = upper pole; Lt ROI = lower pole. Annotate appropriately if drawing the ureters.

### Data Analysis:

Use predefined protocol GE Renal Analysis + Renal Uptake to obtain relative ERPF, curves, and half washout times. The time selected to determine half washout times should be either time of administration of Lasix or the peak (only if this is later). If there is a response to Lasix within a few minutes after administration, then this should be the peak measurement.

### PACS:

Send to PACS: 1) 1 sec/frame raw data (first 4 minutes), 2) Reframed 1 min/frame of the entire study, 3) Post Void (raw), 4) all Screen Caps noted above. 5) Make a screen cap of the urinary collection bag with annotated markers and send it and the raw image.

### Comments:

A Nuclear Medicine staff or resident physician should be consulted to determine if additional views are indicated.

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**Interpretation:** Furosemide is administered to induce a diuresis. This should be confirmed by measurement of the urine flow rate. If there is no obstruction, merely dilatation, then the total activity in the region will be reduced (the volume will be unchanged, just less concentrated with tracer) and so tracer "washout" will occur.

With obstruction, a continued plateau or an increase in tracer will occur within the ROI. With mere dilatation of the system without obstruction, then tracer washout will be seen. If there is massive dilation of the region then the test may be falsely negative (reduced by performing F-15 scan). Normal values for half washout times have been suggested (>20 minutes being abnormal, <15 minutes normal, 15-20 minute indeterminate). The degree of hydration and renal impairment and presence of ureteric reflux profoundly affects the test. When repeat studies are performed the prior test result should be provided and tests standardized.

If there is a full bladder, test may be falsely abnormal. If catheter in-situ, it may have to be manipulated (call pediatric specialty clinic) or replace it. If this is unsuccessful and the child can void or with removal of catheter, urine is obtained post void. Images should be obtained which may indicate the absence of obstruction.

The report should include information about hydration, Lasix dose, and whether or not a catheter was used.

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Reviewed By: NM Faculty, Residents and Technologists

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Scott B. Perlman, MD, MS  
Chief, Nuclear Medicine

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Derek Fuerbringer, CNMT  
Manager, Nuclear Medicine  
University Hospital

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Kandace Nowakowski  
Manager, Nuclear Medicine  
The American Center

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John Vetter, PhD, DABR  
Medical Physicist

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Scott Knishka, RPh, BCNP  
Radiopharmacist

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Taylor AT. Radionuclides in Nephrourology, Part 2: Pitfalls and Diagnostic Applications. J Nuc Med 2014; 55:786-798.

Shulkin BL, Mandell GA, Cooper JA, et al. Procedure guideline for diuretic renography in children 3.0. J Nucl Med Technol 2008;36(3):162-168.

Infinia GE Lasix Renal Protocols, acquisition and processing.  
Society of Nuclear Medicine Procedure Guidelines

Appendix 1: **Kidney Flow/Function with Diuretic Worksheet:** Attached below (next page) is a work in progress and may be modified outside the protocol review process. See the forms folder in tech area for the most current.

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### Kidney Flow/Function with Diuretic Worksheet

Date of Study: \_\_\_\_\_ Creatinine: \_\_\_\_\_ mg/dL

Patient: \_\_\_\_\_ Date of Creatinine: \_\_\_\_\_

MR#: \_\_\_\_\_ Diuretic/ACE Inhibitors? Yes No

DOB: \_\_\_\_\_ IV Contrast Day of or Prior?: Yes No

Oral Hydration: Yes No Other: \_\_\_\_\_

**UWHC Normal Range:**  
Peds: 0.30-0.65 mg/dL  
Adults: 0.55-1.02 mg/dL

Height: \_\_\_\_\_ cm

Weight: \_\_\_\_\_ kg

Urinary Catheter: Yes No Other: \_\_\_\_\_

- If Yes → Draining Properly? Yes No

Before Tc-MAG3, O.K. to give Lasix per NM Faculty or Resident:

Dose of 99Tc-MAG3: \_\_\_\_\_ mCi Administered @: \_\_\_\_\_

Time of Patient Void/Catheter Emptied Pre-Lasix: \_\_\_\_\_

Time of Scan Restart: \_\_\_\_\_

Time Lasix Given: \_\_\_\_\_ min

Amount of Lasix Given: \_\_\_\_\_ mg

Time of Post-Scan Void: \_\_\_\_\_

Total Time Pre-Lasix Void to Post-Void: \_\_\_\_\_ min

Volume Urine Output: \_\_\_\_\_ mL

#### Tech Notes: