Rate this Article

Email to a Colleague

Get CME/CE for article

Nephrostomy

Last Updated: January 31, 2006

Synonyms and related keywords: nephrostomy, percutaneous renal access, renal drainage, percutaneous endourology, urinary drainage

AUTHOR INFORMATION Section 1 of 10 Next

Author Information Introduction Indications Relevant Anatomy And Contraindications Workup Treatment Complications Future And Controversies Pictures Bibliography

Author: **Stefan H Hautmann, MD**, Assistant Professor, Department of Urology, University Hospital Kiel, Germany

Coauthor(s): **Raymond J Leveillee, MD**, Associate Professor, Department of Urology, University of Miami School of Medicine; Chief, Division of Endourology/Laparoscopy and Minimally Invasive Surgery, Department of Urology, Jackson Memorial Hospital

Editor(s): **Raymond Rackley, MD**, Professor of Surgery, Cleveland Clinic Lerner College of Medicine at CWRU; Co-Section Head, Section of Voiding Dysfunction and Female Urology, Glickman Urological Institute, Cleveland Clinic Foundation; **Francisco Talavera, PharmD, PhD**, Senior Pharmacy Editor, eMedicine; **Shlomo Raz, MD**, Professor, Department of Surgery, Division of Urology, University of California at Los Angeles School of Medicine; **J Stuart Wolf, Jr, MD**, Director of Michigan Center for Minimally Invasive Urology, Associate Professor, Department of Urology, University of Michigan Medical Center; and **Stephen W Leslie, MD, FACS**, Founder and Medical Director, Lorain Kidney Stone Research Center; Clinical Assistant Professor, Department of Urology, Medical College of Ohio; Chief Editor - eMedicine Urology

Disclosure

INTRODUCTION Section 2 of 10 Back Top Next

Author Information Introduction Indications Relevant Anatomy And Contraindications Workup Treatment Complications Future And Controversies Pictures Bibliography

The term nephrostomy refers to a passageway maintained by a tube, stent, or catheter that perforates the skin, passes through the body wall and renal parenchyma, and terminates in the renal pelvis or a calyx.

Quick Find

Author Information
Introduction
Indications
Relevant Anatomy And Contraindications
Workup
Treatment
Complications
Future And Controversies
Pictures
Bibliography

Click for related images.

Continuing Education

CME available for this topic. Click here to take this CME.

Patient Education

Click here for patient education.

The nephrostomy has multiple functions but most commonly is used to provide urinary drainage when the ureter is obstructed and retrograde access is inadvisable or impossible. It also can be used to gain access to the upper urinary tract for various antegrade endourologic procedures, such as intracorporeal lithotripsy, chemical stone dissolution, and antegrade radiologic studies of the ureter, as well as double-J stent placement.

Nephrostomy has several other functions, including the following:

- An avenue to remove or dissolve renal calculi
- To obtain direct access to the upper urinary tract for various endourologic procedures
- To diagnose ureteral obstruction, filling defects, and anomalies through antegrade radiography
- To deliver chemotherapeutic agents to the renal collecting system
- In tumors of the renal pelvis as prophylaxis after resection for local chemotherapy

Blood serum creatinine levels can help evaluate obstruction and dilatation of the renal pelvis. If creatinine is elevated, the obstruction of the renal pelvis is relevant to the kidney function. However, in all patients, nephrotoxic substances should be excluded as a source of renal failure. A renal scan is helpful in borderline cases when the renal pelvis is normal or minimally dilated and the creatinine is elevated slightly above normal levels.

To determine whether an obstruction is new or old, the patient's history is essential. Old films or ultrasound findings also can be helpful. Most commonly, renal stones cause acute obstruction, whereas renal or ureteral tumors and postoperative and radiation strictures of the ureter cause chronic obstruction. Those cases of chronic obstruction usually will be the reason for an old event of renal failure.

The most dangerous cases of renal obstruction are associated with patients who have urosepsis with renal obstruction and elevated creatinine. In those cases, fast renal access can save the patient's life. However, as with any procedure, the patient's general situation and prognosis must be evaluated prior to the procedure.

Tumors, such as sarcomas, ovarian tumors, and other retroperitoneal tumors (Ormond disease, intraperitoneal tumors), can compress the ureter. A nephrostomy can be required in all those incidents. Do not attempt retrograde access if a tumor spill or vascular lesion is likely to occur. Depending on the anatomical situation of the stricture, patients with ureteral strictures after vascular surgery, eg, for an aortofemoral bypass, should have a nephrostomy placed.

Anatomical anomalies, such as an ureteropelvic junction (UPJ) obstruction, can create difficulty in retrograde access. Tumors or strictures that compress the ureter completely make retrograde access to the kidney difficult and sometimes impossible. Passing a stent or guide-wire antegrade rather than retrograde can be easier, because a cystoscopy is not needed when using the antegrade access to the ureter.

History of the Procedure: In 1912, Hugh Hampton Young passed a pediatric cystoscope percutaneously into a massively hydronephrotic kidney. Willard Goodwin, MD, described percutaneous access and nephrostomies in 1955. In 1976, a percutaneous nephrostomy was performed by Fernstroem and Johannson for the specific purpose of removing a kidney stone. In 1979, Smith and colleagues, from the University of Minnesota, began to remove stones in the renal pelvis and the ureter through percutaneous nephrostomy tracts (Image 3). In 1981, Alken and colleagues, who were working in Germany, removed stones through matured percutaneous tracts.

Problem: Nephrostomy involves creating an opening into the kidney to maintain temporary or permanent urinary drainage. The procedure is performed by puncturing the collecting system of the kidney percutaneously with a needle under fluoroscopic, ultrasound, or CT scan guidance. The needle passes through the skin, subcutaneous tissue, external and internal muscle layers, and the renal parenchyma to

reach the collecting system. When the needle has entered the renal collecting system, a guide-wire is passed through the needle into the kidney and possibly down the ureter. Over the guide-wire, various dilators can be used to establish and enlarge the nephrostomy tract, which then is maintained by a tube.

Alternatively, a nephrostomy tube can be placed during open surgery. In this procedure, a tube is placed into the renal pelvis, perforating the renal parenchyma and puncturing the flank musculature, subcutaneous tissues, and skin to create a direct passage between the renal collecting system and the external environment.

Anesthetic agents can be more hazardous in patients with overt renal shock. Therefore, performing the nephrostomy under local anesthesia is especially important in those patients for whom the procedure is potentially life saving.

Clinical: Symptoms of upper urinary tract obstruction can include flank or abdominal pain, nausea, vomiting, fever, or mild-to-severe urosepsis, including septic shock. Patients with calculi may be asymptomatic.

Percutaneous nephrostomy sometimes is essential, if not life saving, in the treatment of acute or chronic upper urinary tract obstruction. It is the first step in obtaining antegrade access to the kidney for various procedures. Specific indications for percutaneous nephrostomy include the following:

- Acute or chronic upper urinary tract obstruction with inability to obtain access to the kidney from the lower urinary tract due to stones, infections, tumors, or anatomic anomalies, especially in a situation when a double-J stent cannot be placed through the ureter due to above-mentioned circumstances
- In those cases in which a patient's creatinine level is rising above normal levels and the urine cannot be drained through the ureter
- Renal pelvis disorders, eg, UPJ obstruction, horseshoe kidneys, ureter duplex, ureter fissures, in patients with 2 collecting systems of the kidney
- Hydronephrosis in renal transplant allografts: When the dilation of the renal pelvis has an influence on the kidney function such that a double-J stent is difficult to place or cannot be placed at all, the percutaneous nephrostomy may be an easier option.
- Treatment of staghorn calculi and large or lower pole kidney stones (when a percutaneous nephrolithotomy [PCN] is likely to be followed because of the stone burden and an extracorporal shock-wave lithotripsy [ESWL] is less likely to be successful)
- Contraindications to ESWL, ie, size of patient: Most ESWL units have a weight limit of 140 kg (~300 lb).
- Body habitus not allowing ESWL, eg, contractures: Patients who are handicapped sometimes cannot be positioned on an ESWL unit in a prone or supine position.
- Stones or tumors associated with distal obstruction or foreign body that cannot be removed through the ureter (Image 3)
- When rapid dilation of the nephrostomy tract is required, eg, if an access is needed instantly for operative procedures within the collecting system of the kidney (for stone removal or tumor ablation)

- Sequential dilation over a longer period: Gradually increasing the size of the catheter may be necessary when the nephrostomy tube is a permanent solution of urine drainage in patients in whom a retrograde access to the kidney cannot be achieved (eg, advanced metastatic tumors, loss of the total ureter, patients with a palliative nephrostomy tube whose cases are inoperable).

RELEVANT ANATOMY AND CONTRAINDICATIONS

Relevant Anatomy: The kidneys are paired retroperitoneal organs below the diaphragm—below the liver on the right and below the spleen on the left. The kidney is located at the level of the 10th to the 12th ribs. The kidney's major parts are the renal cortex and medulla, renal pelvis, renal papillae, renal pyramids, ureter, renal artery, and renal vein (see Image 1). A fat capsule, the fascia of Gerota, surrounds the kidney. Brödel line also has historical interest. The minor renal calyces come together to the major renal calyces and make up the renal pelvis. The following organs supply blood to the kidney, in descending order: renal artery, interlobar artery, arcuate artery, intralobular artery, afferent arterioles, and glomerulus. All arterioles end arteries without communication, which is important for a possible embolization.

Contraindications:

- Bleeding diathesis (eg, hemophilia, thrombocytopenia) and uncontrolled hypertension
- Anticoagulant use (eg, aspirin, heparin, warfarin)

WORKUP

Lab Studies:

- Bleeding time as indicated
- Prothrombin time
- Platelet count
- Activated partial thromboplastin time (aPTT)
- CBC count
- Urine culture
- Electrolytes
- Creatinine

Imaging Studies:

- Any of the following studies can be used to assess patient anatomy:
  - Intravenous pyelogram (IVP)

- Abdominal computed tomography (CT) scan (see Image 4 and Image 5)
- Renal ultrasound

TREATMENT

Medical therapy: Evaluation can be conducted on an outpatient basis if the patient's medical condition permits. Inpatient studies and surgical treatment may be necessary in emergencies or for unstable patients.

- Medications
  - Most patients should receive broad-spectrum parenteral antibiotics.
  - If drugs are administered, the authors recommend cephalosporin or a combination of penicillin and aminoglycoside prior to the procedure, depending on the patient's allergies.
  - In pediatric patients, adjust antibiotics for age and weight.
  - Drug contraindications include corresponding drug allergies and urinary tract infection in an elective setting, hepatic failure, and renal failure.
- Pregnancy: During pregnancy, the indication for performing a nephrostomy has to be limited to selected individuals only, such as those with obstruction of the kidney with symptoms and an inability to access the kidney from the bladder.
- Consultations
  - Nephrologist, for possible dialysis
  - Oncologist, for prognosis and survival of patients with oncologic causes for urinary tract obstruction
  - Surgeon and gynecologist for urinary tract obstruction due to disorders in their respective fields

Preoperative details:

- No special diet is required if surgery is performed under local anesthesia.
- The procedure can be performed under fluoroscopic or ultrasonographic guidance. A CT-guided nephrostomy or placement during open surgery is possible but only rarely used.
- Perform the procedure in the operating room, the fluoroscopy suite, or the ultrasound room.
- Use lead glasses, a thyroid shield, and a lead apron when overhead x-ray is used. Limit fluoroscopy time and cone down the radiation field.
- Several ultrasound transducers can be used (eg, 7.5-MHz transducers). Ultrasound has become the preferred guidance modality in the placement of a percutaneous nephrostomy. Previously, opacifying the renal collecting system by intravenous or retrograde injection of iodinated contrast was necessary to allow fluoroscopic visualization. Use of ultrasound reduces both the amount of radiation and the possible complications of intravenous administration. Furthermore, the real-time, multidimensional imaging reduces procedure time, allows visualization of adjacent structures, and reduces the possibility of iatrogenic trauma. Following placement of the nephrostomy needle, the procedure can be completed under ultrasound; more commonly, the collecting system is opacified directly, and the procedure is completed under fluoroscopy.
- Even if the kidney has limited hydronephrosis and still needs nephrostomy, ultrasound can be used to identify the collecting

system of the kidney.

- Proper selection of the appropriate calyx is vital in nephrostomy tube placement to allow access to various parts of the kidney. If the tube is placed too low, it may be difficult to access the ureter, which is reached better from an upper pole calyx.
- Failed access can be a problem at times. If the nephrostomy placement is not in an emergency situation, wait a few hours (or even days) until the dilatation of the renal collecting system has increased to facilitate the puncturing of the collecting system.
- Usually, the nephrostomy tract matures within a few weeks; therefore, after removal of the tube after maturation, the nephrostomy remains open for hours to days. Whenever a tube is removed after a long time, place a pressure dressing to cover the skin and tract defect.

Intraoperative details:

- Always achieve adequate visualization of the calices.
- Identify a posterior calyx for puncture that provides access to the appropriate segment of the kidney for anticipated procedures and allows safe creation of a tract.
- Puncture the collecting system of the kidney with a needle below the 11th rib and, preferably, below the 12th rib when feasible.
- Puncture the tip of a posterior calyx from a 20- to 30-degree posterior oblique approach to avoid major blood vessels (eg, renal vein, renal artery).
- The nephrostomy can be placed through any posterior calyx within the kidney.
- A lower pole calyx often is selected for drainage purposes because it usually is infracostal, thereby precluding a pneumothorax/hydrothorax complication (Image 2).
- A supracostal puncture of the middle or upper portion of the kidney may be needed for stone or tumor removal.
- Use 5 mL of lidocaine (1%) for local anesthesia.
- Fluoroscopic guidance can be used for access, but some urologists and radiologists prefer ultrasound guidance (eg, with a 3-MHz or 5-MHz curvilinear transducer), especially until the nephrostomy needle passes into the collecting system.
- After entering the collecting system, withdraw the obturator of the needle. If urine flow is present, use 3-5 mL of contrast to check for proper placement.
- Advance a guide-wire (eg, 0.035 in) into the collecting system.
- Remove the needle with the guide-wire in place.
- Use a fascial incising needle or scalpel to cut the lumbodorsal fascia.
- The tract can be dilated with a plastic fascial dilating catheter passed over the guide-wire (6F, 8F, and 10F catheters). Further dilation of the tract can be necessary if a percutaneous nephrolithotomy is planned.
- A nephrostomy catheter (8-14F) can be put into position over the guide wire; fix it to the skin with a suture or plastic retainer. The catheter size depends on the intended purpose of the nephrostomy. Simple urine drainage can be achieved with an 8F catheter. If the collecting system is punctured for further procedures in the kidney (eg, tumor or stone removal), a larger catheter must be used (14-22F).
- The guide wire can be removed after the nephrostomy catheter has been checked fluoroscopically. If the tube leaks after placement, a larger tube may be used to solve the problem. However, most leakage resolves within a few hours. If the tube falls out, typically it can be replaced through the same tract, if the tract is matured. In freshly placed tubes, a new kidney

puncture may be necessary.

- Use a pigtail with a lock; most nephrostomy catheters have a locking mechanism to prevent displacement.
- As indicated, send the aspirate from a kidney urine specimen for culture.
- Bleeding during nephrostomy placement may be enough to terminate the procedure; however, clamping the tube for 30-40 minutes and administering intravenous diuretics stops most venous bleeding. For arterial bleeding, obtain an angiogram and consider an embolization of the bleeding vessel.
- To preclude kinking, smoothly drape the tube as it exits the skin over a roll of gauze.
- Connect the nephrostomy catheter to a urine bag that can be strapped to the leg.

Postoperative details: After nephrostomy tube placement, most patients will have bloody urine for several hours; usually, the bleeding spontaneously resolves. The nephrostomy tube can be irrigated gently with 5 mL of sodium chloride 0.9%. Clots can be removed from the nephrostomy catheter. Observe for fever if the urine appears cloudy. If the hematuria does not resolve spontaneously, then troubleshoot the nephrostomy as follows:

- If bleeding occurs from around the nephrostomy tube, an additional skin suture may resolve the bleeding.
- If bleeding occurs inside the nephrostomy tube, check the bleeding time and CBC, then consider an arteriogram and possible segmental embolization of the kidney in the interventional radiology department.

Postobstructive diuresis can occur with polyuria (for management, refer to Chronic Renal Failure and Acute Renal Failure). Check blood pressure, blood count, and urine on a regular basis until they become stable. Conditions vary according to individual circumstances.

Follow-up care:

- Further inpatient care may require testing and surgical intervention, which may include nephrolithotomy or reconstructive surgery.
- Most patients can be discharged home the same day as the procedure. Outpatient instructions focus on nephrostomy tube care (eg, change dressing daily, keep dressing dry and clean when showering, avoid submersion).
- Patients should avoid strenuous activity and sports until the nephrostomy tube is removed.

Inpatient and/or outpatient medications

- Prophylaxis with suppressive antibiotics is not recommended.
- Medications include antibiotics (eg, cephalosporin in cases of urinary tract infections) until infection is treated.
- Carefully monitor medication dose and adverse effects and treat infections only when symptomatic.

Common complications

- Perforation of the collecting system (<30%), typically resolves within 48 hours after nephrostomy tube placement, providing that the drainage of the collecting system is established (via nephrostomy tube or ureteral catheter).

- In the patient with an intercostal approach, complications include possible pleural effusion, hydrothorax, or pneumothorax, possibly requiring chest tube placement (<13%).
- Acute bleeding requiring transfusion (<5%): People with bleeding through the nephrostomy tube may require clamping the tube for 30 minutes to 2 hours and consecutive irrigation of the tube with sodium chloride 0.9% after enforced diuresis.
- Failed access (<5%): Attempt access again after the dilatation of the collecting system has increased in the course of hours or days.

Rare complications

- Periorgan injury, including bowel perforation, splenic injury, and liver injury (<1%): Extraperitoneal colon injury and duodenal injury can be managed conservatively by stenting the urinary system and using the percutaneous tube as an enterostomy tube for 48 hours. Remove the enterostomy after that time.
- Intraperitoneal injury that mandates open exploration (<1%)
- Infection leading to septicemia (<1%)
- Significant loss of functioning renal tissue (<1%)
- Delayed hemorrhage (<0.5%): The authors recommend keeping patients overnight with any doubtful or difficult nephrostomy.
- Emergency arterial embolization of the kidney (<0.5%) with arterial bleeding that cannot be stopped: Clamping the nephrostomy tube for a few hours stops most venous bleeding.
- Administration of antihistamines and steroids and use of nonionic or low-osmolar contrast media in cases of known allergic contrast reaction (<0.2%)
- Nephrectomy (<0.2%)
- Mortality (<0.05%)
- Patients with uncontrolled hypertension have a chance of developing a perirenal hematoma or an extensive renal hemorrhage. Use all efforts to control blood pressure.

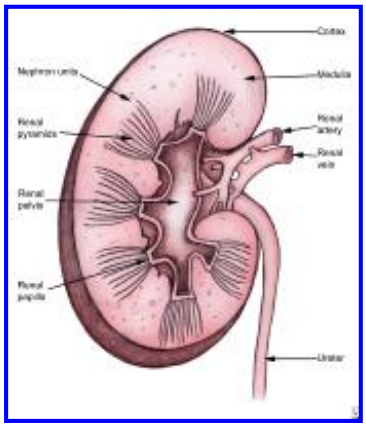
Medical/Legal Pitfalls

- Failure to obtain informed consent on the indications and complications
- Removal of the nephrostomy tube
  - Fluoroscopic guidance may be necessary, especially to ensure proper drainage of urine through the ureter into the bladder prior to nephrostomy removal.
  - A thorough inspection of the catheter is necessary to ensure complete removal.
  - Retained fragments of a catheter predispose the patient to infection and calculi formation.

Acknowledgment

The authors thank E. Russel, MD, and H. Huson, MD, from the Department of Radiology and J. Posey, MD, from the Department of Urology of the University of Miami for their help.

Caption: Picture 1. Renal anatomy.

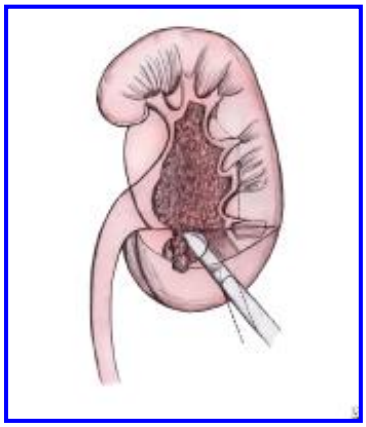


View Full Size Image

eMedicine Zoom View (Interactive!)

Picture Type: Image

Caption: Picture 2. Positioning of nephrostomy tube into the lower pole of the kidney.



View Full Size Image

eMedicine Zoom View (Interactive!)

Picture Type: Image

Caption: Picture 3. Outside appearance of a nephrostomy tube from the flank after stone removal.

View Full Size Image

eMedicine Zoom View (Interactive!)

Picture Type: Photo

Caption: Picture 4. CT scan of bilateral hydronephrotic kidneys without IV contrast medium.

View Full Size Image

eMedicine Zoom View (Interactive!)

Picture Type: CT

Caption: Picture 5. CT scan with dilated right ureter without IV contrast medium.

View Full Size Image

eMedicine Zoom View (Interactive!)

Picture Type: CT

- Alken P, Hutschenreiter G, Günther R, Marberger M: Percutaneous stone manipulation. J Urol 1981 Apr; 125(4): 463-6 [Medline].
- Biyani CS, O'Connor JP, Browning AJ: Laparoscopic removal of retained nephrostomy tubing. J Urol 2003 Sep; 170(3): 916-7 [Medline].
- Bloom DA, Morgan RJ, Scardino PL: Thomas Hillier and percutaneous nephrostomy. Urology 1989 Apr; 33(4): 346-50 [Medline].
- Carson CC, Little N: The absolute and relative contraindications to ESWL. In: Problems in Urology. Vol 1. Philadelphia, Pa: JB Lippincott Co; 1987:580.
- Clayman RV, Kavoussi LR: Endosurgical techniques for noncalculous disease. In: Campbell's Urology. 7th ed . Philadelphia, Pa: WB Saunders Co; 1992:2235-45.
- Coleman CC, Kimura Y, Reddy P: Complications of nephrostolithotomy . Sem Intervent Radiol 1984; 1: 24.
- Fernström I, Johansson B: Percutaneous pyelolithotomy. A new extraction technique. Scand J Urol Nephrol 1976; 10(3): 257-9[Medline].
- Goodwin WE, Casey WC, Woolf W: Percutaneous trocar (needle) nephrostomy in hydronephrosis. J Am Med Assoc 1955 Mar 12; 157(11): 891-4[Medline].
- Grasso M, Loisides P, Beaghler M, et al: The case for primary endoscopic management of upper urinary tract calculi: I. A critical review of 121 extracorporeal shock-wave lithotripsy failures. Urology 1995 Mar; 45(3): 363-71[Medline].
- Grasso MG, Taylor F: Techniques for percutaneous renal access. In: Sosa RE, Albala DM, eds. Textbook of Endourology. Philadelphia, Pa: WB Saunders Co; 1996.
- Kaskarelis IS, Papadaki MG, Malliaraki NE, et al: Complications of percutaneous nephrostomy, percutaneous insertion of ureteralendoprosthesis, and replacement procedures. Cardiovasc Intervent Radiol 2001 Jul-Aug; 24(4): 224-8[Medline].
- Lam HS, Lingeman JE, Mosbaugh PG, et al: Evolution of the technique of combination therapy for staghorn calculi: a decreasing role for extracorporeal shock wave lithotripsy. J Urol 1992 Sep; 148(3 Pt 2): 1058-62[Medline].
- LeRoy AJ, Williams HJ Jr, Bender CE, et al: Colon perforation following percutaneous nephrostomy and renal calculus removal. Radiology 1985 Apr; 155(1): 83-5[Medline].
- Little B, Ho KJ, Gawley S, Young M: Use of nephrostomy tubes in ureteric obstruction from incurable malignancy. Int J Clin Pract 2003 Apr; 57(3): 180-1[Medline].
- Mariappan P, Smith G, Bariol SV, et al: Stone and pelvic urine culture and sensitivity are better than bladder urine as predictors of urosepsis following percutaneous nephrolithotomy: a prospective clinical study. J Urol 2005 May; 173(5): 1610-4

[Medline].

- Motola JA, Smith AD: Therapeutic options for the management of upper tract calculi. Urol Clin North Am 1990 Feb; 17(1): 191-206[Medline].
- Picus D, Weyman PJ, Clayman RV, McClennan BL: Intercostal-space nephrostomy for percutaneous stone removal. AJR Am J Roentgenol 1986 Aug; 147(2): 393-7[Medline].
- Segura JW: Percutaneous management. In: Campbell's Urology. 7th ed. Philadelphia, Pa: WB Saunders; 1992:2183-94.
- Segura JW, Preminger GM, Assimos DG, et al: Nephrolithiasis Clinical Guidelines Panel summary report on the management of staghorn calculi. The American Urological Association Nephrolithiasis Clinical Guidelines Panel. J Urol 1994 Jun; 151(6): 1648-51[Medline].
- Smith AD: Management of iatrogenic ureteral strictures after urological procedures. J Urol 1988 Dec; 140(6): 1372-4 [Medline].
- Tanaka T, Yanase M, Takatsuka K: Clinical course in patients with percutaneous nephrostomy for hydronephrosis associated with advanced cancer. Hinyokika Kiyo 2004 Jul; 50(7): 457-62[Medline].
- Whitaker RH: An evaluation of 170 diagnostic pressure flow studies of the upper urinary tract. J Urol 1979 May; 121(5): 602-4 [Medline].
- Zagoria RJ, Dyer RB: Do's and don't's of percutaneous nephrostomy. Acad Radiol 1999 Jun; 6(6): 370-7[Medline].

Nephrostomy excerpt

About Us | Privacy | Terms of Use | Contact Us | Advertise | Institutional Subscribers