American College of Radiology
ACR Appropriateness Criteria®

Radiologic Management of Urinary Tract Obstruction

Variant: 1 Urinary diversion after remote history of cystectomy for cancer. No fever, normal white blood cell (WBC) count and urine output. Loopogram shows no reflux into distal ureters. CT shows new moderate bilateral hydronephrosis.

Procedure	Appropriateness Category
PCN (includes PCNU)	Usually Appropriate
PCN (includes PCNU) followed by delayed surgery	Usually Appropriate
Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)	May Be Appropriate
Retrograde ureteral stenting	May Be Appropriate
Medical management without decompression	Usually Not Appropriate

Variant: 2 Seven-day history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. CT scan shows a 10 mm calculus in the mid right ureter without hydronephrosis.

Procedure	Appropriateness Category
Retrograde ureteral stenting	Usually Appropriate
PCN (includes PCNU)	May Be Appropriate
PCN (includes PCNU) followed by delayed surgery	May Be Appropriate
Medical management without decompression	Usually Not Appropriate
Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)	Usually Not Appropriate

Variant: 3 Pregnant patient (20+ weeks) with 3-day history of left flank pain, fever, and leukocytosis. Urinalysis positive for infection. Ultrasound shows new, moderate left hydronephrosis.

Procedure	Appropriateness Category
Retrograde ureteral stenting	Usually Appropriate
PCN	Usually Appropriate
Medical management without decompression	Usually Not Appropriate
Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)	Usually Not Appropriate
PCN followed by delayed surgery	Usually Not Appropriate

Variant: 4 Advanced cervical carcinoma with decreased estimated glomerular filtration rate <15. Normal WBC, positive pelvic pressure, no flank pain. CT scan reveals new bilateral hydronephrosis and hydroureter that is due to local invasion by a pelvic mass.

Procedure	Appropriateness Category
PCN (includes PCNU)	Usually Appropriate
Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)	Usually Appropriate
Retrograde ureteral stenting	Usually Appropriate
PCN (includes PCNU) followed by delayed surgery	May Be Appropriate
Medical therapy without decompression	Usually Not Appropriate

Variant: 5 **Prolonged history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. Patient appears septic and is hypotensive. CT scan shows dilated right ureter and renal pelvis with perinephric stranding. No etiology for ureteral obstruction identified with current imaging.**

Procedure	Appropriateness Category
PCN (includes PCNU)	Usually Appropriate
Retrograde ureteral stenting	May Be Appropriate
PCN (includes PCNU) followed by delayed surgery	May Be Appropriate
Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)	Usually Not Appropriate
Medical therapy without decompression	Usually Not Appropriate

Variant: 6 **Urinary ascites after recent abdominal surgery. Elevated blood urea nitrogen or creatinine, moderate abdominal pain, and no peritoneal signs. CT urogram reveals contrast leak from left pelvic ureteral injury. Current therapy consists of Foley catheter in the bladder.**

Procedure	Appropriateness Category
PCN (includes PCNU)	Usually Appropriate
Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)	Usually Appropriate
PCN (includes PCNU) followed by delayed surgery	Usually Appropriate
Retrograde ureteral stenting	Usually Appropriate
Medical therapy without decompression	Usually Not Appropriate

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Summary of Literature Review

Introduction/Background

Acute obstructive uropathy is a medical emergency that often is accompanied by acute renal failure or sepsis. In use for more than 60 years [1], percutaneous nephrostomy (PCN) catheter placement provides access into the renal collecting system for urinary decompression and, more recently, facilitates endourologic surgery. PCN was originally performed with limited imaging guidance, and its acceptance was therefore marginalized. Over the ensuing decades, with the improvement in catheters and interventional radiological techniques and the standard use of imaging guidance, the procedure has become increasingly safe. Over this same period, the procedure itself has been performed with increasing frequency as indications have expanded. PCN access entails placing a drainage catheter into the renal collecting system and typically uses imaging guidance and the Seldinger needle-wire technique. The catheter permits either external urinary decompression (external PCN catheter) or internal drainage through the ureter and bladder by a longer internal ureteral catheter component (percutaneous nephroureteral catheter, or percutaneous internal/external nephroureteral [PCNU]). The following are the most common

procedural indications for PCN along with its subsequent success and complication rates. Overall, PCN placement is proven to be a safe and effective technique with limited morbidity and mortality [2].

Special Treatment Considerations

Retrograde nephrostomy catheter placement has been described [3], but experience with this technique is very limited and rarely performed relative to antegrade nephrostomy placement. Subcutaneous urinary diversion is occasionally used in patients who have malignant obstructions [4]. Open surgical nephrostomy tube placement is rarely used [5,6]. Interestingly, in a recent opinion survey conducted in the United Kingdom, PCN was favored more often by urologists than by radiologists (mean of 69% versus 48%, respectively) for the treatment of uncomplicated obstructive nephropathy [7].

In the majority of cases, a ureteral stent can be placed, either via the bladder or via the kidney, after nephrostomy. In special situations, combined procedures with "rendezvous" techniques or even a 1-step antegrade stent [8] placement (without leaving the nephrostomy as a safety measure) can yield similar successful alternative approaches. Standard plastic, as well as newer, metal/reinforced stents, have been used with similar results [9,10]. Tandem double-J ureteral stents have also been used to treat malignant ureteral obstruction [11].

Discussion of Procedures by Variant

Variant 1: Urinary diversion after remote history of cystectomy for cancer. No fever, normal white blood cell (WBC) count and urine output. Loopogram shows no reflux into distal ureters. CT shows new moderate bilateral hydronephrosis.

Variant 1: Urinary diversion after remote history of cystectomy for cancer. No fever, normal white blood cell (WBC) count and urine output. Loopogram shows no reflux into distal ureters. CT shows new moderate bilateral hydronephrosis.
A. Medical management without decompression

Without evidence of declining renal function or infection, conservative management could be considered until the clinical status changes.

There is no relevant literature regarding the use of conservative medical management in the evaluation of obstructive uropathy.

Variant 1: Urinary diversion after remote history of cystectomy for cancer. No fever, normal white blood cell (WBC) count and urine output. Loopogram shows no reflux into distal ureters. CT shows new moderate bilateral hydronephrosis.
B. PCN (includes PCNU)

If there is evidence of declining renal function or pyonephrosis and if a loopogram demonstrates no evidence of reflux into the distal ureters suggesting inherent stricture, PCN may be beneficial. When performed with image guidance, the technical success rate for PCN placement approaches 100%, as demonstrated by a large UK registry with data from over 3,000 PCN procedures [15-18]. More conservative thresholds have suggested that the technical success of PCN is >95% when accessing dilated collecting systems and approximately 80% to 90% when accessing nondilated systems [19].

The Society of Interventional Radiology quality improvement (SIR QI) guidelines set threshold percentages for technical success rates for PCN at 95% for urinary obstruction without stones, including renal transplant obstruction [20]. For nondilated collecting systems, SIR QI set the threshold for technical success rate at 80%, and for complex stone disease including staghorn calculus, it set the minimal threshold at 85% [20]. Although often performed as an inpatient procedure, PCN can be performed safely in selected low-risk patients as an outpatient procedure with same-day discharge [21]. Most operators use ultrasound [22] for initial access and then fluoroscopy to place the nephrostomy tube. Additional imaging modalities have included CT and MRI in special circumstances.

Complication rates related to PCN are low in most series and are usually reported at ≤10% [16,23,24]. A UK registry data showed an even lower rate of 6.3% [15], although much higher rates have been reported in patients who have advanced malignancies [25]. The SIR QI guidelines have suggested thresholds for PCN complications, including septic shock at 4%, septic shock in pyonephrosis at 10%, hemorrhage requiring transfusion following PCN alone at 4%, hemorrhage requiring transfusion following percutaneous nephrolithotomy at 15%, vascular injury requiring embolization or nephrectomy at 1%, bowel injury at <1%, pleural complications with PCN (pneumothorax, empyema, or hemothorax) at 1%, and pleural complications from percutaneous nephrolithotomy at 15% [20].

Adverse events are attributed mostly to catheter displacement, bleeding, and sepsis [15]. Potential risk factors for postprocedural sepsis include diabetes and renal calculi, but these have not been shown to be predictive of postprocedural infection [16].

Clinically asymptomatic bleeding is a common finding. Mild hematuria is present in approximately 50% of patients after PCN [15,26]. Clinically significant bleeding, either into the collecting system or into the retroperitoneum, is less common [15,16,24,27]. Bleeding occurs more commonly in patients who have thrombocytopenia [16]. Persistent bleeding should prompt consideration of arteriographic evaluation for renal artery abnormality, such as pseudoaneurysms, fistulas, or frank extravasation. These vascular injuries can usually be treated using transcatheter embolization.

Less common complications related to PCN include bowel injury [28], splenic injury [29], gallbladder puncture, and pneumothorax [16]. Pneumothorax is more common when an upper-pole calyceal puncture is used [16], but occasionally such an intercostal approach may be necessary to allow optimal access for stone removal. In uroepithelial neoplasms, tumor growth along the nephrostomy tract has been reported but is believed to be a very uncommon phenomenon. As with any indwelling drainage catheters, PCN tubes are subject to fracture, dislodgement, and occlusion [30].

Variant 1: Urinary diversion after remote history of cystectomy for cancer. No fever, normal white blood cell (WBC) count and urine output. Loopogram shows no reflux into distal ureters. CT shows new moderate bilateral hydronephrosis.
C. PCN (includes PCNU) followed by delayed surgery

Surgical revision or re-anastomosis of the ureteral-ileal conduit stricture should be considered for definitive therapy. PCN can be placed for decompression prior to definitive surgical therapy when the patient becomes an appropriate candidate. Brush biopsy should also be considered at the time of intervention to confirm benign stricture. Surgical management historically has included

exploratory open or laparoscopic exploratory laparotomy, excision of the strictured ureteral segment, and reimplantation of the viable ureter to the intestinal conduit. The resulting success rates ranged between 76% and 92% [14]. However, this is a major operation with significant morbidity, including wound infections, vascular injuries, and gastrointestinal complications [14,32]. However, over the past several decades, treatment and surgical options have changed with more aggressive use of endoscopic and radiological techniques, including balloon dilatation, endoureterotomy, and metal stents. Poor long-term patency rates of available endourological options should be weighed against the increased morbidity associated with repeat open surgery.

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D. Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)

Internalized double-J ureteral stents alone are likely to quickly become occluded within the ileal loop because of mucus production. Therefore, as mentioned previously, routine multistage therapy involves placement of a diverting PCN or antegrade nephroureteral catheter, followed by fluoroscopically guided conversion to a transileal retrograde nephroureteral catheter. In one study, technical success was achieved in 56 of 61 renal units (91.8%) [31]. Clinical success, which was defined as resolution of creatinine elevation, urosepsis, and pain associated with hydronephrosis, occurred in 44 of 49 patients (89.8%) with a mean clinical follow-up of 22 months with only minor complications observed, including tube dislodgement [31].

Variant 1: Urinary diversion after remote history of cystectomy for cancer. No fever, normal white blood cell (WBC) count and urine output. Loopogram shows no reflux into distal ureters. CT shows new moderate bilateral hydronephrosis.
E. Retrograde ureteral stenting

A retrograde approach after urinary diversion avoids the morbidity associated with percutaneous access, but other challenges exist including crossing the ureteroenteric anastomosis. Retrograde access is often initially attempted, either by radiological or endoscopic guidance, but success is limited. It can be difficult to visualize the ureteric opening in the bowel conduit, and if identified adequately, navigating the angulations and curvature associated with the new anatomy can be difficult. More flexible endourologic instruments are necessary. Therefore, there are limited reported cases of its use, and urologists usually prefer image-guided percutaneous antegrade access with either immediate (1-step) or delayed (2-step) conversion to retrograde percutaneous nephroureterostomy [12-14]. Additionally, retrograde PCNU catheters are generally preferred over retrograde "internal" double-J ureteral stents because the latter tend to occlude quickly because of mucous plugging within the ileal conduit.

Variant 2: Seven-day history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. CT scan shows a 10 mm calculus in the mid right ureter without hydronephrosis.

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A. Medical management without decompression

In the setting of obstructing stone disease with sepsis, medical management is mostly indicated for preprocedure antibiotic treatment and postprocedural care. Without evidence of obstruction in

this clinical scenario, medical management with fluids and intravenous antibiotics, and close clinical and imaging follow-up could be considered. Retrograde ureteral or antegrade access will likely be required for definitive therapy of the mid-ureteral stone.

Variant 2: Seven-day history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. CT scan shows a 10 mm calculus in the mid right ureter without hydronephrosis.

B. PCN (includes PCNU)

Acute ureteral obstruction is most commonly related to stone disease and accounts for as many as one-fourth of PCNs performed [16]. Although currently not demonstrating signs of obstruction given lack of hydronephrosis, the patient requires close clinical and imaging follow-up to ensure stone passage. PCN would be indicated in the case of failed retrograde ureteral stenting.

A prospective, randomized, controlled trial of hydronephrosis secondary to stone disease was conducted to compare PCN with retrograde double-J stenting. The technical success rates were 80% for retrograde stenting compared with 100% for PCN. In addition, the dwell time for the PCN tubes was significantly shorter than that for the double-J ureteral stent [42]. Although some ureteral stones will pass spontaneously with a nephrostomy tube in place, many will not. In these scenarios, PCN access can be a conduit for definitive antegrade ureteral stone treatment [43]. Additionally, some patients may be too ill to undergo definitive stone treatment/removal.

Recently, a prospective randomized trial demonstrated safety and efficacy of emergent nephrolithotomy compared with diverting PCN in the initial management of obstructing ureteropelvic stone disease in the setting of related sepsis. The length of hospital stays (in days) was 10.09 ± 3.43 for the emergency PCN group and 8.18 ± 2.72 for the percutaneous nephrolithotomy group. There was no difference in complication rates or time to normalization of temperature, white blood cell (WBC) count, and C-reactive protein levels [44].

Variant 2: Seven-day history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. CT scan shows a 10 mm calculus in the mid right ureter without hydronephrosis.

C. PCN (includes PCNU) followed by delayed surgery

Because endourologic approaches have replaced some conventional open surgical procedures, the indications for PCN and nephroureteral catheter access have expanded to facilitate these procedures. PCN has been shown to be useful in obtaining access for stone interventions [27,28,43], particularly when the stone burden is so large that extracorporeal shock-wave lithotripsy is unlikely to completely fragment and eradicate the stone disease. The ease or complexity of percutaneous stone removal depends on precise nephrostomy access [27,28], which occasionally necessitates high intercostal space access with an associated small increase in risk for pleural effusion or pneumothorax development. Similarly, PCN access has been shown to be helpful for endopyelotomy, which affords less morbidity and shorter recovery times than open pyeloplasty for ureteropelvic junction stenoses.

Risk of systemic inflammatory response syndrome following percutaneous nephrolithotomy has been shown to correlate with the number of tracts, receipt of a blood transfusion, stone size, and presence of pyelocaliectasis [45].

Variant 2: Seven-day history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. CT scan shows a 10 mm calculus in the mid right ureter without

hydronephrosis.

D. Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)

If placement of retrograde double-J ureteral stent is unsuccessful, antegrade ureteral stenting may be considered; however, prolonged guidewire and catheter manipulation while obtaining access or attempting to traverse the obstructing stone can lead to increased incidence of urosepsis. This can be minimized by limiting the degree of manipulation during initial access for decompression of the infected collecting system. The patient must be monitored closely intraprocedure and immediately postprocedure for signs of worsening sepsis.

Variant 2: Seven-day history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. CT scan shows a 10 mm calculus in the mid right ureter without hydronephrosis.

E. Retrograde ureteral stenting

Cystoscopic retrograde ureteral decompression with double-J stents prior to definitive ureteroscopic stone extraction should be considered. Decompression of the collecting system in cases of sepsis can be managed safely and effectively with ureteroscopic management [33,34]. In cases of acute ureteral obstruction, extracorporeal shock-wave lithotripsy and retrograde double-J ureteral stenting have been shown to be more successful for complete stone eradication and passage than simple nephrostomy placement [35]. Therefore, this method is no longer considered contraindicated for treatment in patients with obstructing stones. Those treated with PCN are more likely to receive definitive treatment for their stones via a percutaneous approach and those with double-J ureteral stents via an ureteroscopic approach.

Compared with PCN, retrograde ureteral catheters may be associated with a higher risk of urosepsis in some patients who have an extrinsic ureteral obstruction [36]. PCN may be the preferred option in patients at high risk for anesthesia, or in a setting such as pyonephrosis, when larger tube decompression may be warranted [37-39].

A randomized comparative study comparing double-J ureteral stent placement versus PCN demonstrated no significant difference between the PCN and double-J-stent groups in regard to the operative and imaging times, the period for return to a normal creatinine level, and failure of insertion. The number of subsequent interventions was significantly higher in the PCN group, especially in patients with bilateral stones destined for chemolytic dissolution (alkalinisation) or extracorporeal shockwave lithotripsy [40]. Ureteral stent placement has been shown to be safe and effective in the presence of obstructing ureteral stones and sepsis with an overall decreased duration of hospital stay and intensive care unit admission rate compared with PCN placement [33,41]; however, these patients did experience a higher rate of documented fever.

Variant 3: Pregnant patient (20+ weeks) with 3-day history of left flank pain, fever, and leukocytosis. Urinalysis positive for infection. Ultrasound shows new, moderate left hydronephrosis.

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A. Medical management without decompression

Hydronephrosis is common in the later stage of pregnancy, usually caused by external compression on the ureter by the enlarging uterus. If the hydronephrosis was thought to be

caused by stone disease, without evidence of infection, medical management with adequate rest, hydration, antiemetics, and analgesia can be employed with a 70% to 80% success rate [46].

The most significant risk of urolithiasis during pregnancy is that it may induce preterm labor. The risk completely ceases once the stone passes or has been removed.

Variant 3: Pregnant patient (20+ weeks) with 3-day history of left flank pain, fever, and leukocytosis. Urinalysis positive for infection. Ultrasound shows new, moderate left hydronephrosis.
B. PCN

Hydronephrosis in pregnancy can often be seen after week 20 as the enlarging uterus compresses the ureter. It is also thought that hormonal changes contribute to this by reducing ureteric peristalsis. However, obstructive uropathy, which is most commonly due to stones, can occur. Although many small stones pass spontaneously, urinary tract intervention is occasionally necessary. In settings in which ureteral catheterization is not technically possible, PCN can safely provide temporary urinary tract decompression, although the data are from small observational series [47-50]. The incidence of spontaneous abortion or preterm labor related to PCN tube placement is exceedingly low [48-51]; however, because of the small sample sizes, this issue requires further study [52].

To limit radiation to the fetus, PCN can sometimes be performed using ultrasound guidance alone, thus obviating the need for radiation [50]. In many cases, however, fluoroscopy will be necessary to safely place the catheter [48]. Usually, nephrostomy catheters are left in place until after delivery, and definitive stone intervention is then performed postpartum [48,50,51].

Variant 3: Pregnant patient (20+ weeks) with 3-day history of left flank pain, fever, and leukocytosis. Urinalysis positive for infection. Ultrasound shows new, moderate left hydronephrosis.
C. PCN followed by delayed surgery

See above regarding PCN tube placement. Usually nephrostomy catheter remains in place until after delivery, at which time definitive intervention can be performed, particularly to remove an obstructing stone.

Variant 3: Pregnant patient (20+ weeks) with 3-day history of left flank pain, fever, and leukocytosis. Urinalysis positive for infection. Ultrasound shows new, moderate left hydronephrosis.
D. Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)

There is no relevant literature regarding percutaneous antegrade ureteral stenting in the treatment of pregnant patients with hydronephrosis. However, inherently in the setting of infection, less is more. Placement of an antegrade ureteral stent or PCNU requires increased fluoroscopy time and radiation dose to the fetus. Additionally, prolonged manipulation in the setting of an active infection can lead to systemic inflammatory response syndrome or urosepsis.

Variant 3: Pregnant patient (20+ weeks) with 3-day history of left flank pain, fever, and leukocytosis. Urinalysis positive for infection. Ultrasound shows new, moderate left hydronephrosis.
E. Retrograde ureteral stenting

With minimal radiation to the fetus and significant advancement in ureteroscopy for both diagnostic and therapeutic purposes, retrograde stenting of the ureter remains an attractive

treatment option for pregnant patients with obstructive uropathy. Fluoroscopy during retrograde ureteral stenting is usually avoided in pregnant patients and therefore confirmation of appropriate intraoperative stent positioning may be limited, similar to that of PCN, and may require ultrasound guidance. Improved imaging resolution and smaller caliber scopes have made the procedure safe and feasible. Complications include ureteral injury, perforation, or sepsis that could lead to preterm labor.

Several small case reports have demonstrated the effective use of rigid and flexible ureteroscopy during all trimesters of pregnancy [46].

Variant 4: Advanced cervical carcinoma with decreased estimated glomerular filtration rate <15. Normal WBC, positive pelvic pressure, no flank pain. CT scan reveals new bilateral hydronephrosis and hydroureter that is due to local invasion by a pelvic mass.

Although PCN and nephroureteral stent placement can provide urinary diversion in a variety of obstructing pelvic neoplasms, most of the literature addresses gynecological malignancies, such as cervical cancer, for which ureteral obstruction is a relatively frequent complication.

Variant 4: Advanced cervical carcinoma with decreased estimated glomerular filtration rate <15. Normal WBC, positive pelvic pressure, no flank pain. CT scan reveals new bilateral hydronephrosis and hydroureter that is due to local invasion by a pelvic mass.
A. Medical therapy without decompression

Conservative management is usually reserved for palliative purposes and comfort care and does not address the underlying etiology of the patient's obstructive uropathy. Stratification of prognosis based on risk factors related to the patient's malignancy may help guide medical management based on 6-month survival rates [53].

Variant 4: Advanced cervical carcinoma with decreased estimated glomerular filtration rate <15. Normal WBC, positive pelvic pressure, no flank pain. CT scan reveals new bilateral hydronephrosis and hydroureter that is due to local invasion by a pelvic mass.
B. PCN (includes PCNU)

PCN or stent placement will improve renal function in most cases [4,58]. Some investigators have reported improved survival benefits [6] as well as quality of life [59-62]. However, the patients most likely to benefit from this technique are those who have reasonable treatment options for their malignancy [63-65].

In patients with advanced disease for whom only palliative treatment is planned, PCN may offer little benefit because patient performance status and survival rates are frequently poor and further procedures may be necessary [25,66,67]. Furthermore, the procedure itself is not without significant morbidity [68]. With placement of a PCN, there is a significant risk of developing pyelonephritis or asymptomatic bacteriuria. Neutropenia and history of urinary tract infection were significant risk factors for pyelonephritis [69]. Management of obstructive uropathy may increase risk of symptomatic bacteriuria, and in cases of advanced cervical cancer such as with this patient, which are commonly treated with chemotherapy, symptomatic bacteriuria may delay or interrupt chemotherapy treatment.

However, PCN can be used in the palliative treatment of certain patients with advanced pelvic malignancies, in particular, those with prostate carcinoma and transitional carcinoma [63,70]. PCN decompression has been shown to be valuable in improving renal function and survival [63].

Careful attention to patient selection in determining who may ultimately benefit is critical.

Variant 4: Advanced cervical carcinoma with decreased estimated glomerular filtration rate <15. Normal WBC, positive pelvic pressure, no flank pain. CT scan reveals new bilateral hydronephrosis and hydroureter that is due to local invasion by a pelvic mass.
C. PCN (includes PCNU) followed by delayed surgery

As stated previously, when intervention is being considered for patients who have an underlying pelvic malignancy, PCN could have a higher technical success rate in relieving obstruction compared with retrograde double-J ureteral stenting, especially in cases that are due to extrinsic compression or obstruction involving the ureteropelvic junction in the emergent setting [55,56].

Variant 4: Advanced cervical carcinoma with decreased estimated glomerular filtration rate <15. Normal WBC, positive pelvic pressure, no flank pain. CT scan reveals new bilateral hydronephrosis and hydroureter that is due to local invasion by a pelvic mass.
D. Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)

Percutaneous antegrade ureteral stenting is certainly an alternative to PCN tube placement; however, it is usually delayed 1 to 2 weeks following initial placement of a diverting PCN. Ureteral stents are used to bypass a blocked or an injured segment of the ureter, thus restoring continuity of flow. Percutaneous nephroureteral catheters can accomplish this but often are not tolerated well by patients because of discomfort or skin irritation/infection at the catheter exit site. Double-J ureteral stents are therefore better tolerated. These catheters are routinely placed by urologists via a retrograde approach; however, if unsuccessful, they may require placement from an antegrade approach [71].

Variant 4: Advanced cervical carcinoma with decreased estimated glomerular filtration rate <15. Normal WBC, positive pelvic pressure, no flank pain. CT scan reveals new bilateral hydronephrosis and hydroureter that is due to local invasion by a pelvic mass.
E. Retrograde ureteral stenting

Retrograde ureteral stenting is a first-line therapy for management of ureteral obstruction caused by gynecologic malignancies [54].

However, when intervention is being considered for patients who have an underlying pelvic malignancy, PCN could have a higher technical success rate in relieving obstruction compared with retrograde double-J ureteral stenting, especially in cases that are due to extrinsic compression, obstruction involving the uretero-vesical junction, or ureteral obstruction length >3 cm in the emergent setting [54-56]. It has been proposed that antegrade PCN placement may be the preferred option if imaging demonstrates ureteric orifice occlusion that is due to a tumor or if there is a tight stricture very close to the uretero-vesical junction [57].

Variant 5: Prolonged history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. Patient appears septic and is hypotensive. CT scan shows dilated right ureter and renal pelvis with perinephric stranding. No etiology for ureteral obstruction identified with current imaging.

Variant 5: Prolonged history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. Patient appears septic and is hypotensive. CT scan shows dilated right ureter and renal pelvis with perinephric stranding. No etiology for ureteral obstruction identified with current imaging.
A. Medical therapy without decompression

Antibiotics alone are insufficient in treating acute obstructive pyelonephritis. If recurrent urinary tract infections occur, continued long-term monitoring and low-dose antibiotic prophylaxis may be necessary [72].

Variant 5: Prolonged history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. Patient appears septic and is hypotensive. CT scan shows dilated right ureter and renal pelvis with perinephric stranding. No etiology for ureteral obstruction identified with current imaging.
B. PCN (includes PCNU)

In patients who have pyonephrosis (hydronephrosis with infection), urinary tract decompression can be lifesaving. Depending on local practice preferences, emergent drainage can be obtained with retrograde ureteral catheterization or percutaneous drainage in those patients who are unstable or have multiple comorbidities [17,18,73]. The decision regarding emergent, urgent, or elective PCN placement depends primarily on clinical symptoms of sepsis. However, recent data suggest serum C-reactive protein may be a useful, less subjective parameter [74].

In the setting of pyonephrosis, PCN is usually technically successful and often results in marked clinical improvement [17,18,37,43,73,75]. PCN can yield important bacteriological information and alter antibiotic treatment regimens by correctly identifying the offending pathogen and improving the sensitivity of bladder urine cultures [38,76]. In a retrospective analysis, patient survival was 92% when PCN was used, compared with 88% for open surgical decompression and 60% for medical therapy without decompression [43]. In addition, hospitalization times were shorter in the nephrostomy group. Postprocedural bacteremia and sepsis are common when infected urinary tracts are drained [27]. However, when urosepsis is suspected or known to be present, preprocedural antibiotics are recommended [17,18,37,43]. A recent study demonstrates superiority of third-generation cephalosporin ceftazidime versus fluoroquinolone ciprofloxacin in both clinical and microbiological cure rates with improved early and long-term cure rates in those who received PCN versus ureteral stent [77].

In neonatal renal candidiasis, fungus balls obstruct the upper urinary tract and predispose to obstructive uropathy and fatal systemic candidiasis. In this setting, PCN drainage allows for both urinary tract decompression and the direct administration of antifungal agents into the renal collecting system [78]. Although the literature in this setting is limited, this technique seems to be valuable in eradicating funguria and is an attractive alternative to surgical decompression.

Variant 5: Prolonged history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. Patient appears septic and is hypotensive. CT scan shows dilated right ureter and renal pelvis with perinephric stranding. No etiology for ureteral obstruction identified with current imaging.
C. PCN (includes PCNU) followed by delayed surgery

In patients who have pyonephrosis, urinary tract decompression is considered lifesaving. Retrograde ureteral catheterization or PCN drainage is adequate in patients who are unstable or have multiple comorbidities, often based on local practice patterns.

For patients who have pyonephrosis or noninfected obstruction of a nonfunctioning kidney, preoperative PCN could increase the rate of wound infections following nephrectomy [80].

Variant 5: Prolonged history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. Patient appears septic and is hypotensive. CT scan shows dilated

right ureter and renal pelvis with perinephric stranding. No etiology for ureteral obstruction identified with current imaging.

D. Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)

Both PCN placement and ureteral stent placement are effective at managing urinary obstruction in patients with retroperitoneal fibrosis with similar incidence of postprocedural complications [79].

Variant 5: Prolonged history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection. Patient appears septic and is hypotensive. CT scan shows dilated right ureter and renal pelvis with perinephric stranding. No etiology for ureteral obstruction identified with current imaging.

E. Retrograde ureteral stenting

After diagnosis of obstructive pyelonephritis/pyonephrosis, primary nephrostomy or ureteral stenting and antibiotic therapy are the first-line treatment options [72].

Variant 6: Urinary ascites after recent abdominal surgery. Elevated blood urea nitrogen or creatinine, moderate abdominal pain, and no peritoneal signs. CT urogram reveals contrast leak from left pelvic ureteral injury. Current therapy consists of Foley catheter in the bladder.

Variant 6: Urinary ascites after recent abdominal surgery. Elevated blood urea nitrogen or creatinine, moderate abdominal pain, and no peritoneal signs. CT urogram reveals contrast leak from left pelvic ureteral injury. Current therapy consists of Foley catheter in the bladder.

A. Medical therapy without decompression

Conservative management is of limited usefulness in correcting the underlying ureteral injury. There is no relevant literature regarding the use of medical therapy in the treatment of ureteral leak.

Variant 6: Urinary ascites after recent abdominal surgery. Elevated blood urea nitrogen or creatinine, moderate abdominal pain, and no peritoneal signs. CT urogram reveals contrast leak from left pelvic ureteral injury. Current therapy consists of Foley catheter in the bladder.

B. PCN (includes PCNU)

Ureteral leaks and strictures occasionally occur after both ureteral and nonureteral open surgical procedures. Use of PCN decompression as the primary management of ureteral injuries results in a decreased need for reoperation and decreased morbidity rates [81]. PCN can provide access for definitive treatment of ureteral strictures [27,43] and leaks and thus obviates the need for repeated surgery [81,82].

PCN has been shown to be similarly useful in the management of renal transplant ureteral complications. In cases of post-transplant ureteral leaks, fistulas, strictures, and obstructions, PCN decompression and possible placement of PCNU may preserve or improve renal function [83].

In the setting of ureteral leak, nephrostomy access and possible PCNU placement is often established when retrograde ureteral access is not possible. In surgical ureteral repair, failure rates are 13% when PCN placement is performed, compared with 87% when it has not been used [84]. Accordingly, PCN and/or PCNU catheter placement is considered very helpful in optimizing transplant patient and renal-unit survival.

Variant 6: Urinary ascites after recent abdominal surgery. Elevated blood urea nitrogen or creatinine, moderate abdominal pain, and no peritoneal signs. CT urogram reveals contrast leak from left pelvic ureteral injury. Current therapy consists of Foley catheter in the bladder.

C. PCN (includes PCNU) followed by delayed surgery

In the acute trauma setting, PCN can act as a bridge to surgery in the treatment of fistulas, urinomas, and urinary ascites [86].

Variant 6: Urinary ascites after recent abdominal surgery. Elevated blood urea nitrogen or creatinine, moderate abdominal pain, and no peritoneal signs. CT urogram reveals contrast leak from left pelvic ureteral injury. Current therapy consists of Foley catheter in the bladder.

D. Percutaneous antegrade ureteral stenting (with or without safety nephrostomy)

Antegrade ureteral stent may be placed if the injury is easily crossed during initial renal access but may consider a diverting PCN first for patient comfort and control of symptoms. In the setting of ureteral injury, when retrograde ureteral catheterization fails, PCN access, often with ureteral stent placement, is useful [27,43,81,82]. Following a cesarean section, 75% of ureteral injuries were successfully managed with percutaneous management utilizing ureteral stent placement with or without ureteral dilatation [85].

Variant 6: Urinary ascites after recent abdominal surgery. Elevated blood urea nitrogen or creatinine, moderate abdominal pain, and no peritoneal signs. CT urogram reveals contrast leak from left pelvic ureteral injury. Current therapy consists of Foley catheter in the bladder.

E. Retrograde ureteral stenting

If initial retrograde stenting fails and the lesion/leak cannot be crossed primarily, then interval placement of a PCN could be considered. The patient may then need to undergo a secondary procedure to attempt placement of PCNU or a double-J ureteral stent to cross the injury.

Summary of Highlights

- **Variant 1:** PCN (includes PCNU) or PCN (includes PCNU) followed by delayed surgery is usually appropriate for patients with urinary diversion after remote history of cystectomy for cancer and no fever, normal WBC count, and urine output. A loopogram shows no reflux into distal ureters, and a CT shows new moderate bilateral hydronephrosis. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 2:** Retrograde ureteral stenting is usually appropriate for a patient with a 7-day history of right flank pain, fever, and leukocytosis. Patient has a urinalysis positive for blood and infection and CT scan shows a 10 mm calculus in the mid right ureter without hydronephrosis.
- **Variant 3:** Retrograde ureteral stenting or PCN is usually appropriate for a pregnant patient (20+ weeks) with a 3-day history of left flank pain, fever, and leukocytosis. Patient has a positive urinalysis for infection and ultrasound shows new moderate left hydronephrosis. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 4:** Retrograde ureteral stenting, PCN (includes PCNU), or percutaneous antegrade

ureteral stenting (with or without safety nephrostomy) is usually appropriate for a patient with advanced cervical carcinoma and decreased estimated glomerular filtration rate <15. Patient has normal WBC, positive pelvic pressure, and no flank pain. CT scan reveals new bilateral hydronephrosis and hydroureter due to local invasion by a pelvic mass. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

- **Variant 5:** PCN (includes PCNU) is usually appropriate for a patient with a prolonged history of right flank pain, fever, and leukocytosis. Urinalysis positive for blood and infection and patient appears septic and is hypotensive. No etiology for ureteral obstruction identified with current imaging. A CT scan shows dilated right ureter and renal pelvis with perinephric stranding.
- **Variant 6:** Retrograde ureteral stenting, PCN (includes PCNU), percutaneous antegrade ureteral stenting (with or without safety nephrostomy), or PCN (includes PCNU) followed by delayed surgery is usually appropriate for a patient with urinary ascites after recent abdominal surgery. Symptoms include elevated blood urea nitrogen or creatinine, moderate abdominal pain, and no peritoneal signs. A CT urogram reveals contrast leak from left pelvic ureteral injury. Current therapy consists of Foley catheter in the bladder. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

· ACR–SPR Practice Parameter for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging (MRI)
· ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation
· ACR-ACOG-AIUM-SMFM-SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound
· ACR Manual on Contrast Media
· ACR Manual on MR Safety

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition

Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of

this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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