This document was amended in October 2020 to reflect changes in literature since it was originally released for publication in August 2017. This document will continue to be periodically updated to reflect the growing body of literature related to this topic.

UROLOGIC EMERGENCIES

Keywords: Obstructive uropathy, priapism, Fournier's gangrene, paraphimosis, trauma, testicular torsion

Learning Objectives*:*
At the end of medical school, the medical student will be able to:

1. Describe the most frequent conditions that are considered urologic emergencies requiring immediate recognition and treatment.
2. Distinguish, through the history and physical examination, the key features of obstructive uropathy, priapism, Fournier's gangrene, paraphimosis, trauma, testicular torsion
3. Appropriately order imaging studies and lab tests to help evaluate the patient presenting with a urologic emergency.
4. Formulate an initial treatment plan for the most common urologic emergencies.

Introduction:

Emergencies are medical conditions requiring prompt treatment to minimize the likelihood of loss of organ structure or function, and in rare cases, of the patient's life. While, fortunately, urologic emergencies are rare, it is incumbent on providers to recognize the often-subtle clinical presentations of these conditions. After completing this module, students should be confident in their ability to diagnose and formulate a treatment plan for the most common urologic emergency conditions.

Obstructive Uropathy:

Acute Urinary Retention:

Acute urinary retention (AUR), or the involuntary inability to pass urine from the bladder, is the most common reason for emergent urologic care,[1] with 10% of men aged 70-79 and 30% of men aged 80-89 having at least one episode.[2] AUR (the passage of no or only extremely small amounts of urine) may result from an acute obstruction to urine outflow or from abnormalities in bladder contractility. Obstructed urine flow may result from any blockage of the bladder neck, urethra, or meatus, including stones, tumors, blood clots, prostate enlargement, local edema, or phimosis. Women may have pelvic organ prolapse or urethral diverticula.[2, 3] Abnormalities in bladder contractility can arise from neurologic conditions or medications. Trauma, drugs, and neurologic conditions may cause either problems with contractility or difficulties with outflow. For example, anticholinergic drugs may decrease bladder contractility, while sympathomimetic drugs may prevent sufficient relaxation of the bladder neck. After surgery, acute urinary retention may occur in up to 70% of patients and is often due at least in part to anesthesia

(general or regional, including epidural), drugs (including narcotic pain medications), constipation, and decreased mobility.[4]

Patients with significant urinary retention often have significant discomfort and a palpable bladder (Figure 1). Imaging, including bedside ultrasound, can also confirm the presence of a large volume of urine in the bladder. Initial treatment consists of decompression of the bladder; typically placement of a urethral (or catheterizable channel) catheter is sufficient although suprapubic catheter placement may be necessary in cases where a urethral catheter is unsuccessful. Any patient in whom urinary outflow is completely obstructed should be monitored postoperatively for the development of postobstructive diuresis. Postobstructive diuresis is diagnosed when the urine output exceeds 200 cc/hour for two consecutive hours, or more than three liters in 24 hours.[5] While the incidence of postobstructive diuresis is widely variable, [6] a high index of suspicion for its development must be maintained in the first 24 hours after decompression, as solute loss accompanying the diuresis may be associated with severe electrolyte derangements as well as hypovolemia.

Figure 1: Acute urinary retention, with a distended bladder and enlarged prostate.

Gross Hematuria with Clot Retention:

Gross hematuria is the presence of visible blood in the urine, and may develop from renal or urologic pathology. True hematuria (the presence of red blood cells in the urine) should be distinguished from other causes of reddish urine, including myoglobinuria, hemoglobinuria, and drugs (e.g. rifampin) or dietary causes (e.g. beets). In children, renal causes of hematuria predominate.[7] While true gross hematuria necessitates a prompt evaluation, clot retention, or the inability to urinate owing to the volume of blood clot in the bladder, is a true emergency.

Urinary clots develop when the amount of blood in the bladder exceeds the ability of the urinary urokinase to prevent clot formation; retention of urine associated with blood clots in the urine can occur when the clots physically block the urethra or bladder neck (see Figure 2). Thus,

treatment of clot retention has two goals: to relieve the outflow blockage and to prevent new clot formation.[8, 9] In patients who are unable to void because of clots, placement of a large urethral catheter (usually at least 22 Fr, and often larger), and irrigation with 0.9% normal saline and a catheter-tipped syringe is often sufficient to remove the intravesical clots and re-establish spontaneous bladder drainage. Hematuria catheters, which have large drainage holes at the tip and which are often reinforced so as not to collapse with withdrawal of fluid, are helpful when irrigating. If a three-way catheter is used, it is important to remember that the lumen of the drainage port is smaller than in a two-way catheter of similar external (French) size. Patients in whom the urine cannot be cleared using hand irrigation require cystoscopy and clot evacuation in the operative setting, in which intravesical clots can be removed and any specific actively bleeding sites can be treated. Once the urine has been successfully cleared of clots, continuous bladder irrigation (CBI) with 0.9% normal saline through a three-way catheter is typically used to prevent further clotting in the immediate postoperative period, with the irrigation rate titrated to the minimal amount needed to achieve clear or very light pink urine. CBI should always be performed with the irrigant infused via gravity (never on a pump), to minimize the risk of bladder perforation. Patients with clot retention should be evaluated and treated for underlying causes of bleeding (e.g. bladder cancer, coagulopathy).

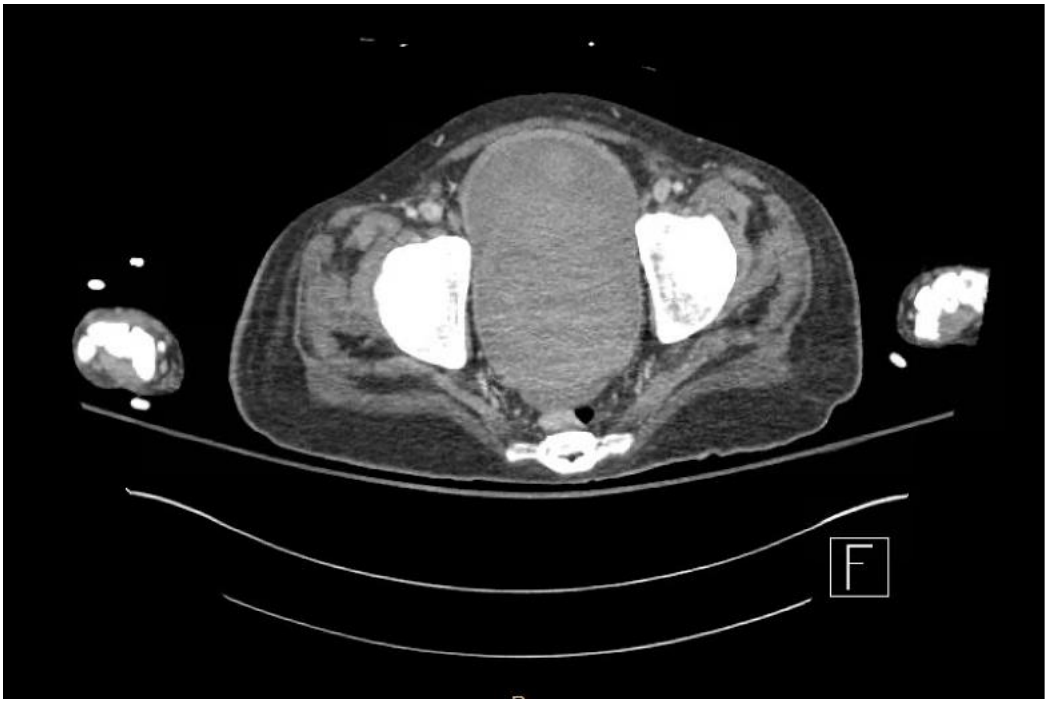

Figure 2: Bladder distension due to clot retention; the heterogeneous nature of the intravesical fluid reflects mixing of clot and urine.

Ureteral Obstruction

Ureteral obstruction, in which the antegrade flow of urine from the kidney to the bladder is blocked, can occur in either or both renal units. Urgent or emergent intervention is needed when obstruction affects all renal units, infection or immunosuppression are present, or in the presence of acute worsening of renal function. Causes of ureteral obstruction may be intrinsic (including stones, ureteropelvic junction obstruction, ureteral polyps or tumors, blood clots, or ureteroceles), or extrinsic (including blood vessels or external masses such as tumors). Stones

(Figure 3) are the most common cause of ureteral obstruction, with an 11% lifetime risk of nephrolithiasis, and can be diagnosed using ultrasound or CT scans.[10] Figure 4 shows an obstructing ureterocele with infected urine.

Figure 3: Left ureteral stone with associated collecting system dilatation.

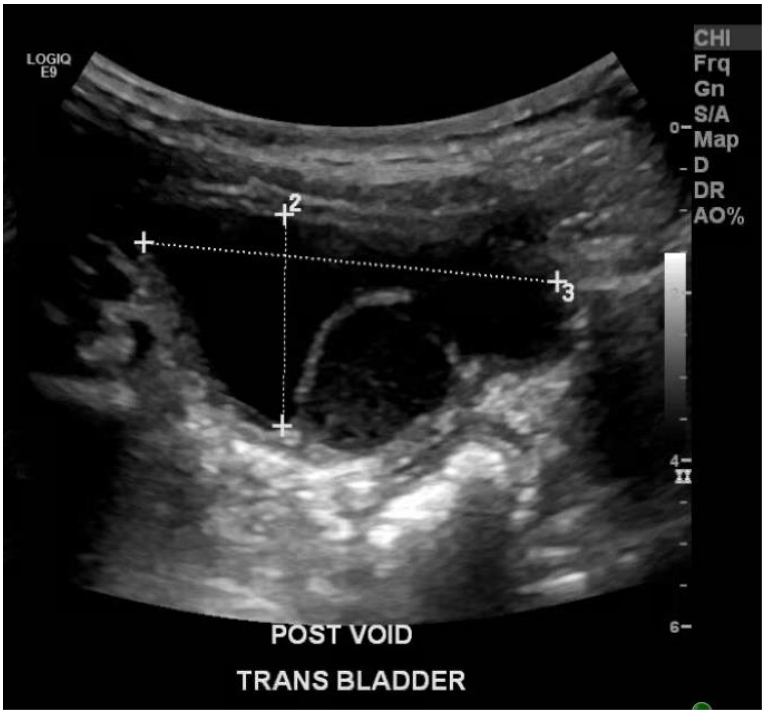

Figure 4: An obstructing ureterocele containing purulent urine.

In patients in whom adequate pain control can be achieved, in whom there is no evidence of immunosuppression (e.g. diabetes, pregnancy, immunosuppressive medications such as chemotherapy or antirejection medications) or infection (e.g. fever, urinalysis suggestive of infection), and in whom serum creatinine is not elevated from baseline, non-urgent management based on the underlying etiology of the obstruction may be considered.[11,12] In patients with obstruction of both kidneys or of a solitary functioning kidney, or in whom there is worsening of renal function from baseline, urgent endoscopic drainage with a ureteral stent or percutaneous drainage with a nephrostomy tube should be considered. Patients with fevers or significant pain that cannot be controlled with oral medications should undergo drainage as well; while both endoscopic and percutaneous approaches may be considered in these cases, patients with sepsis associated with ureteral obstruction should be managed with percutaneous rather than endoscopic drainage. Culture of the urine proximal to the obstruction should be performed once drainage has been achieved, and antibiotic regimen tailored to the culture and sensitivity results. In pregnant patients, ultrasound guidance can be used to define anatomy during drainage procedures, and fetal monitoring should be employed intra- and perioperatively.[13]

In general, definitive treatment of the ureteral obstruction should not be undertaken concurrent with urgent or emergent upper tract decompression given the risk of sepsis, and should be scheduled at a later time: endoscopic management of intraluminal causes such as stones and polyps can often be scheduled on an outpatient basis, while extrinsic causes such as abdominal masses should typically prompt more urgent evaluation once decompression has even achieved.

Priapism:

The American Urologic Association has published a Guideline on the Management of Priapism: https://www.auanet.org/guidelines/priapism-(2003-reviewed-and-validity-confirmed-2010), [14] which contrasts the pathophysiology and management of ischemic and nonischemic priapism. Priapism is defined as a persistent (four or more hours) penile erection in the absence of sexual stimulation. The incidence of priapism is low; one study reported 1.5 cases per 100,000 men per year with the incidence in men aged 40 and older being 2.9 cases per 100,000 men per year.[15] However, more recent research suggests that the incidence of this condition is higher (5.34 cases per 100,000 men annually),[16] particularly in men with sickle cell anemia.[17] Almost three-quarters of patients with sickle cell anemia may have at least one episode of priapism.[18] Patients may seek care for priapism more frequently in the summer than in the winter.[16]

The precise etiology of priapism is often unknown or multifactorial, but generally results in the inflow of blood to the corpus cavernosum exceeding the outflow. Obstruction to outflow of cavernosal blood can occur when the cavernosal smooth muscle fails to relax or when there is physical blockage of the venous drainage (e.g. sickle cell anemia, pelvic mass). Priapism can be ischemic or nonischemic, with the former being more common. Ischemic priapism develops when the increased intracavernosal pressure generated by impaired drainage results in an effective penile compartment system, causing damage to local tissues and decreasing arterial inflow. The resulting hypoxia and acidosis can further damage the tissue. Non-ischemic priapism typically results when the arterial inflow exceeds the venous outflow; because arterial blood is being supplied to the tissues and there is some venous drainage, there is little risk of tissue death.

The classic presentation of ischemic priapism is as a "rock hard" erection that is painful. On examination, the corpora cavernosa are erect while the glans and corpus spongiosum are spared. The most common causes are sickle cell disease, malignancy (leukemia/lymphoma, primary or metastatic penile cancer, or pelvic mass), and drugs (most commonly agents used to treat erectile dysfunction, such as PDE-5 inhibitors and intracavernosal injections, but also including trazodone, cocaine, alpha blockers and total parenteral nutrition).[19,20] The prompt initiation of definitive treatment is paramount to minimizing the risk of permanent tissue damage and erectile dysfunction: 50% patients with resolution of the priapism within 24 hours will retain erectile function, compared with almost none of patients after 36 hours.[21] The diagnosis can be confirmed with a penile blood gas, which often shows signs of abnormal tissue perfusion ($pO2<30$, $pCO_2>60$, $pH<7.25$).[22,23] Doppler ultrasonography will demonstrate poor intracavernosal arterial inflow, and is useful for confirming successful treatment.[24,25] A complete blood count should be performed in all patients to evaluate for hematologic disease, with hemoglobin electrophoresis considered in patients at risk for sickle cell disease.

Treatment of ischemic priapism centers on removing the blood from the corpora in order to allow arterial inflow. Initial treatment includes aspiration and irrigation of the corpora with normal saline; this is most successful early in the priapism episode, often before most patients have presented for medical care. Intracorporal injection of 1 cc of 1 mg/1mL phenylephrine, diluted in 19 cc of 0.9% normal saline (20 cc total) can be performed every three to five minutes until detumescence is achieved. Vital signs (heart rate and blood pressure) should be monitored during sympathomimetic injection. If injection is unsuccessful, surgical intervention is necessary. Distal shunts (Ebbehoj, Winter, and Al-Ghorab) involve creation of a communication between the distal corpora cavernosa and the corpus spongiosum of the glans, while proximal shunts (Quackels or Sacher and Grayhack or Barry) involve drainage of the proximal corporal cavernosa into the corpus spongiosum or veins (saphenous or deep dorsal) vein, respectively.[26] Extremely refractory cases may require dilatation of the corpora cavernosa and ultimate placement of a penile prosthesis.

Although the immediate care of a patient with ischemic priapism centers on the return of blood flow to the penis, comprehensive evaluation of the patient to identify contributing factors should be performed. In addition to bloodwork, imaging of the pelvis may be appropriate if a local malignancy is suspected. Patients with drug-related priapism may benefit from discontinuation of that drug when feasible.

In contrast to ischemia priapism, non-ischemic (or "high-flow") priapism typically develops in the setting of a local vascular malformation or after surgical or accidental trauma, although malignancies have also been reported.[27] Because blood flow to the corpora is preserved, nonischemic priapism is not an emergency and may resolve independently (in 60% of cases).[28] Patients with nonischemic priapism have a persistent, partial, and painless erection. Penile blood gases in patients with nonischemic priapism show high oxygen levels and no acidosis ($pO_2>90$, $pCO_2<40$, $pH \sim 7.40$).[28] Doppler ultrasonography may show arteriosinusoidal flow.[29] In patients with persistent nonischemic priapism, selective embolization is often successful.[30, 31]

Penile Trauma:

Penile fractures occur when application of force to the erect penis results in rupture of the tunica albuginea, often during sexual activity. The diagnosis is suggested by a "popping" sound or sensation, accompanied by development of pain and spontaneous DE tumescence accompanied by significant penile bruising. Some patients may have blood at the meatus, which should raise suspicion for a coexisting urethral injury. The diagnosis of penile fracture is primarily clinical, although the use of MRI and ultrasound have been reported, and retrograde urethrogram should be considered in patients with potential urethral injury. False negative (plaque rupture) or delayed penile fractures have been reported in patients after collagenase injection for penile plaques.[32, 33]

Immediate repair of penile fractures is associated with a lower incidence of complications, including erectile dysfunction and development of chordee.[34] A circumcising incision and complete penile degloving is recommended in order to facilitate visual inspection of the entire penis for multiple injuries.

Penetrating trauma to the penis is uncommon. Primary repair with debridement of vascularized tissue can be performed. In cases of penile amputation, the phallus (if recovered) can be reimplanted. The severed penis should be placed in a bag inside a bag of ice. After debridement of devascularized tissue, corpora cavernosal, and urethral continuity is re-established, and the dorsal arteries, vein, and nerve are re-anastomosed.[35]

Urethral injury should be considered in all patients with penile trauma, and consideration should be given to suprapubic urinary diversion to minimize tension on surgical repairs.

Fournier's gangrene:

Fournier's gangrene is a life threatening, necrotizing infection of the soft tissue of the perineum. Fournier's gangrene is uncommon, with a prevalence of 1.6 per 100,000 men per year,[36] and less common in women (23% of patients in one series),[37] usually aged 50 and older. While men and women are similar demographically with regard to age and comorbidities, with the exception of obesity (women tend to have a BMI that is, on average, ten points higher than that of men),[37,38] although women may fare worse clinically.[39] Risk factors include diabetes mellitus, obesity, immunosuppression (e.g. HIV infection), malignancy, alcoholism, smoking, and renal failure.[40] The infection is typically polymicrobial, with mixed aerobic and anaerobic bacteria (E. *coli*, *Klebsiella*, enterococci, *Bacteroides*, *Fusobacterium, Clostridium)* and rarely fungi.[41,42]

In the early stages, necrotizing soft tissue infections may appear unimpressive, but as the bacterial infection spreads along fascial planes with accompanying vascular thrombosis, the patient's condition can deteriorate quickly. The classic presentation of a necrotizing soft tissue infection is of a patient presenting with pain out of proportion to the accompanying physical findings. Depending on the progression of the disease at the time of evaluation, patients may have a spectrum of local findings or may have apparent systemic disease. Early on, patients may simply have exquisite tenderness without other outward findings; later in the disease there may be changes in the skin and soft tissue overlying the infection (e.g. edema, bullae, blisters,

crepitus, and local anesthesia). Severely ill patients may have abnormal vital signs such as tachycardia, tachypnea, hypotension, and hyper- or hypothermia, in some cases presenting in florid septic shock.[43] Clinicians must maintain a high index of suspicion for the disease in order to make a prompt diagnosis in the early stages, as case fatality rate is approximately 6-7%.[36,37]

Immediate treatment consists of aggressive surgical debridement, combined with broad-spectrum intravenous antibiotics. Because the extent of tissue involvement is often not apparent at initial debridement, patients should undergo "second look" procedures, with additional debridement if necessary. Coordination with general surgery colleagues is critical as perirectal tissue can be involved and in some cases, may be the source of the infection. Excision of affected tissue is a necessary component of treatment; treatment with antibiotics alone typically has a 100% mortality. After surviving the initial infection, many patients will need multiple reconstructive procedures. Treatment with hyperbaric oxygen may preserve healthy tissue and reduce the amount of debridement necessary.[44]

Paraphimosis:

Paraphimosis occurs when the foreskin becomes trapped behind the penile corona. Subsequent obstruction to venous and lymphatic outflow results in increasing preputial and glanular edema; in extreme cases, the increased pressure generated by the edema and the venous congestion will decrease arterial inflow, resulting in ischemia and tissue death.[45]

Paraphimosis occurs when the foreskin is pulled back behind the glans, but is not replaced in anatomic position.[46] Failure to replace the foreskin after cleaning the penis, after voiding, or after other manipulation of the prepuce may result in paraphimosis. Importantly, paraphimosis can be iatrogenic, occurring when the foreskin is manipulated in a medical setting but not reduced to the anatomic position. Contributing factors include pre-existing phimosis and abnormal skin quality (e.g. inflammation, decreased elasticity).[47] Patients typically present with pain, preputial and glanular edema, and an apparent transition point just proximal to the edema; patients who are obtunded or otherwise unable to describe pain may have solely physical findings. Patients with urethral compression may be unable to void normally. Tissue constriction from external materials (e.g. hair) should be excluded, as similar presentations can occur with externally applied materials.[48, 49]

The initial treatment of paraphimosis is to relieve the obstruction. Initial efforts should center on reduction of the foreskin. After placement of a penile block, decompression of the distal glanular edema, followed by firmly pulling (not pushing) the foreskin over the glans, is typically successful. Placement of water-based lubricant on the glans often facilitates reduction.[50-52] If this is not successful, emergent dorsal slit (incision of the dorsal foreskin) should be performed, and the foreskin then reduced. Patients with a history of paraphimosis should be counseled on operative intervention with a formal dorsal slit or circumcision to prevent future occurrences.

Testicular Torsion:

See Testicular Torsion sub-section within "Acute Scrotum" on the AUA Medical Student Curriculum page: http://www.auanet.org/education/educational-programs/medical-student-education/medical-student-curriculum/acute-scrotum

Trauma

The American Urological Association Guideline on Urotrauma can be found at https://www.auanet.org/guidelines/urotrauma-guideline, and provides detailed recommendations for management.[53]

Bladder Rupture:

Leakage of urine may occur into the peritoneum or the extraperitoneal space. Both intra- and extraperitoneal leakage of urine may have iatrogenic causes (e.g. perforation of the bladder during a transurethral resection of a bladder tumor). Other than iatrogenic causes, intraperitoneal leakage of urine classically occurs when sufficient force is transmitted to the abdomen or suprapubic region with a full bladder; in these cases, the bladder rupture usually occurs at the dome. Blunt trauma-associated extraperitoneal bladder rupture most commonly occurs in the setting of pelvic fractures and associated pelvic trauma.[54] Penetrating bladder trauma is most commonly associated with gunshot wounds. Around 10% of patients with abdominal trauma will have a bladder injury.[55] Bladder injuries can also be iatrogenic, such as during gynecological or urologic procedures or associated with catheter placement.[56]

The presentation of bladder injury, especially after blunt trauma, may be subtle, especially when other injuries are present. Patients may present with gross hematuria, inability to void, extravasation of urine into the abdomen or surrounding soft tissues, local bruising, and suprapubic or abdominal pain and tenderness. Patients may also have electrolyte abnormalities or changes in serum creatinine levels attributable to peritoneal absorption of urine. There may be injury to surrounding structures (e.g. the pelvic ring), or history of a mechanism of injury that suggests a high likelihood of damage to the bladder (e.g. bicycle injury with handlebars striking the abdomen with a full bladder).[57]

Patients with a history of trauma should always undergo a primary and secondary survey.[57] Evaluation for possible bladder injury should be performed in all patients with a history of trauma and with gross hematuria. If bladder injury is suspected, a fluoroscopic or computed tomography cystogram should be performed. In order to be considered a sufficiently sensitive study to rule out bladder leakage, a cystogram should be performed by filling the bladder retrograde (not antegrade) to 300 cc in adults with normal bladders (i.e. absence of neurogenic bladder and other causes of decreased bladder capacity), expected bladder capacity in children, and less than those volumes only if there is significant pain. Imaging should be performed not only during filling but also during and after bladder drainage (Figure 5). Intraperitoneal leakage of urine is characterized by contrast outlining loops of bowel, while extraperitoneal bladder leakage typically shows lateral leakage of urine.[58]

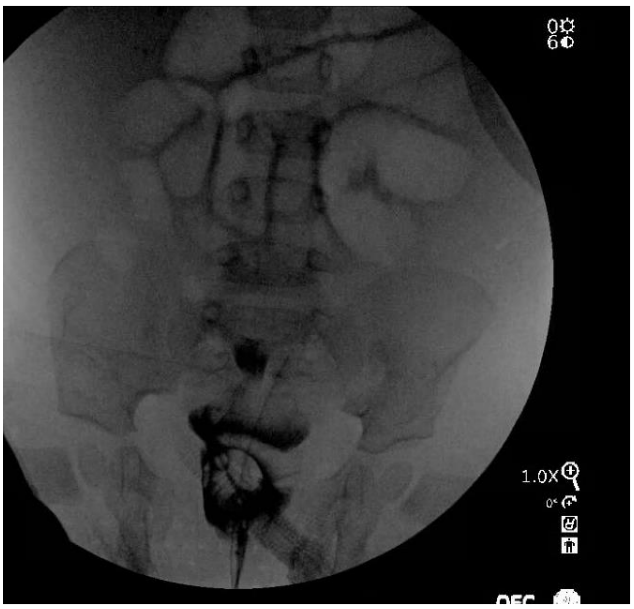

Figure 5: Drainage film after a cystogram shows contrast after draining the bladder, confirming bladder rupture obscured during the filling phase.

Surgical repair of bladder injuries should be undertaken for penetrating trauma, blunt trauma with intraperitoneal bladder injury, or blunt trauma-associated extraperitoneal injury with bone fragments penetrating the bladder, rectal or vaginal injury, or injury to the bladder neck or ureteral orifices. Isolated extraperitoneal bladder injuries may be managed with urethral catheter drainage, although consideration should be given to open repair if the patient is being taken to surgery for another reason. In addition, some extraperitoneal cases involving a large defect in the bladder may be best managed with surgical repair. A critical step in the operative repair of bladder injuries is to open the bladder and completely evaluate the organ for injury; this also facilitates evaluation of the bladder neck and the ureteral orifices. After any necessary debridement of devascularized tissue, the bladder should be closed in two watertight layers using absorbable suture. The bladder should be drained with a large-bore (at least 16 French, often larger) catheter for 2-3 weeks, with a cystogram performed prior to catheter removal. Routine suprapubic tube drainage is discouraged, although may be considered for especially complex repairs or for patients in whom prolonged bladder drainage (beyond 2-3 weeks) is anticipated.[53]

Ruptured enterocystoplasty or colocystoplasty constitutes a special subset of intraperitoneal bladder ruptures. Bladder injury in these patients may develop after comparatively minor trauma (e.g. fall from a low height), or as a result of mucus buildup, and altered sensation and/or cognition in these patients may alter perception or report of symptoms. Patients who do report symptoms tend to report signs of peritonitis (discomfort with "bumps in the road," or shoulder pain), less urine than usual, or bloody urine. Perforation in these cases usually occurs along the anastomosis between the bowel and bladder segments. Most patients require surgical repair, although nonoperative management of stable patients with small-volume leaks has been reported.[59]

<u>Urethral Trauma</u>

Urethral injuries are more common in men than in women. Posterior (at or proximal to the membranous urethra) urethral injuries are nearly universally associated with pelvic fractures; up to 10% of patients with pelvic fractures will also have a urethral injury.[54,60,61] Injuries to the

anterior (penile or bulbar) urethra may be associated with sharp or blunt trauma. The most common physical examination finding associated with urethral injury is blood at the meatus, although it can occur in as few as one-third of patients, and so its absence does not exclude urethral injury.[62] Inability to void, bruising, and a "high riding" prostate are also suggestive of urethral injury. Women may have blood in the vagina or significant labial swelling.

The diagnosis of urethral injury is made by retrograde urethrogram (RUG), in which contrast is gently injected retrograde into the urethra. The absence of contrast in the bladder suggests a complete urethral disruption, while contrast in the bladder suggests a partial disruption.[63] Patients with posterior urethral injuries should not undergo primary repair, since primary repair in this setting is associated with increased risk of erectile and urinary complications.[64] Anterior urethral injuries, especially when penetrating, may be closed primarily with absorbable sutures and catheter drainage, provided that this can be safely accomplished while adhering to other tenets of surgery (e.g. debridement of potentially devascularized tissue and a tension-free closure). Primary realignment of the urethra with a single attempt to place a catheter manually, followed by cystoscopic attempts, may improve clinical outcomes compared with suprapubic drainage alone.[65,66] However, primary alignment should not be considered definitive treatment as a majority of patients develop some degree of urethral narrowing requiring additional intervention.

Renal Trauma

Renal trauma occurs more frequently in male patients and can occur in up to 10% of abdominal traumas. It is important to differentiate between penetrating and blunt renal traumas, as a mechanism of injury can determine the severity and management of the injury.

Blunt traumas occur in the setting of motor vehicle accidents, motorcycle accidents, falls, and some sports. Penetrating trauma occurs often in the setting of a gunshot or stab wound.

In the adult patient population, imaging for possible renal trauma should be performed in the setting of gross hematuria, or if microscopic hematuria is present with a systolic blood pressure less than 90 mmHg. Imaging should include CT scan with intravenous contrast. Delayed phase imaging is critical, to evaluate for collecting system or ureteral injury. Staging of the renal injury is based on the 2018 revised AAST staging system, shown in Table 1.[67]

Figure 6: Large urinoma accompanying Grade 4 renal injury.

Initial management of a hemodynamically stable patient with a renal trauma include conservative measures, including bedrest, serial hemoglobin or hematocrit measurements, and close monitoring of the abdominal exam and vital signs. Conservative management can certainly include blood transfusion, though ongoing requirements for blood products should be a trigger to consider an active intervention.

If the patient is hemodynamically unstable despite resuscitation, and intervention should be performed. There are 2 categories of intervention, including angioembolization and surgical management. If the patient has not yet had any imaging studies and is taken directly to the operating room, an IVP should be performed on the operating room table to confirm that there is a normal, uninjured, contralateral kidney before performing any maneuvers on the injured kidney. This is performed by administering to milliliters per kilogram of intravenous contrast with a plain film performed 10 to 15 minutes later.

Angioembolization can be useful for bleeding from segmental renal vessels. This can be considered a very reasonable tool for patients who are hemodynamically stable, but have continued to demonstrate evidence of ongoing bleeding.

The finding of urinary extravasation does not always necessitate an intervention. On occasion, patient with urinary extravasation may have worsening flank pain, low-grade fevers, or a rising creatinine. These patients may require ureteral stenting, and if this fails nephrostomy tube placement. The exception to active surveillance of the patient with urinary extravasation is one who has a ureteropelvic junction or renal pelvis laceration. In these cases, operative intervention is usually indicated. Figure 5 demonstrates a large urinoma in a patient with urinary extravasation from a renal injury.[53]

Ureteral Trauma

Ureteral trauma can occur from external trauma and during urologic and non-urologic surgery (iatrogenic injury). External ureteral trauma is most often associated with penetrating trauma, though blunt trauma can also result in avulsion of the ureter at the level of the ureteropelvic junction. Similar to renal trauma, appropriate imaging with delayed films is critical to detect an injury.

In the setting of external penetrating trauma, if the patient is taken directly for exploratory laparotomy, the ureter should be evaluated for viability and vascular supply. A high suspicion for ureteral injury should be maintained based on the trajectory of the injury. Nonviable ureteral tissue should be debrided with care to preserve as much vascularity as possible. If the patient does not require laparotomy, an attempt at ureteral stenting in the setting of a partial ureteral injury is a reasonable approach. If a stent cannot be placed, options include a nephrostomy tube with delayed repair, or in some cases immediate exploration if the injury occurred recently.

There are a number of options to repair the ureter based on the location of the injury. Injuries distal to the iliac vessels should be repaired with a primary reimplantation if feasible. Other maneuvers to allow ureteral implantation into the bladder include a Boari flap and a psoas hitch. Midureteral injuries can be repaired with a ureteroureterostomy if there is adequate length to create a tension-free anastomosis. Alternatives include a transureteroureterostomy, Boari flap,

and psoas hitch. In the acute setting, bowel interposition (also called an ileal ureter) should not be performed but remains an option in the delayed setting. Other options include auto transplant and nephrectomy.[53]

Testis Trauma

Testicular trauma is relatively rare, and like bladder and renal trauma, can occur due to penetrating and blunt injury. The imaging modality of choice in the setting of a suspected testis trauma is a scrotal ultrasound. Severe injury to the testis can result in impairments in both spermatogenesis and hormone production. For this reason, timely diagnosis and repair of severe injuries is important. Ultrasound findings of a large hematocele (blood around the testis) can indicate an injury to the testis or the structures surrounding the testis. Ultrasound may also demonstrate disruption of the tunica albuginea, and this requires surgical exploration and repair.[53] Figure 7 demonstrates the cutaneous findings that can be seen in the setting of scrotal and testis trauma.

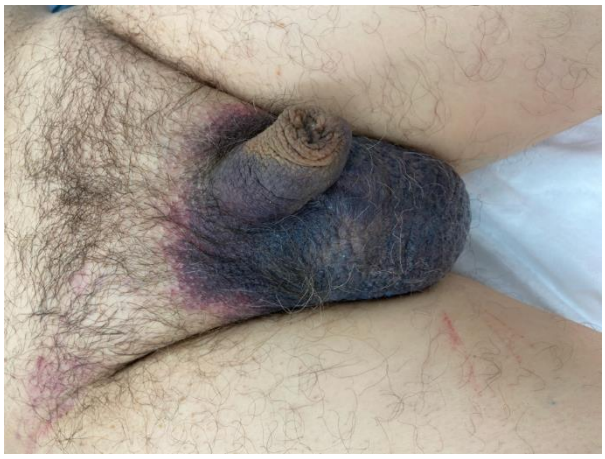

Figure 7: Perineal and scrotal ecchymosis accompanying testicular injury.

Table 1. Grading of Renal Injury

AAST Grade	Imaging Finding (CT)
I	Subcapsular hematoma and or parenchymal contusion without laceration
II	Perirenal hematoma confined to Gerota's fascia. Renal parenchymal laceration less than or equal to 1 cm depth without urinary extravasation
III	Renal parenchymal laceration greater than 1 cm depth without collecting system rupture or urinary extravasation
IV	Parenchymal laceration extending into urinary collecting system with urinary extravasation. Renal pelvis laceration and/or complete ureteropelvic junction disruption Segmental renal vein or artery injury

	Active bleeding beyond Gerona's fascia into the retroperitoneum or peritoneum Segmental or complete kidney infarctions due to for vessel thrombosis without active bleeding
V	Main renal artery or vein laceration or avulsion of hilum Devascularized kidney with active bleeding Shattered kidney with loss of identifiable parenchymal renal anatomy

Summary:

Urologic emergencies are numerous and variable in presentation, and can be associated with significant acute and delayed morbidity. A high index of suspicion as well as a thorough history and physical exam and judicious use of lab studies and imaging are critical to the timely diagnosis and treatment of urologic emergencies.

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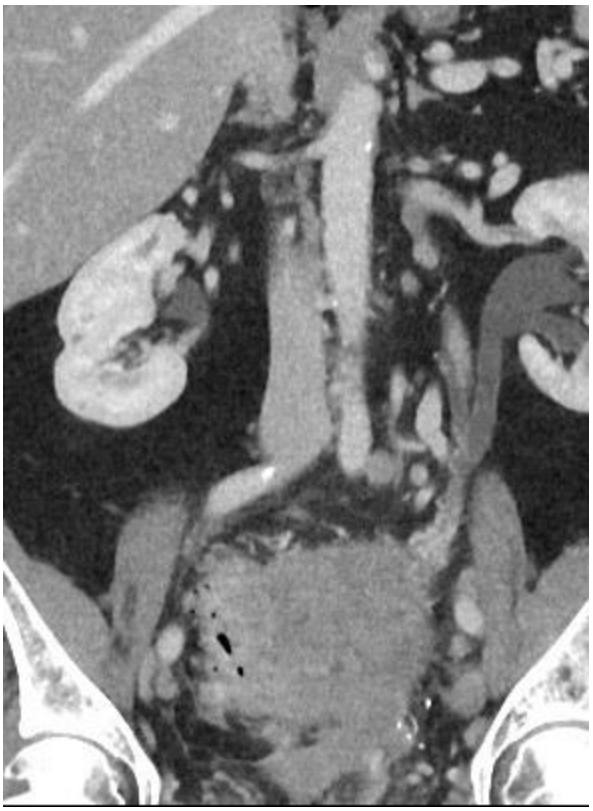
Appendix 1:
Imaging of Urologic Emergencies

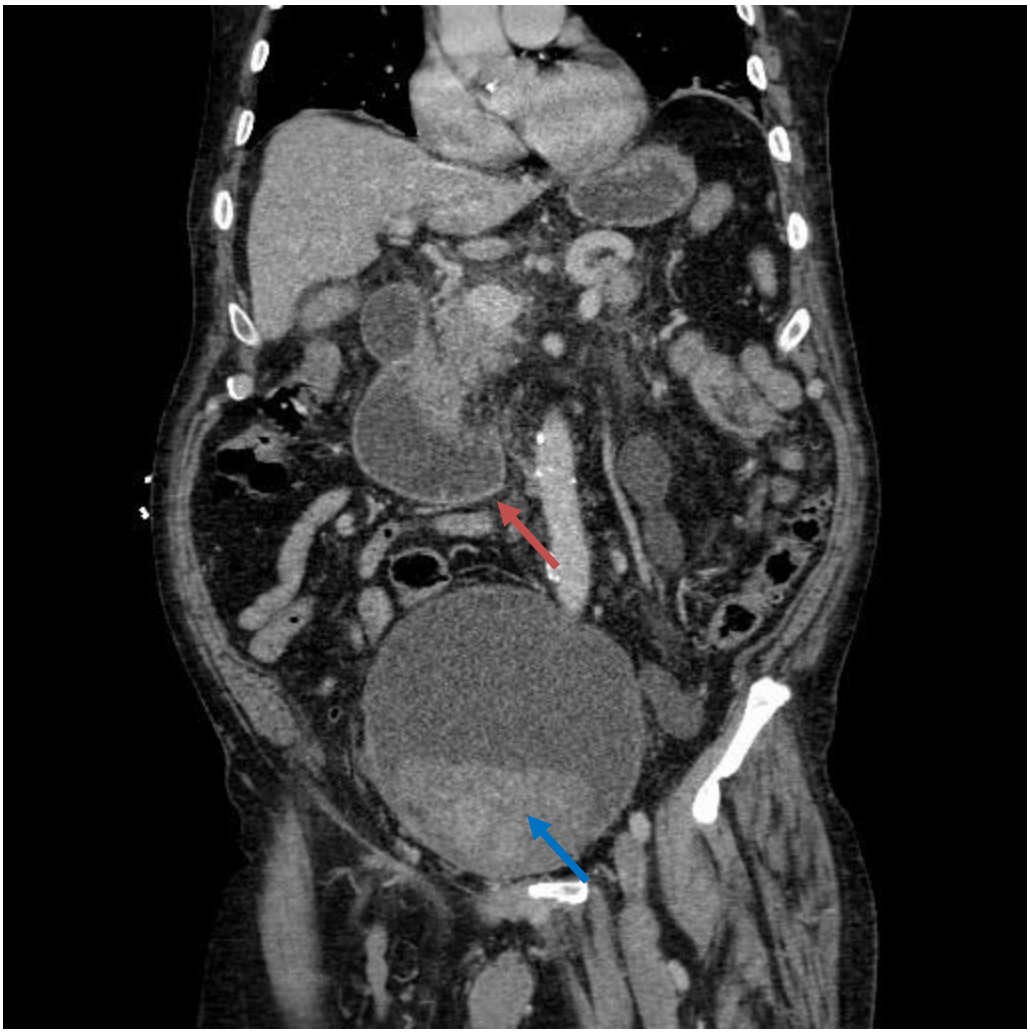
The left kidney demonstrates xanthogranulomatous pyelonephritis (XGP), which can be an emergency in the setting of acute infection. The obstructed calyces of the kidney are unable to drain infected urine, leading to sepsis or abscess.

These two images of the same patient demonstrate bilateral hydronephrosis (seen best in the top image) and ureteral dilation with bilateral ureteral stones (seen best in the bottom image).

This adult patient presented with right flank pain. Noticed the right hydronephrosis, cortical thinning from long-term obstruction, and a crossing vessel (red arrow) which is the likely source of the obstruction. This represents a ureteropelvic junction obstruction (UPJO) from a crossing vessel.



The left kidney in this patient is obstructed from a large pelvic mass causing compression of the mid and distal ureter. Urgent decompression is indicated to prevent long-term renal damage. Emergent decompression is indicated if the patient has a concurrent urinary tract infection.



This patient developed bilateral hydronephrosis with ureteral dilation (red arrow) due to a massively enlarged prostate (blue arrow). It would be very reasonable to consider bladder cancer in the differential diagnosis for a mass like this with associated hydronephrosis. Cystoscopy would help determine whether this mass is an enlarged prostate or a bladder neoplasm.

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