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Urology and Nephrology

DND Primary Care Paramedicine

Module: 07

Section: 04

Lecture Outline

- Introduction
- General mechanisms
- General pathophysiology
- General assessment
- General management
- Renal and urologic emergencies

Introduction

- More than 4000 Canadians suffer from end-stage renal failure
  - Sixth leading cause of death
- Every day an average of 10 Canadians find out that they have renal failure

Functions of the Urinary System

- Maintains blood volume
- Balance of water, electrolytes and pH
- Ensures that key elements remain in the blood
  - Glucose
- Waste removal
- Regulation of arterial blood pressure
- Development of red blood cells

Urinary System

- Female anatomy
  - Urinary and reproductive systems distinct
- Male anatomy
  - Systems share some structures
  - Urine and semen secreted from the same place
  - Therefore the term genitourinary system
- Nephrology
  - Branch of medicine devoted to renal disorders

Non-Traumatic Tissue Problems

- Inflammatory or immune-mediated disease
- Infectious disease
- Physical obstruction
- Hemorrhage

Basis of Pain

- Triggers
  - Damage to epithelial lining of an organ exposed underlying tissue
  - Stretching forces when an organ is inflamed
- Similar presentations of GI and urologic problems
  - Differentiation is difficult when the only complaint is pain

Types of Pain

- Visceral
  - Aching, crampy, poorly located
  - Hollow structures
  - Ureters, urethra, urinary bladder, vas deferens, epididymus
- Referred
  - Location other than the site of origin
  - Polynephritis results in flank pain

Assessment

- Steps the same as for abdominal emergencies
- Specific signs
  - Lloyd's sign
    - Pain on percussion of costovertebral angle
  - Indicative of pyelonephritis

General Management

- Airway, breathing circulation
- Pharmacologic interventions
  - IV access and analgesics
- Nonpharmacological interventions
  - Treat patients as potential surgical cases
- Transport considerations

Renal and Urologic Emergencies

- Risk Factors
  - Older patients
  - History of diabetes
  - History of hypertension
  - Multiple risk factors
- Renal and Urologic Emergencies
  - Acute renal failure
  - Chronic renal failure
  - Renal calculi
  - Urinary tract infection

Acute Renal Failure

- Sudden drop in urine output
  - Often over a period of days
  - Output of less than 400 to 500 mL
- Oliguria
  - Decreased urine elimination
- Anuria
  - No elimination of urine

Acute Renal Failure

- Prerenal acute renal failure
  - Dysfunction before the level of kidneys
  - Most common and most easily reversible
- Renal acute renal failure
  - Dysfunction within the kidneys themselves
- Postrenal acute renal failure
  - Dysfunction distal to the kidneys

Table 33-1 Causes of Prerenal, Renal, and Postrenal Acute Renal Failure (ARF)

Prerenal ARF	Renal ARF	Postrenal ARF
Hypovolemia (hemorrhage, dehydration, burns)	Small vessel/glomerular damage (vasculitis—often immune-mediated, acute glomerulonephritis, malignant hypertension)	Abrupt obstruction of both ureters (secondary to large stones, blood clots, tumor)
Cardiac failure (myocardial infarction, congestive heart failure, valvular disease)	Tubular cell damage (acute tubular necrosis—either ischemic or secondary to toxins)	Abrupt obstruction of the bladder neck (secondary to benign prostatic hypertrophy, stones, tumor, clots)
Cardiovascular collapse (shock, sepsis)	Interstitial damage (acute pyelonephritis, acute allergic interstitial reactions)	Abrupt obstruction of the urethra (secondary to inflammation, infection, stones, foreign body)
Renal vascular anomalies (renal artery stenosis, or thrombosis, embolism of renal vein)		

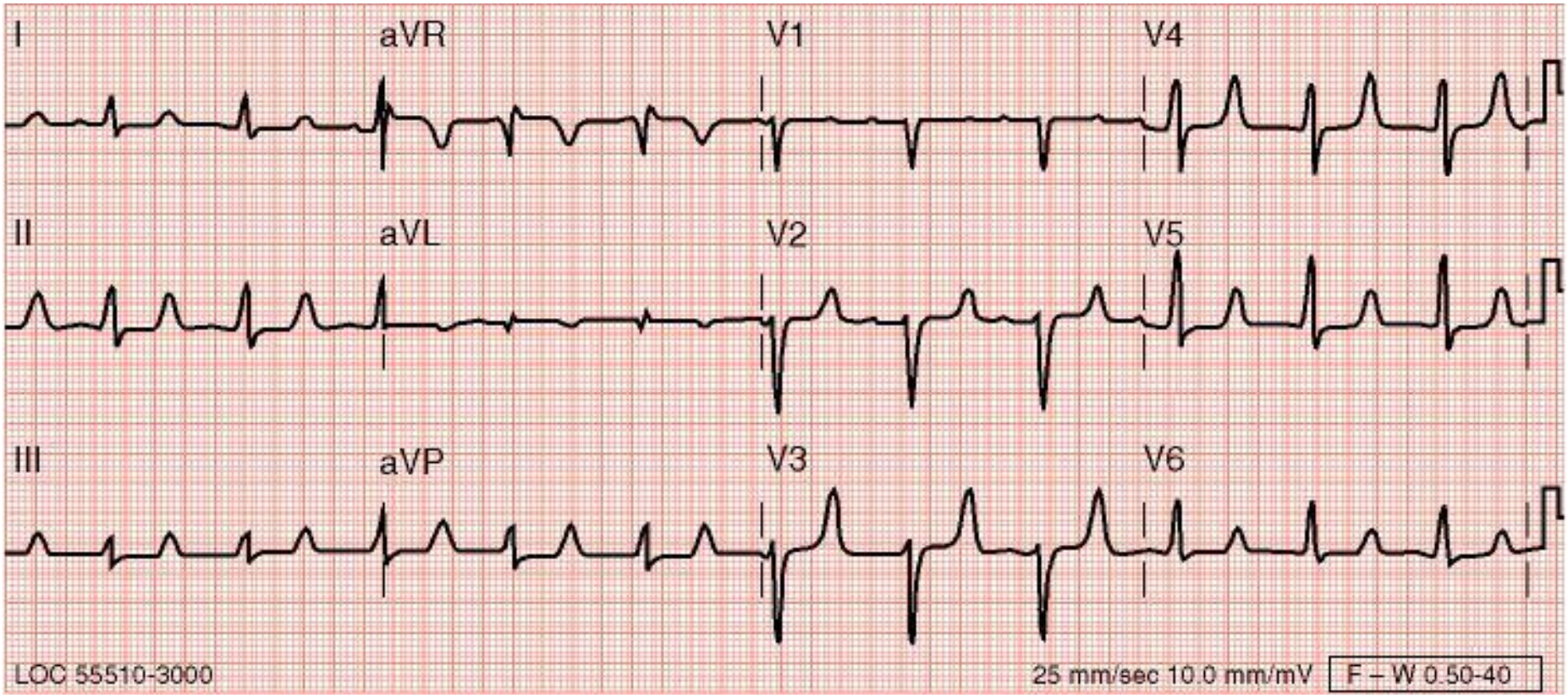
Note: ARF secondary to transplant rejection is considered an immune-mediated form of renal ARF.

Pathophysiology

- As kidneys fail:
  - Less urine produced
  - Water and electrolytes retained
    - Hypertension and increased systemic vascular resistance
    - Profound acidosis (H^+ retained)
    - Electrolyte imbalances (K^+)

Renal Failure

- ECG changes associated with hyperkalemia



History Questions

- When was the decrease in urine first noticed?
  - Changes since then
- Has the patient noticed
  - Edema in face, hands or torso
  - Heart palpitations or irregular rhythm
  - Decreased mental function

Pedal Edema

- Edema of the feet consistent with fluid retention in acute renal failure

Management

- Monitoring and supporting ABCs is vital
  - Prone to life threatening metabolic derangements
- Oxygen therapy
- Protect fluid volume and cardiovascular function
  - Positioning
  - Fluids
  - Medications

Chronic Renal Failure

- Inadequate kidney function due to permanent loss of nephrons
  - Usually at least 70% of nephrons lost
- End-stage renal failure
  - Occurs when at least 80% of nephrons lost
  - Metabolic instability
  - Patient will require dialysis or transplant

Table 33-2 Causes of Chronic Renal Failure

Type of Tissue Injury	Examples
Microangiopathy, glomerular injury	Systemic hypertension, diabetes mellitus, atherosclerosis, glomerulonephritis, systemic lupus erythematosus
Tubular cell injury	Nephrotoxins including analgesics and heavy metals, stones, obstruction at bladder neck or urethra
Interstitial injury	Infections including pyelonephritis, tuberculosis

Note: Congenital disorders resulting in CRF include polycystic disease and renal hypoplasia.

Chronic Renal Failure

- Cycle of nephron damage
- Functional nephrons adapt
  - Decreases resistance in glomerular vessels
  - Hypertrophy of capillaries
  - Increased tubular reabsorption
  - Cellular hypertrophy
- Compensatory mechanisms damage nephrons
  - Most of the damage at the glomeruli
- Adaptive changes

Functional Disturbances

- Maintenance of blood volume with proper balance of water, electrolytes, and pH
  - Increased sodium, water and potassium retention
- Retention of key compounds such as glucose with excretion of wastes such as urea
  - Loss of glucose and buildup of urea within the blood

Functional Disturbances

- Control of arterial blood pressure
  - Renin-angiotensin disrupted
  - Severe hypertension and CHF
- Regulation of erythrocyte production
  - Chronic anemia
  - Contributes to cardiac failure

Assessment

- Differentiate between chronic and acute presentation
- Kidneys affect almost every organ in the body
  - Must assess all systems
- Gastrointestinal complaints
- Changes in mental status
  - Ominous finding
- Uremic frost

Table 33-3 Common Elements of Uremic Syndrome

System	Pathophysiology	Clinical Sign/Symptom
Fluid/Electrolyte	Water/Na^+ retention	Edema, arterial hypertension[1]
	K^+ retention	Hyperkalemia[1]
	H^+ retention	Metabolic acidosis
	PaO_2 retention	Hyperphosphatemia/hypocalcemia[1]
Cardiovascular/Pulmonary	Fluid volume overload	Ascites, pulmonary edema
	Arterial hypertension	Congestive heart failure, accelerated atherosclerosis
	Dysfunctional fat metabolism; retention urea, other wastes	Pericarditis
Neuromuscular		
Central Nervous System	Retention urea, other wastes	Headache, sleep disorders, impaired mentation, lethargy, coma, seizures
Skeletal Muscle	Retention urea, other wastes; hypocalcemia	Muscular irritability and cramps, muscle twitching
Gastrointestinal (GI)	Retention urea, other wastes	Anorexia, nausea, vomiting
	Impaired hemostasis	Peptic ulcer, GI bleeding
Endocrine-Metabolic	Low vitamin D, other factors	Osteodystrophy
	Cellular resistance to insulin	Glucose intolerance
	Mechanisms unclear	Poor growth and development, delayed sexual maturation[2]
Dermatologic	Chronic anemia	Pallor skin, mucous membranes
	Retention urea, pigments	Jaundice, uremic frost
	Clotting disorders	Ecchymoses, easy bleeding
	Secondary hyperparathyroidism	Pruritus, scratches
Hematologic	Lack of renal erythropoeitin	Chronic anemia
	Impaired platelet function and prothrombin consumption	Impaired hemostasis, with easy bleeding, bruising; splenomegaly
Immunologic	Lymphopenia, general leukopenia	Vulnerability to infection

[1] Although relatively uncommon, fluctuations to the other extreme (example, hypokalemia) may occur if oral intake is poor over prolonged period or during or after dialysis treatment.

[2] Primarily seen in children, adolescents, young adults.

Management

- Monitor and support ABCs
- Establish IV access
  - Regulate fluid volume
- Monitor vital signs and cardiac rhythm
- Expedite transport to appropriate facility
  - Dialysis unit

Renal Dialysis

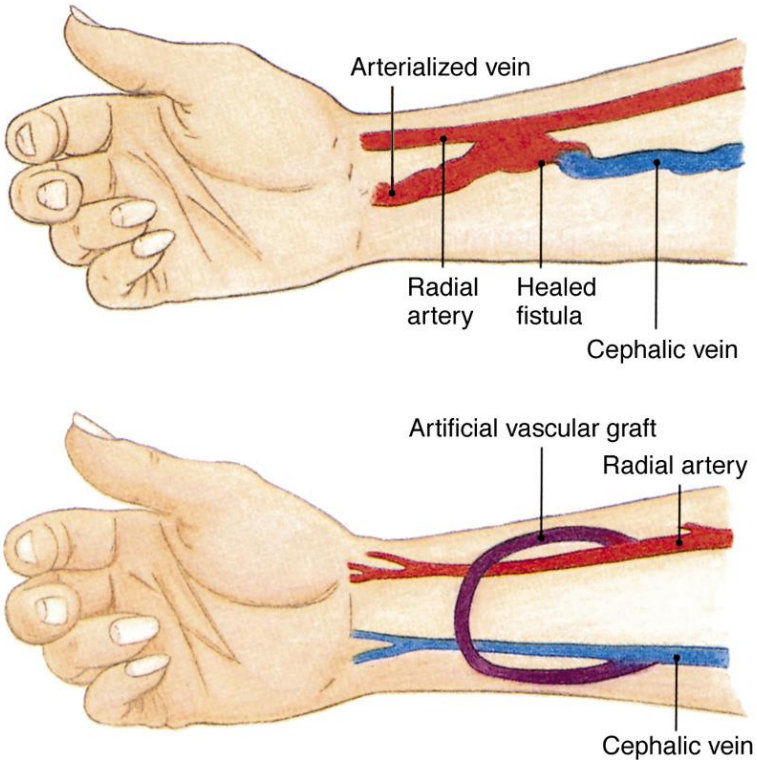
- Artificial replacement of some of kidney's function
- Blood flows past a semi-permeable membrane
  - Cleansing solution on the other side
- Temporarily eliminates volume overload and toxic metabolites

Hemodialysis

- Blood passes through a machine
  - Artificial membrane
  - Dialysate solution
- Vascular access required
  - Minimum blood flow of 300-400 ml/min
  - Often an internal fistula created surgically
- Can be performed in an outpatient clinic or at home

Fistulas and Grafts

- Vascular access for hemodialysis via arteriovenous fistula and artificial graft



Complications

- Complications related to vascular access
  - Bleeding from puncture site
  - Local and systemic infection
  - Thrombosis
- Narrowing or closing of the internal fistula

Peritoneal Dialysis

- Uses the peritoneal membrane as the semipermeable membrane
- Diasylate solution introduced via an indwelling catheter
- Greatly improved technique
- Most common complication is infection

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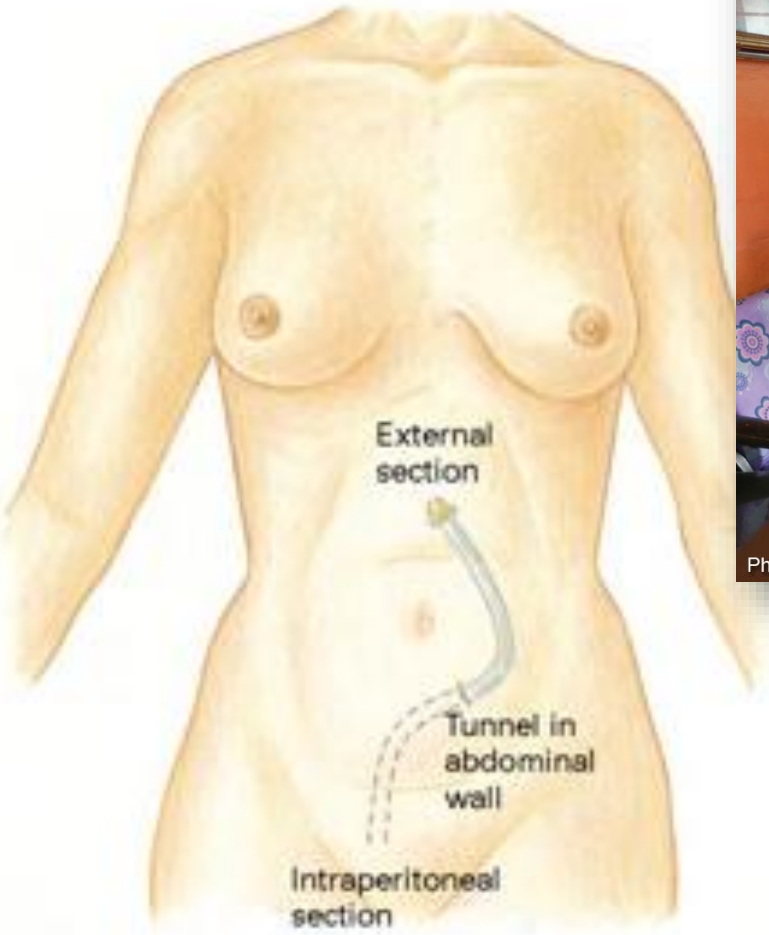
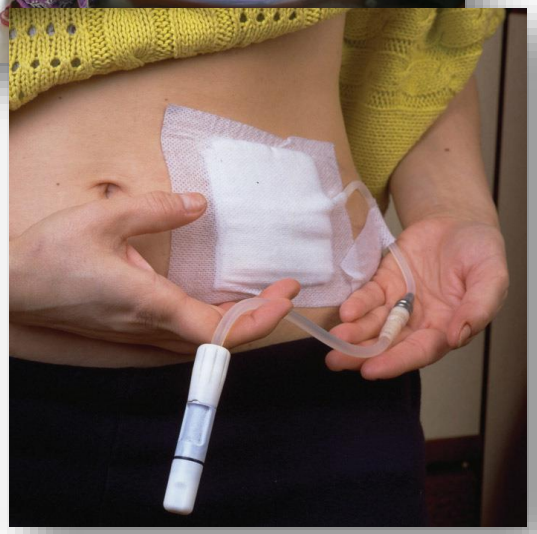
Peritoneal Dialysis





Renal Calculi

- Kidney stones
- Crystal aggregation in the kidney's collecting system
  - Severe pain
  - Complications around hemorrhage and obstruction
- Risk factors
  - Heredity
  - Immobility
  - Certain medications

Renal Calculi

- Imbalance between water and insoluble substances
  - Mineral ions and uric acid
  - Concentrated urine with insoluble collections
- Stones consisting of calcium salts
  - Most common (especially in men)
- Struvite stones
  - Associated with urinary tract infection and frequent bladder catheterization
  - More common in women

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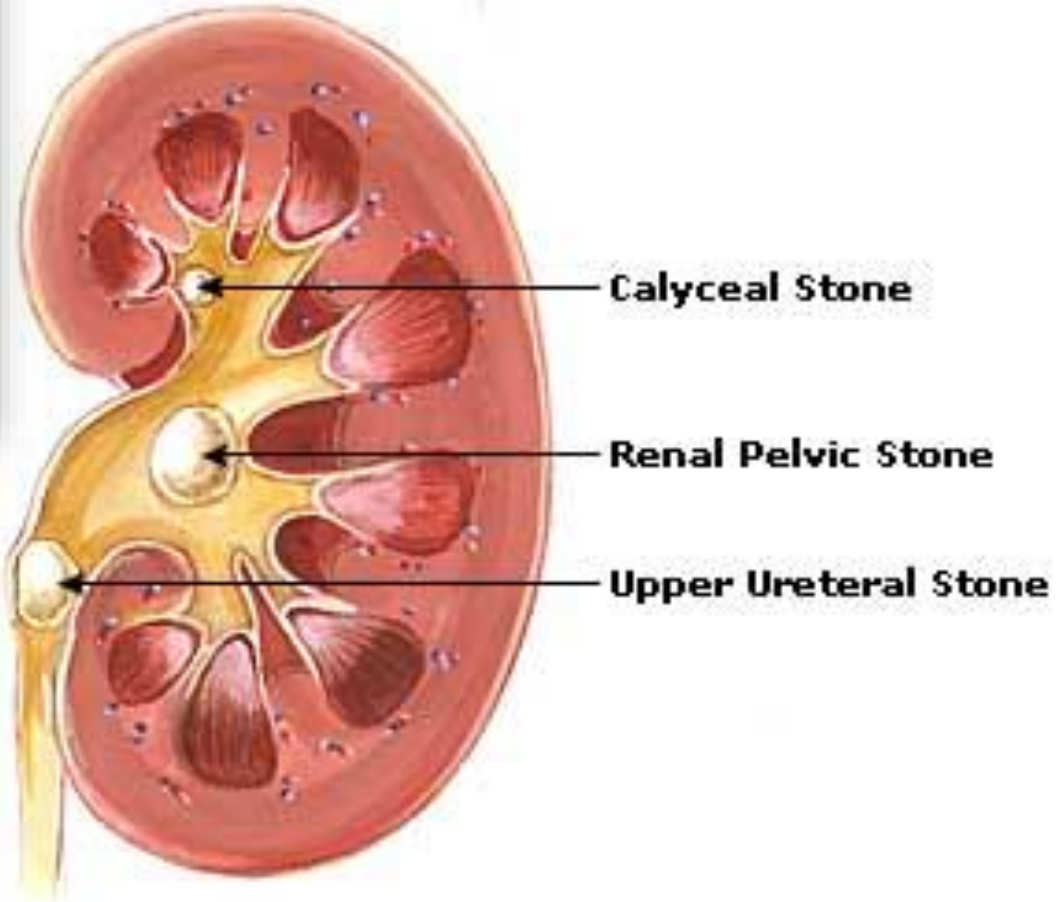
Renal Calculi



Assessment

- Focused history almost always centres on pain
  - One of the most severe
- Sharp flank pain
  - Migrates/radiates into groin
- Increased frequency, urgency, painful urination
- Hematuria
- Restlessness and agitation

Management

- Maintain ABCs.
- Maintain position of comfort.
- Establish IV access.
  - Fluid bolus may promote stone movement and urine formation.
- Consider medication administration.
  - Parenteral narcotic analgesics may be indicated.

Urinary Tract Infection (UTI)

- Infection (usually bacterial) at any site in the urinary tract
- Risk factors
  - Females
    - Relatively short urethra promote bacterial colonization
  - Paraplegics with urinary catheters
  - Diabetics
- Promotes urinary stasis
  - Incomplete emptying of the bladder

Lower Urinary Tract Infection

- More common
  - Seeding of bloodstream with bacteria is rare
  - Bacterial colonization of the urethra is common
  - Especially in women
- Urethritis (urethra)
- Cystitis (bladder)
- Prostatitis (prostate)

Upper Urinary Tract Infection

- Usually evolves from an infection that migrates upward
- Pyelonephritis
  - Inflammation of the renal parenchyma
  - Pregnant and during sexual activity
- Intrarenal abscess
- Perinephric abscess

Urinary Tract Infection

- Community acquired
  - Non-hospitalized patients and patients not undergoing medical treatment
  - E. coli accounts for ~80%
- Nosocomial
  - Acquired in hospital or related to catheterization
  - Proteus, Klebsieia, Pseudamonas

Assessment

- Focused on three symptoms
  - Painful burning urination
  - Frequent urge to urinate
  - Difficulty beginning and continuing to void
- Physical exam
  - Restlessness, uncomfortable appearance
  - Fever
  - Vital signs may vary with pain

Management

- Maintain ABCs
- Establish IV access
- Consider analgesics
- Transport to appropriate facility

Summary

- General mechanisms
- General pathophysiology
- General assessment
- General management
- Renal and urologic emergencies