Lecture 16

Pathology and Clinical Science 1 (BIOC211)

Department of Bioscience

Text Reference:
Session Learning Objectives

This session aims to:

- Understand the use of various diagnostic tests and procedures for the disorders related to the urinary system.
- Comprehend how and why the symptoms and signs of urinary disorder appears
- Discuss the causes and management of acute and chronic renal failure
URINARY SYSTEM

THE KIDNEYS

TYPES OF NEPHRON CELLS

- The Glomerulus is made up of four types of cells
  - Endothelial cells
    - Fenestrated with 500-1000 pores
  - Visceral epithelial cells (podocytes)
    - Support the delicate glomerular basement membrane
  - Parietal epithelial cells
    - Cover the bowman’s capsule
  - Mesangial cells
    - Modified smooth muscle cells of RE system

- Juxtaglomerular cells
  - Macula densa cells in the thick ascending limb of the loop of Henle
THE FILTRATION MEMBRANE

FLOW OF URINE THROUGH THE NEPHRON

Path of urine drainage:

- Urine produced in the Nephron → collecting duct → papillary duct → minor calyx (one for each pyramid) → major calyx (2-3) → renal pelvis (single large cavity) → Ureter → urinary bladder → urethra.
Filtration

- Glomerular filtration
- Tubular reabsorption
- Tubular secretion

**GLOMERULAR Pressures**

- **Glomerular blood hydrostatic pressure (GBHP)** = 55mmHg
- **Capsular hydrostatic pressure (CHP)** = 15mmHg
- **Blood Colloid Osmotic pressure (BCOP)** = 30mmHg
- **Net filtration pressure (NFP)**
  - = GBHP - CHP - BCOP
  - = 55 - 15 - 30 = 10mmHg

CLINICAL EXAMINATION

Clinical presentation may include:

- Hands – brown line pigmentation
- Skin – complexion, bruising, pruritus
- BP - often elevated
- Fundoscopy – hypertensive changes in eyes
- Heart and lungs – auscultation of heart sounds, breath sounds
- Abdomen – enlarged kidney, tenderness
- Sacral and ankle oedema
INVESTIGATION OF RENAL AND URINARY TRACT DISEASE

Tests of function

- Blood urea, serum creatinine
- GFR
- Urinalysis

http://www.mortonmedical.co.uk/images/Medi_Test_Combi_8_Urine_Test_Strips__Tube_of_100.jpg

http://bladder-health.net/images/hematuria.jpg

E-coli

http://www.gregorygordonmd.com/images/urine-culture.jpg
INVESTIGATION OF RENAL AND URINARY TRACT DISEASE

- **Imaging**
  - Plain X ray abdomen
  - Ultrasound
  - Intravenous urography (IVU)
  - Pyelography
  - Renal angiography and venography
  - CT
  - MRI

- **Other tests**
  - Radionuclide studies
  - Renal biopsy / Cystoscopy
### Clinical Presentations of Renal & Urinary Tract Disease

<table>
<thead>
<tr>
<th>Condition</th>
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<tbody>
<tr>
<td>Cystitis and UTIs</td>
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<tr>
<td>Haematuria</td>
</tr>
<tr>
<td>Loin pain/renal colic</td>
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<tr>
<td>Oedema</td>
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<tr>
<td>Excessive micturition</td>
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<tr>
<td>Hypertension</td>
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<tr>
<td>Reduced micturition</td>
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<tr>
<td>Acute renal failure</td>
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<tr>
<td>Erectile dysfunction</td>
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<tr>
<td>Chronic renal failure</td>
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<td>Proteinuria</td>
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Pain associated with Urinary System Disorders

Possible Pain Presentation

○ Back radiating to flank
○ Flank/loin radiating to groin
CYSTITIS AND URINARY TRACT INFECTION

- Most common bacterial infection in general practice
- Up to 50% of women have a UTI at sometime, uncommon in males
- Incidence increases with age

**Causes**

- 75% of infections by *Escherichia coli* derived from fecal reservoir
- Other organisms are *Proteus*, *Pseudomonas*, *Streptococci* & *Staphylococci*
- Most are ascending infections
Microbe Invasion

Microbe Invasion
# CYSTITIS AND URINARY TRACT INFECTION

## Predisposing factors

- Female - short urethra
- Minor urethral trauma - sexual intercourse
- Inadequate perineal hygiene
- Instrumentation of bladder
- Residual urine left after voiding
  - Obstruction below bladder – benign prostatic hyperplasia (BPH)
  - Gynecological abnormalities
  - Vesico-ureteric reflux
  - Neurological problems
Vesico-ureteric Reflux

http://www.urologyhealth.org/urology/articles/images/anatomy_Vesicoureteral_reflux.jpg

http://4.bp.blogspot.com/_ZqtoZ58XLq0/Sq0AlksudLI/AAAAAAAL4/wa4KiJMotZw/s400/vur.jpg
# CYSTITIS AND URINARY TRACT INFECTION

## Clinical features

- Frequency of micturition
- Scalding pain in urethra during micturition (dysuria)
- Suprapubic pain in cystitis (during and after voiding)
- Urgency
- Cloudy urine with unpleasant smell
- Haematuria
CYSTITIS AND URINARY TRACT INFECTION

**Investigation**
- Microscopic examination and culture of urine
- Urine dipstick tests
- Full blood count
- Blood tests
- Pelvic and rectal exam
- Ultrasound or CT
- Intravenous Urogram (IVU)

**Management**
- Antibiotics
- Adequate fluid intake
CYSTITIS AND URINARY TRACT INFECTION

Other UTIs

• Persistent or recurrent UTI (can be due to underlying causes/disorders)
• Asymptomatic bacteriuria
• Catheter related bacteriuria
LOIN PAIN

Renal causes

• Renal stones
• Renal tumour
• Acute pyelonephritis
• Obstruction of the renal pelvis
**LOIN PAIN**

### Acute pyelonephritis
Kidneys are infected in minority of patients with lower UTI or bacteriuria

- **Pathology**
  - Caused by ascending infection from bladder
  - Acutely inflamed renal pelvis with small abscesses in renal parenchyma

- **Clinical features**
  - Loin pain, fever and tenderness over kidneys (classic triad)

- **Investigation and management**
  - Similar to lower UTI
# LOIN PAIN

## Renal colic

- Acute loin pain radiating to the groin (renal colic) together with haematuria is typical of ureteric obstruction most commonly due to calculi.
Kidney stones

KIDNEY STONES

STAGHORN CALCULI

EXCESSIVE MICTURITION

- **Polyuria** > 3L/day due to
  - Excess fluid intake
  - Osmotic diuresis
  - Diabetes insipidus

- **Nocturia** due to
  - Consequence of polyuria
  - Fluid intake or diuretic use in evening
  - Chronic kidney disease
  - Prostate enlargement

- **Frequency** due to
  - Consequence of polyuria
  - Diuretic use
  - UTIs
EXCESSIVE MICTURITION

Urinary incontinence

• Involuntary leakage of urine

• Types
  – Stress incontinence
  – Urgent incontinence
  – Continual incontinence
  – Overflow incontinence
  – Post-micturition dribble
  – Incontinence due to neurological disease
# REDUCED MICTURITION

## Oliguria

<table>
<thead>
<tr>
<th>Less than 300ml/day/ anuria &lt; 50ml/day</th>
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<tbody>
<tr>
<td>• Reduced urine production (pre-renal acute renal failure, rapidly progressive GN)</td>
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<tr>
<td>• Urinary tract obstruction (urinary calculi, prostate enlargement)</td>
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</tbody>
</table>
ERECTILE DYSFUNCTION

In 50% of men with advanced chronic kidney disease or on dialysis

- Causes
  - With reduced libido
    - Hypogonadism
    - Depression
  - With intact libido
    - Psychological - anxiety
    - Vascular insufficiency - atheroma
    - Neuropathic – Diabetes Mellitus, alcohol excess
    - Drugs – beta-blocker
HAEMATURIA

May be visible (frank) or invisible (microscopic)

○ Causes
  • Tumour
  • Stones
  • Infection
  • Trauma
  • Vascular – malformation, infarct
  • Glomerular disease
  • Clotting disorders
PROTEINURIA

More than 150 mg/day indicate renal damage (renal disease/ injury)

- Usually asymptomatic, large amount may make urine frothy
- Microalbuminuria is sign of glomerular abnormality
- In nephrotic syndrome, substantial amounts of protein are lost in the urine
OEDEMA

Pitting oedema reflects increased interstitial fluid

Renal causes

• Nephrotic syndrome (low serum albumin)
• Renal failure (volume expansion)

http://www.pathology.vcu.edu/education/dental2/images/case3-3.jpg
HYPERTENSION

- Common feature of renal parenchymal and vascular disease
- Early feature of glomerular disorders
ACUTE RENAL FAILURE

Sudden and usually reversible loss of renal function which develops over a period of days or weeks and usually accompanied by reduction in urine volume

Causes
- Prerenal
- Renal
- Postrenal
Renal Artery Stenosis
REVERSIBLE PRE-RENAL ACUTE RENAL FAILURE

Pathogenesis
- Due to fall in perfusion pressure (hypovolaemia, shock, heart failure or narrowing of renal arteries)

Management
- Identify and correct the underlying cause
ESTABLISHED ACUTE RENAL FAILURE

- May develop following severe or prolonged under-perfusion of the kidney (pre-renal ARF) → acute tubular necrosis

- In patients without obvious cause of pre-renal ARF, renal and post-renal causes must be considered

Clinical features – depend on underlying cause
- Usually reduced urine volumes
- Disturbances in water, electrolyte and acid base balance
- Uremic symptoms
ESTABLISHED ACUTE RENAL FAILURE

Management
- Emergency resuscitation
- Management of underlying cause
- Fluid and electrolyte balance
- Protein and energy intake
- Infection control
- Renal replacement therapy

Prognosis
- Depends on underlying cause
CHRONIC RENAL FAILURE

Irreversible deterioration in renal function develops over a period of years

**Common causes**

- Glomerular diseases (10-20%)
- Hypertension (5-20%)
- Diabetes mellitus (20-40%)
- Congenital & inherited diseases (polycystic kidneys) 5%
- Renal artery stenosis 5%
- Interstitial diseases 5-15%
- Systemic inflammatory disease (SLE, vasculitis)
- Unknown
CHRONIC RENAL FAILURE

Clinical Features

**Early**
- asymptomatic
- discovered on routine check-up
  - proteinuria
  - anemia
  - hypertension
  - raised blood urea and creatinine

**Late**
- end-stage renal failure and features of uremia
  - anemia
  - renal osteodystrophy
  - neuropathy
  - myopathy
  - hypertension
  - acidosis
  - endocrine abnormalities
  - susceptibility to infection
CHRONIC RENAL FAILURE

Management

Retarding the progression of CRF
- Control BP, diet

Renal replacement therapy
- Haemodialysis
- Peritoneal dialysis
- Renal transplantation

Limiting the complications
- Anemia
- Fluid and electrolyte balance
- Acidosis
- CVS disease and lipids
- Infection
- Bleeding
- Renal osteodystrophy
Readings and Resources

Resources:

- **Set Textbooks:**

- **Additional textbooks:**
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