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

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

HEMATOGENOUS INFECTION
Common agents:
Staphylococcus
E. coli

Bacteremia
Aorta

Intrarenal reflux

Vesicoureteral reflux

Deranged vesicoureteral junction

Bacteria enter bladder

Bacterial colonization

ASCENDING INFECTION

# 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**

<table>
<thead>
<tr>
<th>Clinical features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of micturition</td>
</tr>
<tr>
<td>Scalding pain in urethra during micturition (dysuria)</td>
</tr>
<tr>
<td>Suprapubic pain in cystitis (during and after voiding)</td>
</tr>
<tr>
<td>Urgency</td>
</tr>
<tr>
<td>Cloudy urine with unpleasant smell</td>
</tr>
<tr>
<td>Haematuria</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Caused by ascending infection from bladder</td>
</tr>
<tr>
<td>• Acutely inflamed renal pelvis with small abscesses in renal parenchyma</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clinical features</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Loin pain, fever and tenderness over kidneys (classic triad)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investigation and management</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Similar to lower UTI</td>
</tr>
</tbody>
</table>
## 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

<table>
<thead>
<tr>
<th>Polyuria</th>
<th>&gt; 3L/day due to</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Excess fluid intake</td>
<td></td>
</tr>
<tr>
<td>• Osmotic diuresis</td>
<td></td>
</tr>
<tr>
<td>• Diabetes insipidus</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nocturia</th>
<th>due to</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Consequence of polyuria</td>
<td></td>
</tr>
<tr>
<td>• Fluid intake or diuretic use in evening</td>
<td></td>
</tr>
<tr>
<td>• Chronic kidney disease</td>
<td></td>
</tr>
<tr>
<td>• Prostate enlargement</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency</th>
<th>due to</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Consequence of polyuria</td>
<td></td>
</tr>
<tr>
<td>• Diuretic use</td>
<td></td>
</tr>
<tr>
<td>• UTIs</td>
<td></td>
</tr>
</tbody>
</table>

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# EXCESSIVE MICTURITION

<table>
<thead>
<tr>
<th>Urinary incontinence</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Involuntary leakage of urine</td>
</tr>
<tr>
<td>• Types</td>
</tr>
<tr>
<td>– Stress incontinence</td>
</tr>
<tr>
<td>– Urge incontinence</td>
</tr>
<tr>
<td>– Continual incontinence</td>
</tr>
<tr>
<td>– Overflow incontinence</td>
</tr>
<tr>
<td>– Post-micturition dribble</td>
</tr>
<tr>
<td>– Incontinence due to neurological disease</td>
</tr>
</tbody>
</table>
REDUCED MICTURITION

Oliguria

<table>
<thead>
<tr>
<th>Less than 300ml/day/ anuria&lt;50ml/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduced urine production (pre-renal acute renal failure, rapidly progressive GN)</td>
</tr>
<tr>
<td>• Urinary tract obstruction (urinary calculi, prostate enlargement)</td>
</tr>
</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
<table>
<thead>
<tr>
<th>PROTEINURIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 150 mg/day indicate renal damage (renal disease/ injury)</td>
</tr>
<tr>
<td>- Usually asymptomatic, large amount may make urine frothy</td>
</tr>
<tr>
<td>- Microalbuminuria is sign of glomerular abnormality</td>
</tr>
<tr>
<td>- In nephrotic syndrome, substantial amounts of protein are lost in the urine</td>
</tr>
</tbody>
</table>
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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