Kidney & Urinary Tract Disease – Dr. Alaa

Anatomy and Physiology

- Adult kidneys are 11-14 cm in length, located in the retroperitoneal area on either side of aorta and IVC.
- The right kidney is usually a few centimeters lower (because the liver lies above it)
- Each kidney contain approx. 1000000 nephrons, which receive rich blood supply (20-25% of cardiac output)

Nephrons

Which involve:

- The glomerulus (afferent arteriole, efferent arteriole, bowman's capsule)
- Proximal convoluted tubule
- Loop of Henle
- Distal convoluted tubule
- Collecting tubule

Functions of the kidneys

- Excretion of nitrogenous waste products and toxins.
- Body fluid control.
- Electrolyte balance.
- Acid – base balance
- Endocrine function:
  1. Erythropoietin production
  2. Activation of vitamin D
  3. Renin-angiotensin production
- Large volumes of an ultrafiltrate of plasma (120 ml/min, 170 litres/day) at the glomerulus, and selectively reabsorbing components of this ultrafiltrate at points along the nephron.
- The rates of filtration & reabsorption are under the control of many hormonal and haemodynamic signals.
- The kidney is the main source of erythropoietin, which is produced by interstitial peritubular cells in response to hypoxia. Replacement of erythropoietin reverses the anaemia of chronic renal failure.
- The kidney is essential for vitamin D metabolism; it hydroxylates 25-hydroxycholecalciferol to the active form, 1, 25-dihydroxycholecalciferol. Failure of this process contributes to the hypocalcaemia and bone disease of chronic renal failure.

Renin is secreted from the juxtaglomerular apparatus in response to

1. Reduced afferent arteriolar pressure
2. Stimulation of sympathetic nerves
3. Changes in sodium content of fluid in the distal convoluted tubule at the macula densa

Renin generates angiotensin II, which causes:

1. Aldosterone release from the adrenal cortex,
2. Constricts the efferent arteriole of the glomerulus and thereby increases glomerular filtration pressure.
3. Induces systemic vasoconstriction.
- By these mechanisms, the kidneys 'defend' circulating blood volume, blood pressure and glomerular filtration during circulatory shock. However, the same mechanisms lead to systemic hypertension in renal ischaemia.
Mechanisms of micturition and urinary continence

- Continence is dependent on anatomical structures, and on neurological and muscle (sphincter and detrusor) function.
- Parasympathetic nerves arising from S2-4 stimulate detrusor contraction, resulting in micturition.
- Sympathetic nerves arising from T10-L2 relay in the pelvic ganglia and produce detrusor relaxation and contraction of the bladder neck (both via α-adrenoceptors).
- The distal sphincter mechanism is innervated by somatic motor fibres from sacral segments S2-4 which reach the sphincter either by the pelvic plexus or via the pudendal nerves.
- Afferent sensory impulses pass to the cerebral cortex, from where reflex-increased sphincter tone and associated suppression of detrusor contraction inhibits micturition until it is appropriate.
- These factors operate in a coordinated fashion in the micturition cycle, which has a 'storage' (or 'filling') phase and a 'voiding' (or 'micturition') phase.
- At approximately 75% bladder capacity there is a desire to void. Voluntary control is now exerted over the desire to void, which disappears temporarily.
- The act of micturition is initiated first by voluntary and then by reflex relaxation of the pelvic floor and distal sphincter mechanism, followed by reflex detrusor contraction.
- These actions are coordinated by the pontine micturition centre.

Investigation of Renal and Urinary Tract Disease

- Tests of function
- Imaging techniques
- Other tests (radionuclide studies, renal bx.)
- Renal excretory function can be assessed by measuring serum levels of compounds excreted by the kidney, commonly the products of protein catabolism (urea and creatinine).
- Blood urea is a poor guide to renal excretory function as it varies with protein intake, liver metabolic capacity and renal perfusion.
- Serum creatinine is more reliable as it is produced from muscle at a constant rate and almost completely filtered at the glomerulus.
- If muscle mass remains constant, changes in creatinine concentration reflect changes in GFR.
- However, an increase outside the normal range is typically not seen until GFR is reduced by about 50%, and isolated measurements of serum creatinine may give a misleading impression of renal function, particularly if muscle mass is unusually small (or large).
- Urine measurements to derive creatinine clearance provide a reasonable approximation of the GFR.
- More accurate measurement of GFR is now most easily undertaken by ascertaining the clearance of 51Cr-labelled ethylene diamine-tetra acetic acid (EDTA).
- The blood filtered through the glomerulus in a rate of 90-120 cc/min. (170L/day) and we use the creatinine clearance as approximation of glomerular filtration rate.
- Creatinine clearance= ( 140 - age) wt / (s. creatinine) (72)
- Creatinine clearance in Female=___________* 0.85
- Cr cl =U Cr * v / S Cr * Time ( min)

Urinalysis

- Dipstick test
- GUE (Macro., Micro., SG., PH )
- 24 h urine (Cr. Cl., prot, electrolytes & exc. Compounds).
- Fractional Excretion of sodium. (Normal FENa = 1)
- Examination of an aliquot of urine provides important information on kidney function.
- Dipsticks may be used to screen for blood and protein semi-quantitatively.
Urine microscopy can detect

- Red cells of glomerular origin and red cell casts, indicative of intrinsic renal disease,
- White blood cells and bacteria seen in urine infections.
- Crystals (e.g. of calcium oxalate, cysteine or urate) may be seen in renal calculus disease, although calcium oxalate and urate crystals are also sometimes found in normal urine that has been left to stand.
- Urine pH can provide diagnostic information in the assessment of renal tubular acidosis
- Persistently low specific gravity will be found in diabetes insipidus.

Timed urine collections can be used (24 h)

- To measure creatinine clearance as a surrogate for GFR
- Can provide a quantitative measure of urinary protein loss.
- Measure urinary excretion rates of compounds such as calcium, oxalate & urate that can form renal calculi.
- Simple measurement of tubular excretory function can be made by comparison of blood and urine ratios of electrolytes to creatinine.
- Fractional excretion of sodium (= urinary Na/plasma Na × plasma creatinine/urine creatinine).
- It is reduced in volume depletion when the tubules are avidly conserving sodium, and increased in the tubular damage associated with acute tubular necrosis.

Imaging Techniques

Plain X-rays (KUB)

- May show the renal outlines,
- Opaque calculi and calcification within the renal tract.

Ultrasound

- It can show renal size and position
- Detect dilatation of the collecting system (suggesting obstruction),
- Distinguish tumours and cysts,
- Show other abdominal, pelvic and retroperitoneal pathology.
- Can image prostate & bladder, & estimate completeness of emptying in suspected bladder outflow obstruc.
- Images are often less clear in obese individuals.
- In chronic renal disease (signs of chronicity):
  1. Ultrasonographic density of the renal cortex is increased (increase echogenicity)
  2. Corticomedullary differentiation is lost.
  3. Thin cortical thickness.
  4. Small size kidneys.
     o Except in (MM, DM, Amyloidosis)

Ultrasound (Doppler)

- Used to show blood flow in extrarenal and larger intrarenal vessels.
- The resistivity index (RI) is the ratio of peak systolic and diastolic velocities, & is influenced by the resistance to flow through small intrarenal arteries (Normal RI = 0.7). It may be elevated in various diseases, including:
  1. Acute glomerulonephritis and
  2. Rejection of a renal transplant.
- Severe renal artery stenosis causes damping of flow in intrarenal vessels with high peak velocities.
Intravenous urography (IVU)

- The technique provides excellent definition of the collecting system and ureters, and remains superior to ultrasound for examining renal papillae, stones and urothelial malignancy.
- X-rays are taken at intervals following administration of an intravenous bolus of an iodine-containing compound that is excreted by the kidney.
- The disadvantages of this technique are the need for an injection, time requirement, dependence on adequate renal function for good images, and risk of exposure to contrast medium and irradiation.

Pyelography

- Pyelography (direct injection of contrast medium into the collecting system from above or below) offers the best views of the collecting system and upper tract, and is commonly used to identify the cause of urinary tract obstruction.
- Antegrade pyelography requires the insertion of a fine needle into the pelvicalyceal system under ultrasound or radiographic control. Contrast is injected to outline the collecting system, and particularly to localise the site of obstruction.
- Retrograde pyelography can be performed by inserting catheters into the ureteric orifices at cystoscopy.

Renal arteriography and venography

- The main indication for renal arteriography is to investigate suspected renal artery stenosis or haemorrhage.
- Therapeutic balloon dilatation and stenting of the renal artery may be undertaken, and bleeding vessels or arteriovenous fistulae occluded.

Computed tomography (CT)

- CT is particularly useful for characterising mass lesions within the kidney, or combinations of cysts with masses. It gives clear definition of retroperitoneal anatomy regardless of obesity.
- New developments in spiral CT enable three-dimensional arteriograms to be obtained. This produces high-quality images of the main renal vessels and is of value in trauma, renal haemorrhage and the investigation of possible renal artery stenosis. The speed of image acquisition also enables functional assessment and enhancement of vascular structures, e.g. angiomyolipomas.
- CT is also useful for demonstrating renal stones, and in many centres CT urography is replacing IVU as the first radiological investigation for renal colic. However, there are risks of exposure to contrast medium.

Magnetic resonance imaging (MRI)

- MRI offers excellent resolution and distinction between different tissues.
- Magnetic resonance angiography (MRA) uses gadolinium-based contrast media which are non-nephrotoxic, & avoids risk of atheroemboli which accompany invasive angiography. It can produce good images of main renal vessels, although the resolution is not yet sufficient to exclude branch artery stenosis.
- These techniques are likely to develop further and are finding an important role in non-invasive screening for renal artery stenosis.

Radionuclide studies

- These are functional studies requiring the injection of gamma ray-emitting radiopharmaceuticals which are taken up and excreted by the kidney,
- A process which can be monitored by an external gamma camera.
99mTc-DTPA

- Diethylene triamine-penta acetic acid labelled with technetium (99mTc-DTPA) is excreted by glomerular filtration.
- DTPA injection and analysis of uptake and excretion provides information regarding the arterial perfusion of each kidney. A typical pattern of prolonged transit time, delayed peak activity and reduced excretion is seen in renal artery stenosis.
- In patients with significant obstruction of the outflow tract, persistence of the nuclide in the renal pelvis is seen, and a loop diuretic fails to accelerate its disappearance.

99mTc-DMSA

- Di mercapto succinic acid labelled with technetium (99mTc-DMSA) is filtered by glomeruli and partially bound to proximal tubular cells.
- Following intravenous injection, images of the renal cortex show the shape, size and function of each kidney.
- This is a sensitive method of demonstrating early cortical scarring that is of particular value in children with vesico-ureteric reflux and pyelonephritis.
- It is also possible to assess the relative contribution of each kidney to total function.

Renal Complications of Radiological Investigations

A. Contrast nephrotoxicity

- An acute deterioration in renal function, sometimes life-threatening, commencing < 48 hrs after administration of i.v. radiographic contrast media
- Risk factors
  - Pre-existing renal impairment
  - Use of high-osmolality, ionic contrast media and repetitive dosing in short time periods
  - Diabetes mellitus
  - Myeloma
- Prevention
  - Hydration-e.g. free oral fluids plus i.v. isotonic saline 500 ml then 250 ml/hr during procedure
  - Avoid nephrotoxic drugs and diuretics ; withhold non-steroidal anti-inflammatory drugs (NSAIDs); omit metformin for 48 hrs before and after procedure
  - N-acetyl cysteine, Aminophyline, sodium bicarbonate ( may provide protection).
  - If the risks are high, consider alternative methods of imaging

B. Cholesterol atheroembolism

- Typically follows days to weeks after intra-arterial investigations.

Renal Biopsy

Indications

- Acute renal failure that is not adequately explained
- Chronic renal failure with normal-sized kidneys
- Nephrotic syndrome or glomerular proteinuria in adults
- Nephrotic syndrome in children that has atypical features or is not responding to treatment
- Isolated haematuria or proteinuria with renal characteristics or associated abnormalities
Before the Bx.

- BP normal, Cooperative pt.

IxDF

- CBC
- PT, PTT,
- Bleeding time
- Viral markers (HIV, HBs Ag. Anti HCV Ab.)

Contraindications

- Disordered coagulation or thrombocytopenia. Aspirin and other agents causing platelet dysfunction should be omitted for elective biopsies
- Uncontrolled hypertension
- Kidneys < 60% predicted size
- Solitary kidney (except transplants) (relative contraindication)

Complications

- Pain, usually mild
- Bleeding into urine, usually minor but may produce clot colic and obstruction
- Bleeding around the kidney, occasionally massive and requiring angiography with intervention, or surgery
- Arteriovenous fistula, rarely significant clinically

Presenting Problems in Renal and Urinary Tract Disease

CYSTITIS AND URINARY TRACT INFECTION

- When the urinary tract is anatomically and physiologically normal and local and systemic defense mechanisms are intact, bacteria are confined to the lower end of the urethra.
- UTI is defined as multiplication of organisms in the urinary tract. It is usually associated with the presence of neutrophils and > 105 (100 000) organisms/ml in a midstream sample of urine (MSU).
- Urinary tract infection (UTI) is the most common bacterial infection managed in general medical practice and accounts for 1-3% of consultations.
- Up to 50% of women have a UTI at some time. Prevalence of UTI in women is about 3% at the age of 20.
- In males UTI is uncommon, except in the first year of life and in men over 60, in whom urinary tract obstruction due to prostatic hypertrophy may occur.
- UTI causes morbidity and, in a small minority of cases, renal damage and chronic renal failure.
- Urine is an excellent culture medium for bacteria;
- In women, the ascent of organisms into the bladder is easier than in men because of the relatively short urethra and absence of bactericidal prostatic secretions.

Etiology of UTI

- Organisms causing UTI in the community include:
  o Escherichia coli (E. coli) derived from the gastrointestinal tract (about 75% of infections)
  o Proteus
  o Pseudomonas species
  o Streptococci
  o Staphylococcus epidermidis.
- In hospital, E. coli still predominates, but Klebsiella or streptococci are more common than in the community. Certain strains of E. coli have a particular propensity to invade the urinary tract.
**Risk Factors for UTI**

a. Incomplete bladder emptying:
   - Bladder outflow obstruction
   - Neurological problems (e.g. multiple sclerosis, diabetic neuropathy)
   - Gynaecological abnormalities (e.g. uterine prolapse)
   - Vesico-ureteric reflux

b. Foreign bodies
   - Urethral catheter or ureteric stent

c. Loss of host defenses
   - Atrophic urethritis and vaginitis in post-menopausal women
   - Diabetes mellitus

**The Spectrum of Presentations of UTI**

- Asymptomatic bacteriuria
- Symptomatic acute urethritis and cystitis
- Acute pyelonephritis
- Acute prostatitis
- Septicaemia (usually Gram-negative bacteria)

The 'urethral syndrome'

- Some patients, usually female, have symptoms suggestive of urethritis and cystitis but no bacteria are cultured from the urine (the 'urethral syndrome').
- Possible explanations include:
  1. Infection with organisms not readily cultured by ordinary methods (e.g. Chlamydia, certain anaerobes),
  2. Intermittent or very low-count bacteriuria
  3. Reaction to toilet preparations or disinfectants
  4. Symptoms related to sexual intercourse
  5. Post-menopausal atrophic vaginitis
- Antibiotics are not indicated

**Typical features of cystitis and urethritis include:**

- Abrupt onset of frequency of micturition
- Scalding pain in the urethra during micturition (dysuria)
- Suprapubic pain during and after voiding
- Intense desire to pass more urine after micturition, due to spasm of the inflamed bladder wall (urgency)
- Urine that may appear cloudy and have an unpleasant odour
- Microscopic or visible haematuria.
- Systemic symptoms are usually slight or absent. However, infection in the lower urinary tract can spread.
- Prominent systemic symptoms with fever and loin pain suggest the presence of acute pyelonephritis and may be an indication for hospitalisation.
- Prostatitis is suggested by systemic symptoms and prostatic tenderness.

**DDx**

- Urethritis due to sexually transmitted disease
- Reiter's syndrome.
**Investigations of UTI**

- Culture of MSU, or urine obtained by suprapubic aspiration
- Microscopic examination or cytometry of urine for white and red cells
- Dipstick examination of urine for nitrite and leucocyte esterase*
- Dipstick examination of urine for blood, protein and glucose
- Full blood count
- Plasma urea, electrolytes, creatinine
- Blood culture
- Pelvic examination, Rectal examination
- Renal ultrasound or CT, Intravenous urogram (IVU)
- Micturating cysto-urethrogram (MCU) or radioisotope study
- Cystoscopy

**Antibiotic Regimens for Treatment of UTI in Adults**

- Trimethoprim
- Nitrofurantoin
- Co-amoxiclav
- Ciprofloxacin
- Norfloxacin
- Cefuroxime
- Gentamicin
- Cefalexin

- Antibiotics are recommended in all cases of proven UTI. If urine culture has been performed, treatment may be started while awaiting the result.
- Trimethoprim is the usual choice for initial treatment. Between 10% and 40% of organisms causing UTI are resistant to trimethoprim.
- Nitrofurantoin, quinolone antibiotics such as ciprofloxacin and norfloxacin, and cefalexin are also generally effective.
- Co-amoxiclav or amoxicillin should only be used when the organism is known to be sensitive.
- Penicillins and cephalosporins are safe to use in pregnancy but trimethoprim, sulphonamides, quinolones and tetracyclines should be avoided.
- A fluid intake of at least 2 litres/day is usually recommended.
- Urinary alkalinising agents such as potassium citrate may help symptomatically but are not of proven efficacy.

**Persistent or Recurrent UTI**

- Treatment failure, with persistence of the causative organism on repeat culture, suggests that an underlying cause is present, which should be investigated and treated, if possible.
- Reinfection with a different organism, or with the same organism after an interval, may also occur.
- In women, recurrent infections are common and further investigation is only justified if infections are frequent (three or more per year) or unusually severe.
- Men and children with recurrent infections, and patients with signs of pyelonephritis or systemic infection should also be investigated.
- Recurrent UTI, particularly in the presence of an underlying cause, may result in permanent renal damage, whereas uncomplicated infections rarely (if ever) do so.
- If the underlying cause cannot be removed, suppressive antibiotic therapy can be used to prevent recurrence and reduce the risk of septicaemia and renal damage.
- Urine is cultured at regular intervals;
- A regime of two or three antibiotics in sequence, rotating every 6 months, is often used in an attempt to reduce the emergence of resistant organisms.
- Other simple measures may help to prevent recurrence.
Prophylactic Measures to be adopted by Women with Recurrent Urinary Infections

- Fluid intake of at least 2 litres/day
- Regular complete emptying of bladder
- If vesico-ureteric reflux is present, practice double micturition (empty the bladder then attempt micturition 10-15 minutes later)
- Good personal hygiene
- Emptying of the bladder before and after sexual intercourse

ASYMPTOMATIC BACTERIURIA

- This is defined as > 105 (100 000) /ml organisms in the urine of apparently healthy asymptomatic patients.
- Approximately 1% of children under the age of 1, 1% of schoolgirls, 3% of non-pregnant adult women and 5% of pregnant women have asymptomatic bacteriuria.
- It is increasingly common in those aged over 65.
- There is no evidence that this condition causes renal scarring in adults who are not pregnant and have a normal urinary tract, and in general, treatment is not indicated.
- Up to 30% of patients will develop symptomatic infection within 1 year.
- In infants and pregnant women, treatment is required and investigation is indicated.

CATHETER-RELATED BACTERIURIA

- In patients with a urethral catheter, bacteriuria increases the risk of Gram-negative patients as this may promote antibiotic resistance.
- Careful sterile insertion technique is important, and the catheter should be removed as soon as it is not required.

LOIN PAIN

Dull ache in the loin is rarely due to (intrinsic) renal disease but may be due to

- Renal stone,
- Renal tumour,
- Acute pyelonephritis
- Obstruction of the renal pelvis.
  - PUJ stenosis or obstruction
  - Retroperitoneal fibrosis
  - Sloughed renal papilla,
  - Tumour
  - Blood clot.

ACUTE PYELONEPHRITIS

- Acute renal infection (pyelonephritis) presents as a classic triad of loin pain, fever and tenderness over the kidneys.
- The renal pelvis is inflamed and small abscesses are often evident in the renal parenchyma.
- Histological examination shows focal infiltration by neutrophils, which can often be seen within the tubules.
Pathogenesis

- Renal infection is almost always caused by organisms ascending from the bladder, and the bacterial profile is the same as for lower urinary tract infection.
- Rarely, bacteraemia may give rise to renal or perinephric abscesses, (most commonly due to staphylococci).
- One or more complicating factors are often present; pre-existing renal damage, such as cyst formation or scarring, facilitates infection.
- The renal medulla may be particularly susceptible to infection because of:
  - The low oxygen tension
  - High osmolality (favours conversion of bacteria to antibiotic-resistant forms)
  - High concentrations of H+ and ammonia, which impair leucocyte function

Clinical assessment of pyelonephritis

- There is usually acute onset of pain in one or both loins, which may radiate to the iliac fossae and suprapubic area and is associated with tenderness and guarding in the lumbar region.
- About 30% of patients have dysuria due to associated cystitis.
- Fever is usually present and may be associated with rigors, vomiting and hypotension.

Ix

- Examination of urine reveals neutrophils, organisms, red cells and tubular epithelial cells.

Papillary necrosis

- Rarely, acute pyelonephritis is associated with papillary necrosis.
- Fragments of renal papillary tissue are passed per urethra and can be identified histologically.
- They may cause ureteric obstruction, and if this occurs bilaterally or in a single kidney, may cause acute renal failure.
- Predisposing factors include diabetes mellitus, chronic urinary obstruction, analgesic nephropathy and sickle-cell disease.

The differential diagnosis of acute pyelonephritis includes:

- acute appendicitis,
- diverticulitis,
- cholecystitis
- salpingitis.
- perinephric abscess

Management

- Adequate fluid intake must be ensured, if necessary by the intravenous route.
- Antibiotics are continued for 7-14 days.
- Severe cases require intravenous therapy, with a cephalosporin, quinolone or gentamicin, later switching to an oral agent. In less severe cases, oral antibiotics can be used throughout.
- Penicillins and cephalosporins are safe in pregnancy; other antibiotics should usually be avoided.
- Urine should be cultured during and after treatment.
RENAL COLIC

Etiology:

- Calculi
- Sloughed renal papilla
- Tumour
- Blood clot may be responsible

Urinary calculi

- Urinary calculi consist of aggregates of crystals containing small amounts of proteins and glycoprotein.
- Cal. Oxalate, and cal. Phosphate stones are common
- The stones contain magnesium, ammonium, phosphate (struvite; these are often associated with infection),
- Small numbers of pure cystine or uric acid stones are found.
- Rarely, drugs may form stones (e.g. indinavir, ephedrine).
- Staghorn calculi fill the whole renal pelvis and branch into the calyces, they are usually associated with infection and composed largely of struvite.

Nephrocalcinosis

- Deposits of calcium may be present throughout the renal parenchyma, especially seen in patients with:
  - Renal tubular acidosis
  - Hyperparathyroidism
  - Vitamin D intoxication
  - Healed renal tuberculosis

Predisposing Factors for Kidney Stones

A. Environmental and dietary
- Low urine volumes: high ambient temperatures, low fluid intake
- Diet: high protein intake, high sodium, low calcium
- High sodium excretion
- High oxalate excretion
- High urate excretion
- Low citrate excretion

B. Acquired causes
- Hypercalcaemia of any cause
- Ileal disease or resection (leads to increased oxalate absorption and urinary excretion)
- Renal tubular acidosis type I (distal)

C. Congenital and inherited causes
- Familial hypercalciuria
- Medullary sponge kidney
- Cystinuria
- Renal tubular acidosis type I (distal)
- Primary hyperoxaluria
Clinical assessment

- When a stone becomes impacted in the ureter, an attack of renal colic develops.
- There is pallor, sweating and often vomiting,
- Frequency, dysuria and haematuria may occur.

Investigations

- Investigations are required to confirm the presence of a stone, and to identify the site of the stone and degree of obstruction.
- GUE. for protein, blood, glucose
- Amino acids, crystals.
- Plain abdominal X-ray. IVU… spiral CT (gives the most accurate assessment and will identify non-opaque stones) (e.g. uric acid).
- Ultrasound
- Blood (Calcium, Phosphate, Uric acid, Urea and electrolytes, Parathyroid hormone-only if S.cacium or calcium excretion high)
- 24-hour urine (Urea, Creatinine clearance, Sodium, Calcium, Oxalate, Uric acid)
- Stone Chemical composition-most valuable when possible.

Management

- The immediate treatment of renal pain or renal colic is bed rest and application of warmth to the site of pain.
- Demands powerful analgesia, e.g. morphine (10-20 mg), pethidine (100 mg) intramuscularly or diclofenac as a suppository (100 mg).
- Advised to drink 2 litres per day.
- Antibiotics (if infection is associated)
- Around 90% of stones less than 4 mm in diameter will pass spontaneously, but only 10% of stones of more than 6 mm will pass and these may require active intervention.
- Most stones can now be fragmented by extracorporeal shock wave lithotripsy (ESWL).
- Endoscopic surgery is often required for stones.
- Open surgery is now almost never needed except for large bladder stones. All stones are potentially infected and surgery should be covered with appropriate antibiotics.

Measures to Prevent Calcium Stone Formation

A. Diet

- Fluid
  - At least 2 litres output per day (intake 3-4 litres)-check with 24-hr urine collections
  - Intake distributed throughout the day (especially before bed)
- Sodium (Restrict intake)
- Protein (Moderate; not high)
- Calcium
  - Plenty in diet (because calcium forms an insoluble salt with dietary oxalate, lowering oxalate absorption and excretion)
  - Avoid supplements away from meals (increase calcium excretion without reducing oxalate excretion)
- Oxalate (Avoid foods that are rich in oxalate).
B. Drugs

- Thiazide diuretics
  - Reduce calcium excretion
  - Valuable in recurrent stone-formers and patients with hypercalciuria
- Allopurinol
  - If urate excretion high
- Avoid
  - *Vitamin D supplements* as they increase calcium absorption and excretion
  - *Penicillamine* Stones formed in cystinuria can be reduced by therapy.
  - *Alter urine pH* with ammonium chloride (low pH discourages phosphate stone formation) or sodium bicarbonate (high pH discourages urate and cystine stone formation).

HAEMATURIA

- Haematuria may be visible and reported by the patient (macroscopic haematuria), or invisible and detected on dipstick testing of urine (microscopic haematuria).
- It indicates bleeding from anywhere in the renal tract
- Microscopy shows that normal individuals have occasional RBCs in the urine (up to 12 500 rbc/ml).
- The detection limit for dipstick testing is 15-20 000 rbc/ml, which is sufficiently sensitive to detect all significant bleeding.
- However, dipstick tests are also positive in the presence of free haemoglobin or myoglobin.
- Urine microscopy can be valuable in confirming haematuria and in establishing the cause of bleeding.
- True positive tests may occur during menstruation, infection or strenuous exercise, but persistent haematuria requires further investigation to exclude malignancy.

*Interpretation of Dipstick-Positive Haematuria*

- Haematuria (RBCs in urine)
  - White blood cells (Infection)
  - Abnormal epithelial cells (Tumour)
  - Red cell casts-Dysmorphic erythrocytes (Glomerular bleeding*)
- Haemoglobinuria
  - No red cells (Intravascular haemolysis)
- Myoglobinuria
  - No red cells (Rhabdomyolysis)
- Macroscopic (visible) haematuria is more likely to be caused by:
  - Tumours
  - Severe infections
  - Renal infarction (usually accompanied by pain.)
  - IgA nephropathy (Recurrent episodes of painless gross haematuria in association with respiratory infections are characteristic)=Alport’s syndrome

*Dipstick-Negative Dark Urine*

- Food dyes e.g. Acanthocyanins (beetroot)
- Drugs (e.g. Phenolphthalein, Senna, Rifampicin, Levodopa)
- Porphyria
- Alkaptonuria
- Bilirubinuria e.g. Obstructive jaundice
- Management of haematuria depends upon the cause.