Chapter 15

Nephrology and Urology

Contents :

1. Nephrotic Syndrome (NS)

- **The nephrotic syndrome is a clinical complex characterized by:**
  1. Heavy proteinuria (>40 mg/m^2/h)
  2. Hypoalbuminemia (< 2.5 g/dl)
  3. Generalized massive edema
  4. Hyperlipidemia (Total cholesterol > 250 mg/dl
  5. Recurrence

- **The nephrotic syndrome can be classified according to the etiology into:**
  A. **Primary (Idiopathic) nephrotic syndrome:** where the etiology is unknown.
  B. **Secondary nephrotic syndrome:** where nephrotic syndrome is secondary to another disease.
  C. **Congenital nephrotic syndrome**.

A. Primary (Idiopathic) NS

It is the most prevalent glomerular injury in childhood.

It forms **90%** of cases of nephrotic syndrome in childhood.

The categories of primary NS are:

- Minimal change disease (MCD) **85%.**
- Focal segmental glomerulosclerosis (FSGS) **10%.**
- Mesangial proliferative nephropathy (MPN) **5%.**

B. Secondary nephrotic syndrome

- It forms **10%** of childhood nephrotic syndrome. **It occurs as a consequence of:**

1. **Following glomerulonephritis e.g. acute post streptococcal glomerulonephritis.**
2. **Systemic diseases involving the kidney as in:**
   - Henoch - Schonlein Purpura (HSP).
   - Systemic Lupus Erythematosus (SLE).
   - Hodgkin's Lymphoma.
   - Juvenile Diabetes Mellitus (JDM).
3. **Infections:**
   - Hepatitis B virus.
   - Infective endocarditis.
   - Malaria.
   - Bilharziasis.
   - Syphilis.

C. Congenital nephrotic syndrome:

- Occurs in the **first 3 months** of life.
- It may be **hereditary** disease (Finnish type) or secondary to congenital infection (Toxoplasmosis or syphilis).

▪ Pathophysiology:

The underlying abnormality in nephrotic syndrome is an increase in permeability of the glomerular capillary wall, which leads to massive proteinuria and hypoalbuminemia. The cause of the increased permeability is not well understood.

- In minimal change disease, it is possible that T-cell dysfunction leads to alteration of cytokines, which causes a loss of negatively charged glycoproteins within the glomerular capillary wall. The role of immune-mediated process in the etiology of MCD was supported by the response to immunosuppressive drugs.
- In focal segmental glomerulosclerosis, a plasma factor, perhaps produced by lymphocytes, may be responsible for the increase in capillary wall permeability. Alternately, mutations in podocyte proteins (podocin, α-actinin 4) are associated with focal segmental glomerulosclerosis

Minimal Change Disease (MCD)
(Nil disease)

It is the **most common** form of nephrotic syndrome in childhood.

MCD is common **in boys**, with male to female ratio of 2:1.

Age: It is a disease of young children with a peak incidence from **2 to 5 years** of age.

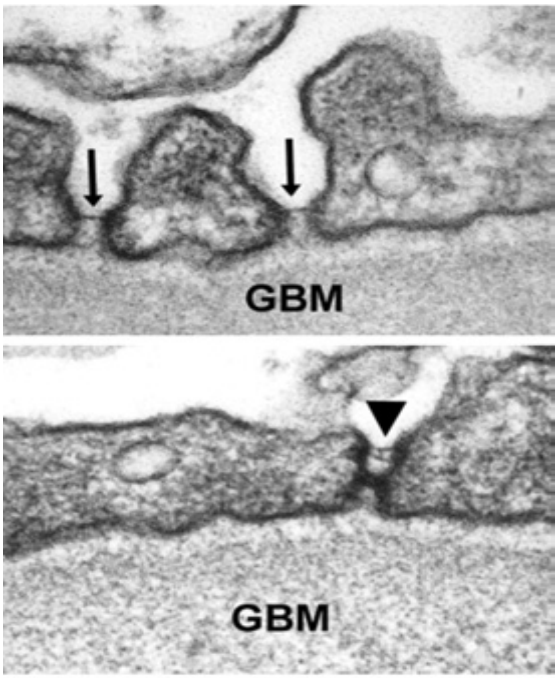
▪ Etiology:

The etiology of MCD remains unknown.

▪ Pathology:

1. **Gross picture:** In MCD the kidneys are large pale and smooth.
2. **Light microscope (LM):** The glomeruli appear normal. With no immune deposits by immunofluorescence
3. **Electron microscope (EM):** Fusion of the foot processes of the epithelial cells lining the glomerulus, and some irregularity of the thickness of the basement membrane. These changes are reversible. ***(see fig.1)***

(A)



(B)

Figure 1: (A) EM picture of the normal glomerular filtration barrier, the arrows show the glomerular slit diaphragm between foot processes of podocytes. **(B)** EM of the glomerular filtration barrier in MCD, The arrow shows fusion of the foot processes and collapsing of slit diaphragm (**GBM,** glomerular basement membrane)

▪ Pathogenesis:

The glomerular leakage of serum proteins mainly albumin results in:

1. **Hypoalbuminemia.**
2. **Edema**: It is the increase in the extra vascular (interstitial) component of the extracellular fluid volume. **It results from:**
   - **i.** The hypoalbuminemia and the decrease in the oncotic pressure of the blood (underfill theory).
   - **ii.** Decrease in plasma volume leads to the activation of the renin angiotensin - aldosterone axis with salt and water retention (overfill theory).

3. **Hyperlipidemia**:
   - **i.** It is mainly due to increase in serum cholesterol and triglycerides.
   - **ii.** This is due to increased liver synthesis of cholesterol and triglycerides and also due to the decrease in peripheral catabolism of lipids.
4. **Increased susceptibility to infection:** This is due to:
   - **i.** Decrease in serum immunoglobulins and complement, which are lost in urine.
   - **ii.** Edema fluid acts as good bacterial culture media.
   - **iii.** Protein deficiency and decreased bactericidal activity of leukocytes.
   - **iv.** Defective opsonization of bacteria due to Loss of properdin factor B in urine
5. **Hypercoagulability:**
   - **i.** Due to increased plasma levels of certain coagulation factors such as factor V, Vll and fibrinogen. While plasma level of antithrombin III is decreased. In addition to increased blood viscosity.
   - **ii.** Tendency for thrombosis is less common in children.

▪ Clinical Picture:

The onset is usually gradual in a child of 2-5 years of age often following influenza like syndrome.

1. Edema:

- It may be mild at first around the eyes (periorbital edema). Then progresses to become generalized with increase in body weight and decreased amount of urine.
- Generalized edema may be severe up to anasarca (Hydrothorax and ascites) leading to dyspnea.
- Gastrointestinal disturbances as nausea, vomiting, diarrhea and abdominal pain due to edema of gastrointestinal wall.

2. **Hematuria, hypertension and renal dysfunction** are rare.

▪ Diagnosis:

A. Clinical presentations.

B. Laboratory investigations:

1. Urine analysis:

a. Proteinuria:

- Normally urine contains very minute amount of protein up to 4 mg/m^2 /hour.
- Significant proteinuria is the presence of > 4 and less than 40 mg/m^2 /hour.
- Heavy proteinuria or proteinuria of nephrotic range is the presence of > 40 mg/m^2 /hour or > 1 g/ m^2 /day.
- So, for the diagnosis, the urine must contain proteinuria of nephrotic range.

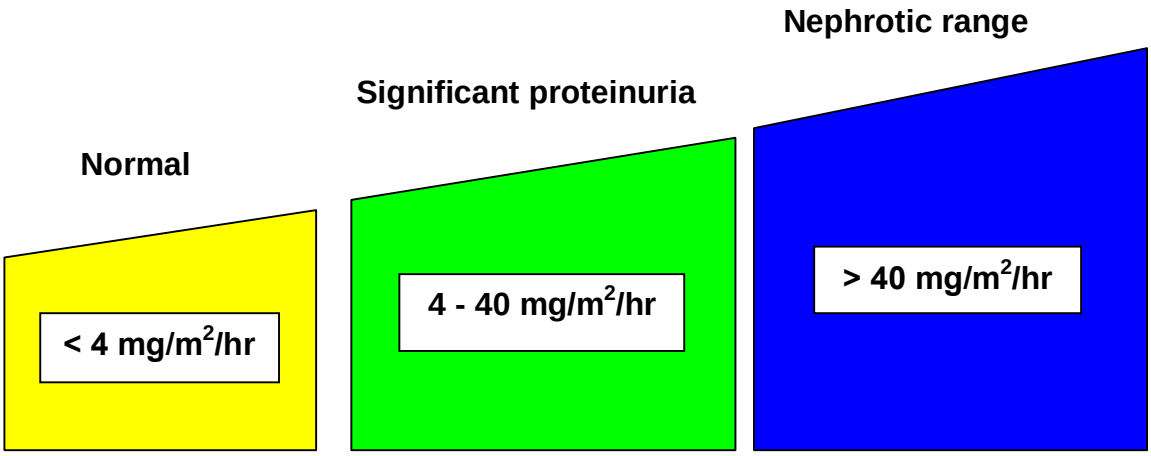


Diagram shows degrees of proteinuria in children

b. The urine contains number of cellular, granular, hyaline and lipoid casts, microscopic hematuria may be present.

2. Blood:

a. Decreased serum proteins, mainly serum albumin. Edema usually starts when serum albumin is ≤ 2.5 g/dl.

b. Increase in serum cholesterol (>250 mg/dl) and triglycerides.

c. Total serum Ca level is diminished owing to the decrease in albumin- bound fraction.

d. The serum complement 3 (C3) level is normal.

e. Increased ESR and anemia are usually present.

f. Renal function tests are normal in MCD.

3. Renal biopsy: It is indicated if other pathology rather than MCD is suspected as:

i. Age of onset less than one year or more than 10 years in the first presentation

ii. Presence of hypocomplementinemia.

iii. Raised BUN and serum creatinine not responding to volume and albumin correction.

iv. Steroid resistant, steroid dependent and multiple relapses.

v. Presence of persistent hypertension and gross hematuria.

• Complications of nephrotic syndrome:

1. Infections:

- Bacterial and viral infections are common due to increased liability of nephrotic patients to infection and the use of steroid therapy.
- The most common organisms are pneumococcus and gram -ve (E. coli).
- Peritonitis is the most common site of infection but pneumonia, Skin infection (cellulitis) and urinary infections are not uncommon.

- Steroid therapy reduces the clinical signs of infection and its flaring, so we must treat infections before starting steroid therapy.
- All children with nephrotic syndrome should receive polyvalent pneumococcal vaccine (if not previously immunized). Children with a negative varicella titer should be given varicella vaccine. These vaccines ideally administered when the child is in remission or on a low dose of alternate-day steroids.
- Nonimmune nephrotic children in relapse exposed to varicella should receive varicella-zoster immunoglobulin within 72 hr of exposure.
- Influenza vaccine should be given on a yearly basis.

2. Hypovolemic shock:

It occurs in severe cases with massive proteinuria, septicemia and aggressive diuretic therapy especially if serum albumin below 1.5 g/dl.

3. Arterial and venous thrombosis:

- Due to hypercoagulability state, it is less common in children than adults.
- Its possibility increases when associated with dehydration, septicemia and serum albumin below 1.5 g/dl.
- Its manifestations occur according to the site of blood vessels (BV) thrombosis as intestinal obstruction (mesenteric BV), skin gangrene (cutaneous BV) hemiplegia (central nervous BV) or severe hematuria (renal BV).

4. Muscle wasting: Due to hypoproteinemia and the steroid therapy.

5. Side effect of therapy:

a. Side effects of steroid therapy:

- Cushingoid obesity, cutaneous striae, poor wound healing.
- Flaring of viral or T.B infection.
- Osteoporosis and delayed growth.
- Systemic hypertension, hyperglycemia.
- Toxic manifestations as: Papilledema, fits and severe osteoporosis.

b. Other immunosuppressive drugs:

- Cyclophosphamide (Depressed immunity, cystitis, sterility and alopecia)
- Cyclosporine (Nephrotoxicity, gum hyperplasia and hirsutism).

6. **Acute Kidney failure:** It occurs after aggressive diuretic therapy due to hypovolemia and decreased renal perfusion, severe hypoalbuminemia and septicemia.

• Differential diagnosis:

Nephrotic syndrome must be differentiated from:

I. Acute post streptococcal glomerulonephritis.

II. Generalized edema.

- Nutritional as PEM and wet Beri Beri.
- Cardiac edema as in cases of right sided or congestive heart failure and constrictive pericarditis.
- Hepatic edema, in late cases of chronic liver diseases with ascites.
- Allergic edema as in angioneurotic edema.

III. Other causes of nephrotic syndrome. A diagnosis other than MCNS should be considered in the presence of age <1 yr, presence of family history of NS, extrarenal findings (arthritis, rash, anemia), hypertension, acute or chronic renal insufficiency, and gross hematuria.

• Treatment:

1. **Hospitalization:** No indication for hospitalization except:

- First time for teaching the mother and to observe the response of the child to steroid therapy.
- Presence of severe infection, electrolyte disturbance or hypertension.
- Severe cases with anasarca.
- Acute kidney failure.

2. **Activities:** Encourage normal activity except in the presence of respiratory distress, anasarca, hypertension, shoch and impaired renal function.
3. **Diet:** Well balanced diet with an adequate protein content (recommended daily allowance). Low salt diet (1 to 2 g / day). Fluid Restriction is indicated in cases with severe edema.
4. **Therapy:**

a. Antibiotic therapy: Treatment of infection has the priority: the suitable antibiotic after culture and sensitivity should be given before starting steroid therapy.

b. Steroid therapy:

- Prednisone is given in a dose of 2 mg/kg/day (maximum 80 mg/day divided into 2 - 3 doses) for :
  - In initial episode : 4 consecutive weeks
  - In case of relapse: till urine becomes free of protein, and remains as such for 5 days.
- Then we shift prednisone to alternate day therapy: 1.5 mg/kg as single morning dose every other day for 4 - 6 weeks to lower the possibility of relapse. The dose is then slowly tapered and discontinued over the next 2- 3 months.

- ***Steroid responder:*** when urine becomes protein free within four weeks of steroid therapy.
- ***Steroid resistant:*** when urine did not become protein free after six weeks of daily full dose steroid therapy.
- ***Steroid dependent:*** when proteinuria reappears after shifting to alternate day therapy or on stopping the alternate day therapy.

c. Other immunosuppressive drugs: Used alone or with steroid therapy in:

- Steroid resistant.
- Steroid dependent.
- Frequent relapses.
- Occurrence of toxic complications of steroid therapy (osteoporosis, fits, papilledama and hypertension).

- **e.g:** **Cyclophosphamide:** 2 - 3 mg/kg/day for 8 - 12 weeks.

  Chlorambucil: 0.1 - 0.15 mg/kg/day for 12 weeks.

  Cyclosporine: 5 mg/kg/day for 6- 12 months.

  Mycophenolate mofetil (MMF): 1200mg/m²/day for 6- 12 months.

d. Diuretics:

- Used in cases with severe edema with salt free human albumin.
- The dose of furosemide as diuretic 2 mg/kg/day.
- Salt free human albumin 0.5 - 1 g/kg/day slow IV infusion.

• Prognosis:

- The majority of children with steroid-responsive nephrotic syndrome have repeated relapses, which generally decrease in frequency as the child grows older.
- It is important to indicate to the family that the child with steroid-responsive nephrotic syndrome is unlikely to develop end stage renal disease (ESRD).
- Children with steroid-resistant nephrotic syndrome, most often caused by FSGS, with a much poorer prognosis, leading to ESRD.

2. Acute Poststreptococcal Glomerulonephritis (APSGN)

- It is the **most common form of nephritis** in childhood.
- **Characterized by sudden onset of:**
  - Gross hematuria.
  - Significant proteinuria.
  - Mild to moderate edema.
  - Hypertension.
  - Variable degrees of impaired renal function.

- **Etiology:**

- APSGN follows infection of the upper respiratory tact (Pharyngitis, nasopharyngitis, or otitis media) or skin infection (impetigo, acne, or erysipelas) with certain nephritogenic strains of group A beta - hemolytic sterptococci.
- A seasonal variation in the incidence of attacks of APSGN due to either streptococcal pharyngitis (winter and early spring) or streptococcal pyoderma (summer and early fall) has been observed.
- Epidemics of nephritis have been described in association with both throat (Serotype 12) and skin (Serotype 49) infections.
- A latent period between the preceding streptococcal infection and the onset of APSGN of 7 to 21 days (average 10 days) in throat infection and 14 to 28 days (average 20 days) in pyoderma is usually present.

- **Pathology:**
  - The kidneys are symmetrically slightly enlarged, pale, and dotted with small punctuate hemorrhages on the cortical cut surface. On light microscopical examination:
  - Glomeruli appear enlarged and relatively bloodless.
  - There is proliferation of capillary endothelium.

- Diffuse mesangial proliferation with increase in mesangial matrix with polymorphnuclear leukocytes in glomernli (Glomerular hypercellularity).
- In severe cases crescents and interstitial inflammation are seen.
- Immunofluorescence microscopy reveals deposits of immunoglobulin (IgG) and complement (C3) on the basement membrane.
- The tubular cells are swollen, granular with fatty and hyaline deposits.
- All these changes start to disappear within 3 weeks and completely disappear after 6 - 8 weeks.

- **Pathogenesis:**

1. Decreased glomerular filtration rate (GFR).
2. Increased permeability of glomerular capillaries leading to escape of RBCs (hematuria) and passing of serum albumin (albuminuria).
3. Edema: Due to salt and water retention and circulatory overload leading to the expansion of extracellular fluid compartment.
4. Hypertension: In addition to salt and water retention and circulatory overload (circulatory congestion), renal ischemia also shares in getting hypertension, hypertensive heart failure, hypertensive encephalopathy and retinal exudate and hemorrhages are the complications of hypertension.
5. Impaired renal function: Decreased renal perfusion due to narrowing of glomerular capillaries leads to oliguria, retention of potassium, non protein nitrogen and results in acute kidneyfailure.

- **Clinical presentation:**

- Age at onset is **3 - 10 years**.
- More common in **males**, male to female ratio 2: 1.
- **Asymptomatic cases:** The disease may be so mild to be passed unnoticed.

1. **General manifestations:** anorexia, nausea, fever (usually low grade) and abdominal pain (loin pain).

2. Urinary manifestations:

***a. Hematuria*:**

- Occurs in 100% of cases
- Ranges from microscopic to gross hematuria.
- Gross hematuria occurs in 50% of cases.
- Most of RBCs are lysed causing tea color, cola color, smoky urine or dark red colored urine.
- Gross hematuria persists for I - 14 days.

b. Decreased urine volume and oliguria *in cases of acute kidney failure (AKF).*

3. Edema:

- Present in over 75% of cases.
- Mild to moderate edema.
- Usually starts in the face in the morning.
- Severe edema occurs in: CHF, and secondary nephrotic syndrome.

4. Hypertension:

- Mild to moderate hypertension but may be severe enough to cause hypertensive HF and hypertensive encephalopathy.
- Occurs in 50% - 60% of cases.
- It occurs during acute phase (first 3 weeks).
- Blood pressure usually returns to normal within two weeks.

5. Manifestations of complications:

a. *Hypertensive heart failure*:

- Due to circulatory congestion and the hypertension.
- Dyspnea and congested pulsating neck veins, cardiomegaly, tachycardia, pulmonary edema, hepatomegaly and increasing generalized edema.

b. ***Hypertensive encephalopathy:*** The child gets severe headache, nausea, vomiting, drowsiness, papilledama and convulsions may occur.

c. ***Acute kidney failure:*** The child develops progressive oliguria and even anuria with increasing edema, with nausea, vomiting, drowsiness and even convulsions may occur.

- **Investigations:**

A. Urine Analysis:

6. Decreased volume or even oliguria.

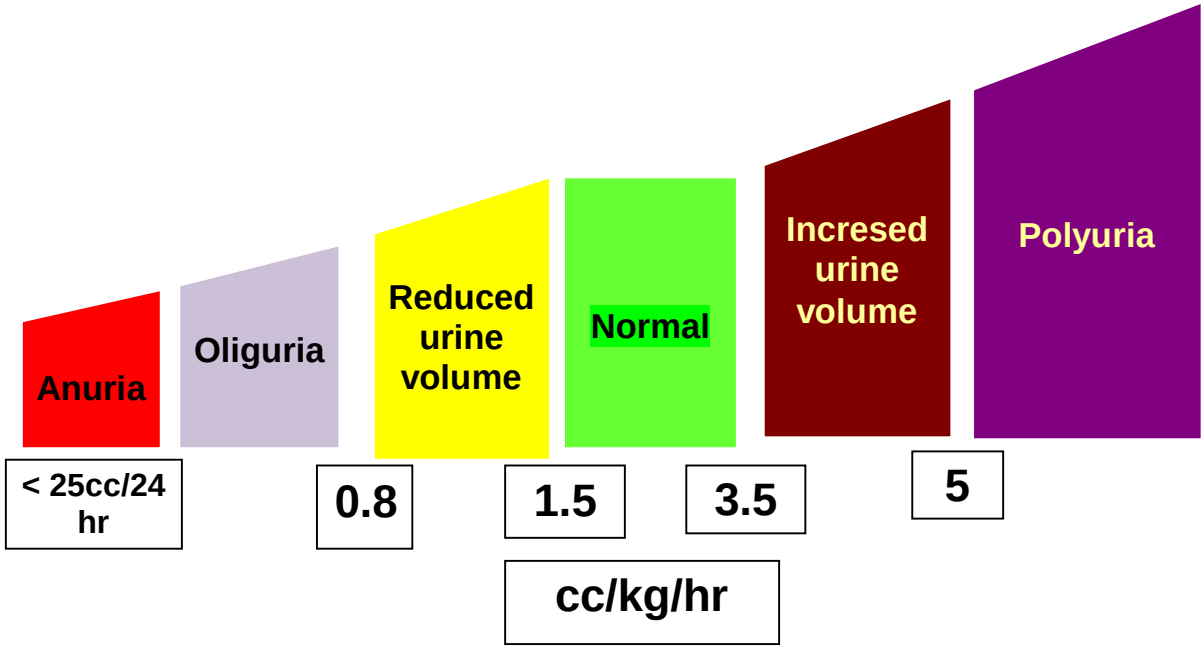


Diagram shows normal and abnormal urine volumes in children

- Normal urine output is (1.5 to 3.5 cc/kg/hr).
- Reduced urine volume (0.8 - 1.5 cc/kg/hr) is normal variation occurs in dehydration, starvation and hot weather
- Oliguria is urine output less than 0.8 cc/kg/hr and anuria is severe oliguria with 24 hour urine volume less than 25 cc in children.
- Increased urine volume (3.5 – 5 cc/kg/hr) is normal variant occurs in cold weather, recovery from edema and excessive drinking.
- Polyuria (5 or more cc/kg/hr).

7. **Specific gravity increase to 1020 or more.**
8. **Gross or microscopic hematuria.**
9. **RBC's are dysmorphic.**
10. **RBC's casts**
11. **Some WBCs and granular casts.**
12. **Significant proteinuria (>4 mg/m2/hr and less than 40 mg /rn2/ hr).**

B. Blood:

- Anemia mild normochromic normocytic anemia due to hemodilution.
- Increased ESR
- Blood chemistry
  - ✓ Hyperkalemia
  - ✓ Increased blood urea nitrogen and serum creatinine.
  - ✓ Metabolic acidosis
  - ✓ Hyperchloremia
- Decreased serum complement (C3) during the first 3 weeks and returns to normal within 6-8 weeks
- Antibody titers to streptococcal antigens:
  - ✓ Increase in antistreptolysin O titer (ASOT) but not in APSGN after pyoderma.
  - ✓ Increased in antideoxyribonuclease B (ADNA ase - B).
  - ✓ But no correlation between the severity of renal insult and the titer levels.
- Leukocytosis.

C. Positive throat culture for streptococci.

D. Chest X-ray: Reveals pulmonary congestion, cardiomegaly and pulmonary edema in severe cases.

E. Renal biopsy: It is indicated in:

i. AKF.

ii. RPGN.

iii. 2nd nephrotic syndrome.

iv. Persistent hypocomplementinemia.

v. Recurrent gross hematuria.

vi. Persistent hematuria and proteinuria.

• Differential Diagnosis:

1. Other glomerular diseases:

- Nephrotic syndrome.
- Acute post-infectious glomerulonephritis (APIGN) following pneumococcal, gram -ve bacteria or viral infections.
- Anaphylactoid purpura.
- SLE.
- IgA nephropathy.

2. Other causes of hematuria:

- Congenital polycystic kidney.
- Trauma. Blunt trauma and urinary stones and crystaluria (oxaluria).
- Infection: Urinary tract infection, Renal T.B, and Urinary Bilharziasis.
- Blood diseases: Coagulation defects (Hemophilia), Thrombocytopenia (I.T.P.), and Sickle cell anemia,
- Malignancy: Leukemia, and Renal tumors (Wilm's tumor).
- Drugs: Anticoagulants (Heparin).

• Prognosis:

- It is benign self - limited disease with complete recovery in over 95% of children with APSGN.
- Early mortality rate is 0.5%.
- Prognosis is better in childhood than in adulthood.

• Prevention:

- No available vaccine.
- Avoid contact with children suffering from streptococcal throat or skin infections.
- Avoid overcrowding during cold weather.
- Adequate skin hygiene during summer.
- Antibiotic prophylaxis is not justified.

• Treatment:

A. General treatment:

1. **Hospitalization:** Indicated in:

- Severe gross hematuria.
- Presence of hypertension.
- Occurrence of complications.

2. **Rest:** Bed rest for the period of gross hematuria, hypertension or complications.

3. **Diet:**

- Dietary salt and water restriction.
- Salt: 1 - 2 g/day.
- Water: equal to insensible water loss (400 cc/m^2 + urinary output of previous day - the planned weight loss). So getting negative fluid balance. This helps reduction of hypertension and edema.

B. Specific treatment:

- A 10 days course of **penicillin** is given to the patient and any culture positive family members, to eradicate streptococcal infection.
- **Diuretics:** as furosemide, at first is given I.M or I.V. in dose 1-2 mg/kg, followed by a dose of 1-2 mg/kg/day orally.
- **Anti hypertensive drugs**:

Indicated if blood pressure is 140/90 or more.

- **There are 2 types of drugs:**

A. Emergency:

Used when the blood pressure (BP) is very high, leading to acute organs damage and the goal is to decrease BP by 20-25% in first 8 hours as:

- ✓ Nifedipine (Ca channel blocker): 0.25-0.5 mg/kg/dose sublingual hourly when needed.
- ✓ Nitroprusside (Vasodilator): 0.5- 2 µg/kg /min IV infusion.
- ✓ Hydralazine (Vasodilator): 0.1-0.4 mg/kg/dose, slow IV hourly when needed.
- ✓ Labetalol (α - β blocker): 0.25 - 1 mg/kg/dose, IV hourly when needed then IV infusion (1-3 mg/kg/hr).
- ✓ Furosemide (Loop diuretic): 0.5-2 mg/kg/dose IV / 6hr.

B. Maintenance:

- ✓ Amlodipine (Ca channel blocker): 0.1-0.4 mg/kg/day orally.
- ✓ Atenolol (β blocker): 1-2 mg/kg/day orally.
- ✓ Furosemide (Loop diuretic) in dose of 1- 6 mg/kg/day orally.
- ✓ Captopril (Angiotensin converting enzyme inhibitor): 1- 6 mg/kg/day orally.

C. Treatment of complications:

i. Hypertensive heart failure:

- Reduction of high blood pressure especially with diuretics.
- In the absence of organic myocardial disease digitalization will offer no beneficial effects.

ii. Hypertensive encephalopathy:

- Reduction of high blood pressure.
- Control of convulsions by diazepam 0.3 mg/kg/dose IV and phenobarbitone sodium in dose of 3-5 mg/kg/day IV to prevent convulsions.

3. Acute Kidney Injury (AKI)

It is a clinical syndrome in which a sudden decrease in the renal function results in retention of nitrogenous waste products and disturbance in water, electrolytes and acid - base balance. The term AKI has largely replaced acute renal failure (ARF), reflecting the recognition that smaller decrements in kidney function that do not result in overt organ failure are of substantial clinical relevance and are associated with increased morbidity and mortality. The term AKF is now reserved for severe AKI, usually implying the need for renal replacement therapy.

• Etiology:

1. **Pre - renal:** Where there is decrease in renal perfusion and subsequent decrease in GFR as in:
   - Hypovolemia: hemorrhage, severe dehydration, burns and nephrotic syndrome.
   - Hypoxia: neonatal asphyxia, severe chest infection and post cardiac surgery.
   - Hypotension: cardiac failure, severe septicemia and cardiomyopathy.
2. **Renal:** as in APSGN, hemolytic uremic syndrome (H.U.S), Henöch-Schonlein purpura (H.S.P.) pyelonephritis and nephrotoxins as aminoglycosides.
3. **Post - renal:** Due to obstruction of urinary tracts as in:
   - **i.** Ureteropelvic junction obstruction.
   - **ii.** Bladder neck obstruction.
   - **iii.** Urethral stricture.
   - **iv.** Spina bifida.
   - **v.** Posterior urethral valve.

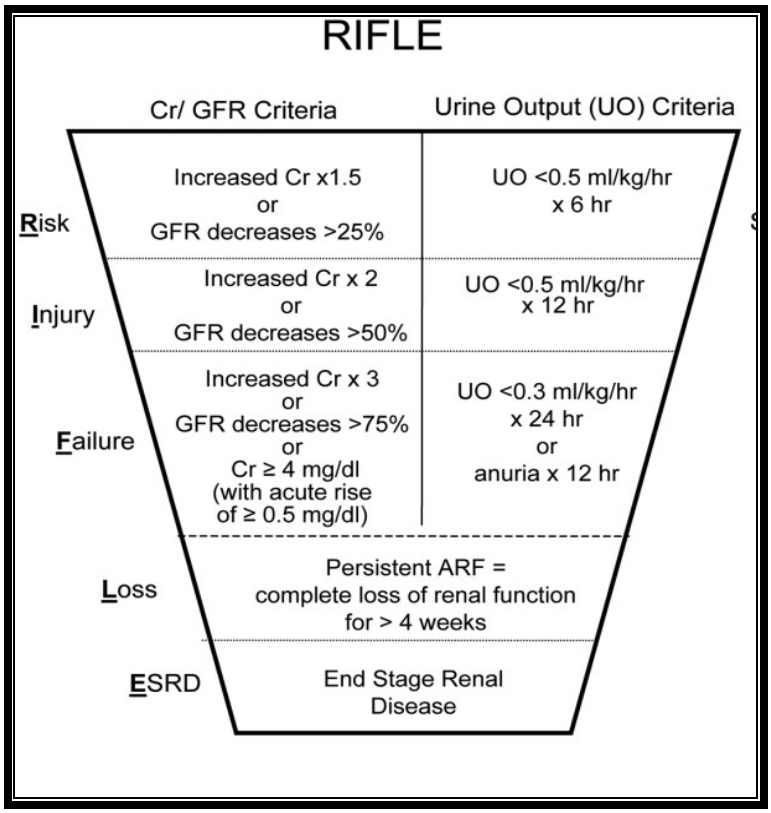


Figure 2: Stages of AKI by RIFLE criteria

- **Clinical presentations:**

- A carefully taken history is critical in defining the cause of AKF. An infant with a 3-day history of vomiting and diarrhea most likely has prerenal ARF caused by volume depletion. A 6 yr old child with a recent pharyngitis who presents with periorbital edema, hypertension, and gross hematuria most likely has intrinsic AKF related to acute post-infectious glomerulonephritis. A critically ill child with a history of protracted hypotension and exposure to nephrotoxic medications most likely has acute tubular necrosis (ATN)

- The physical examination must be thorough, with careful attention to volume status. Tachycardia, dry mucous membranes, and poor peripheral perfusion suggest inadequate circulating volume and the possibility of prerenal AKF. Peripheral edema, rales, and a cardiac gallop suggest volume overload and the possibility of intrinsic AKF from glomerulonephritis or ATN. The presence of a rash and arthritis may suggest systemic lupus erythematosus (SLE) or Henoch-Schönlein purpura nephritis. Palpable flank masses may suggest renal vein thrombosis, tumors, cystic disease, or urinary tract obstruction.

- **Investigations:**

1. **Retention of waste products:** as urea and creatinine (Normal serum BUN is 5 - 18 mg / dl and normal serum creatinine 0.3 - 0.7 mg /dl).
2. **Biochemical disturbance:**
   - Hyperkalemia: serum K >6 mEq /L (Normal serum potassium from 3.5 - 5.5 mEq / L).
   - Hyponatremia: serum Na<130 mEq /L (Normal serum sodium:135-145 mEq/ L).
   - Metabolic acidosis: pH< 7.35 (Normal pH: 7.35 - 7.45).
   - Hypocalcemia: Total serum Ca <9 mg/dl (Normal serum calcium is 9 - 11 mg/dl).
3. **Radiology:**
   - Chest radiography may reveal cardiomegaly and pulmonary congestion (fluid overload).
   - Renal ultrasonography may reveal hydronephrosis and/or hydroureter, which are suggestive of urinary tract obstruction
4. **Urinary indices:** may be useful in differentiating prerenal AKF from intrinsic AKF. Patients whose urine shows an elevated specific gravity (>1.020), elevated urine osmolality (UOsm > 500 mOsm/kg), low urine sodium (UNa < 20 mEq/L), and fractional excretion of sodium (FENa) <1% most likely have prerenal ARF. Those with a specific gravity of <1.010, low urine osmolality (UOsm < 350 mOsm/kg), high urine sodium (UNa > 20 mEq/L), and FENa >1% most likely have intrinsic AKF.
5. **Renal biopsy:** may be required to determine the precise cause of AKF in patients who do not have clearly defined renal cause.

• Treatment:

- **Post renal AKF:** insert a catheter and consult urology surgeon.
- **Pre-renal ARF:** correct volume depletion by the same component lost as blood transfusion in hemorrage, IV fluids in dehydration, plasma transfusion in burns and IV human albumin in hypoabuminemia, to improve the renal perfusion. In addition control of infections in cases of septicemia.
- **Fluid balance:** In case of AKF renal and postrenal fluid must the calculated as:

[Insensible water loss (400 cc./m²/day) + urine volume of the previous day + any ongoing losses as nasogastric or chest tube drainage + 75 cc./m^2/day for each degree centigrade rise in body temperature]

- **Diuretic therapy:** should be considered only after the adequacy of the circulating blood volume has been established. Furosemide (1-6 mg/kg/day) may be administered.

- **Hyperkalemia is corrected by:**

i. Elimination of any dietary exogenous potassium.

ii. Calcium gluconate 10%: to antagonize the effect of excess K+ on myocardium in dose of 0.5 c.c/ kg IV over 5-10 minutes.

iii. B2 agonist inhalation.

iv. Sodium bicarbonate 8.4%: for shifting K+ into cells as it decreases the metabolic acidosis. The dose is 1-2 c.c/kg IV.

v. Glucose and insulin: For shifting K into cells .the I.V. glucose 0.5 g/kg and regular insulin 0.1 unit /kg.

vi. Ion exchange resins: Remove K+ form body, 1g/kg/dose either orally or per rectum.

vii. Dialysis.

- **Hyponatremia:**

  i. Fluid restriction.

  ii. Dialysis.

- **Metabolic acidosis:** (pH below 7.25)

  i. Sodium Bicarbonate 8.4%: 1-2 mEq/Kg/dose slow IV.

  ii. Dialysis.

- **Dialysis:**

It is either peritoneal dialysis (PD) or hemodialysis (HD) indicated in:

- Circulatory overload and pulmonary edema.
- Uremic encephalopathy.
- Persistent hyperkalemia unresponsive to conventional measures or serum K^+ ≥7 mEq/L.
- Intractable metabolic acidosis.
- Persistent hyponatremia.
- Severe CHF and intractable hypertension.

4. Urinary Tract Infections (UTI)

Urinary tract infections are common in infancy and childhood, only exceeded by respiratory tract and gastrointestinal infections. It occurs in as many as 5 % in girls and 1- 2 % in boys.

- **Etiology:**

The causative organism in **80%** of cases is Escherichia coli (**E. coli**), and the rest 20% by streptococcal fecalis, proteus, kiebsiella and pseudomonas.

- **Predisposing factors:**

1. **Age and sex:**
   - During first year of life, U.T.I is more common in boys than in girls, as congenital anomalies of urinary tract are more common in boys.
   - During childhood, UTI is more common in girls than in boys in ratio 5:1 due to the short urethra in females.
2. **Congenital anomalies of urinary tract:**
   - Stasis or obstructive uropathies encourage UTI as in stricture ureters, stones or neurogenic bladder.
3. **Malnutrition:** PEM and vitamin A deficiency favor UTI.
4. **Poor perineal hygiene:** Wiping from back to front in females, Pinworm infestation
5. **Frequent instrumentation of urinary tract.**
6. **Constipation.**
7. **Uncircumcised males.**
8. **Family history** of recurrent UTI or renal anomalies.

- **Pathogenesis:**

Urinary infections have been classified according to their anatomical location into:

1. **Lower UTI:** urethritis and cystitis.
2. **Upper UTI:** pyelitis and pyelonephritis. UTI is rarely limited to a single portion of urinary tract especially in infants and children.

- **Routes of infection:**

1. Hematogenous: Hematgenous spread by blood stream from a distant focus, usually occurs in newborns and infants.

2. Ascending infection: Ascending infection via the urinary passages is the commonest route of infection in childhood.

3. Through lymphatic channels is rare in children.

- **Clinical Presentations:**

A. Acute UTI:

1. In newborns:

Picture of septicemia as; fever, hypothermia, vomiting, diarrhea, poor feeding, jaundice, convulsions and failure to thrive.

2. In infants and preschool age:

- Diarrhea - Vomiting - Fever
- Irritability - Dysuria.
- Strong smelling or bad smelling urine

3. In school aged children:

- Fever and vomiting.
- Abdominal, loin or suprapubic pain.
- Strong or bad urine smelling.
- Frequency, urgency and dribbling.
- Nocturnal enuresis.
- Asymptomatic bacteriuria occurs usually in school children.

B. Complications of recurrent or chronic UTI:

1. Failure to thrive.
2. Renal scaring which leads to; Hypertension, progressive deterioration of renal functions, progressive anemia and finally chronic renal failure.
3. Vesico-ureteral reflux and reflux nephropathy.

• Diagnosis:

A. Clinical presentations

B. Investigations:

1. Urine examination usually reveals:

- Pyuria: presence of 5 or more pus cells (WBC's) per high power field of centrifuged urine sediment.
- Minimal significant proteinuria.
- Leukocyte casts in cases of pyelonephritis.
- Few RBC's (minimal hematuria) without RBC's casts.
- Leukocyte esterase: detects pyuria.
- Nitrites: will only be present in urine sitting in bladder >4 hours, with gram-negative bacteria

2. Bacteriological examination of urine (Colony count):

- Urine may be obtained as a midstream, by catheter, sterile urine bag or by percutaneous suprapubic aspiration especially in neonates.
- The finding of 100 $x10^3$ organisms per ml of single organism is indicative of active UTI Less than 100 x 10^3 organisms/m or if two or more different organisms are cultured, indicate contamination.

3. Renal functions:

Blood urea nitrogen and creatinine are impaired in chronic pyelonephritis with renal scarring.

4. In recurrent cases: renal sonogram, intravenous pyelogram (IVP) and voiding cystourethrogram (VCUG) are indicated to exclude reflux nephropathy (RN). Also renal scanning (DMSA) to detect any functional changes.

• Treatment:

While waiting the result of urine culture; we must start with one of the sulfa drugs or ampicillin.

- If the culture reveals that theses drugs are effective continue the treatment, otherwise switch to the antibiotic of choice.
- Treatment should continue for a minimal of 2 weeks as urinary tract infections commonly recur, urine should be cultured after 1 -2 Weeks of cessation of treatment and repeated at increasing intervals for a period of 1-2 years.

- **Some drugs are commonly used in the treatment of UTI in children:**

Ampicillin	100 mg/ kg / day orally.
amoxicillin	50-100 mg/ kg/day orally.
Trimethoprim	5 mg/kg/day orally.
Nalidixic acid	25-50 mg/kg/day. Orally.
Gentamicin	5-7 mg/kg/day I. M. Injection
Cefaclor	25 mg/kg/day orally.

• Prophylaxis in recurrent cases:

1. Nitrofurantion 1- 2 mg/kg/day.
2. Trimethoprim 1-2 mg/kg/day for 6 months.

5. Congenital Anomalies of the Kidneys and the Urinary Tract

A. Congenital anomalies of the kidneys:

1. Renal agenesis
2. Renal dysplasia and hypoplasia
3. Renal fusion and ectopia
4. Polycystic diseases of the kidney
5. Renal tubular disorders

- **Polycystic diseases of kidney:**

1. Infantile type:

- Autosomal recessive **(AR)** inheritance.
- **Presented early** in life.
- **Clinical picture:**

  At birth, both kidneys are enlarged and renal failure

  May present later in childhood by hypertension and chronic renal failure

  Bad prognosis

- **Diagnosis:** by clinical presentation, abdominal ultrasonography and CT.
- **Treatment :**

  Supportive: including fluid and electrolyte therapy and control of hypertension.

  Renal replacement therapy: dialysis and renal transplantation

2. Adult type:

- Autosomal dominant (**AD)** inheritance.
- Usually presented in **middle age** but can occur in any age even in neonates.

- **Clinical picture:**

  Hematuria, flank pain or mass.

  Hypertension.

  End stage renal disease (ESRD).

- **Diagnosis:** by the clinical presentation, abdominal ultrasonography and CT.

- **Treatment:**

  Supportive, with hypertension control.

  Renal replacement therapy: dialysis and renal transplantation.

B. Congenital anomalies of the urinary tract:

A large number of congenital abnormalities may be found in the urinary tract, especially in males. They are mainly of importance because they lead to either:

1. Urinary obstruction with increase of pressure in the pelvis of the kidney and renal tubules, and so interfere with the filtration function of the kidney.
2. retention of urine which predispose to recurrent and prolonged infections

- **These urinary tract anomalies are:**

1. Pelvi-ureteric junction obstruction.
2. Duplication of the renal pelvis and ureter.
3. Ureteral stenosis.
4. Congenital vesico-ureteral reflux.
5. Divarication of the bladder and ureter.
6. Congenital bladder neck obstruction.
7. Posterior uretheral valve.

• Posterior Urethral Valve (PUV) obstruction:

Posterior urethral valves, which is seen in male infants, and is important to recognize early as prompt surgical treatment may prevent rapid progression to renal failure which is irreversible and may have already occurred prior to birth.

▪ Diagnosis:

- Antenatal diagnosis: could be done by the presence of hydronephrosis and enlarged bladder.
- May present in neonates as sepsis.
- In infants and children: the stream of urine is thin, interrupted with dribbling or even no urine with enlarged hypertrophied bladder.
- Diagnosis is confirmed by uretheroscopy or VCUG.

▪ Treatment:

- Before birth : insertion of suprabladder catheter to drain the fetal urine into the amniotic fluid.
- After birth: prompt surgical treatment for the valve and prolonged post-operative observation.