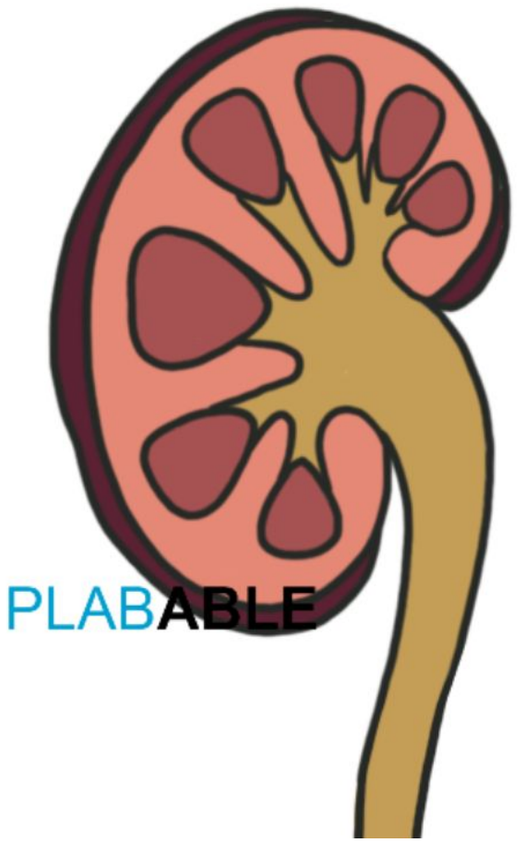
PLABABLE

GEMS

VERSION 3.0

Nephrology



Acute Kidney Injury

Definition:
Acutely raised creatinine with reduced urine output

Increase in serum creatinine of ≥ 26.5 μmol/L from baseline within 48 hours

or

Increase in serum creatinine of ≥ 50% from baseline within 7 days

or

A reduction in urine volume below 0.5ml/kg/hr for 6 hours

Chronic Kidney Disease

Definition:
Chronically reduce eGFR and/or proteinuria

Persistent reduction in renal function (eGFR is less than 60 mL/min/1.73 m2) and/or proteinuria (urinary ACR is greater than 3 mg/mmol) lasting for at least three months.

Goodpasture Syndrome

Facts

It is a combination of:

- Rapidly progressive glomerulonephritis
- Pulmonary alveolar haemorrhage

It is an autoimmune disease

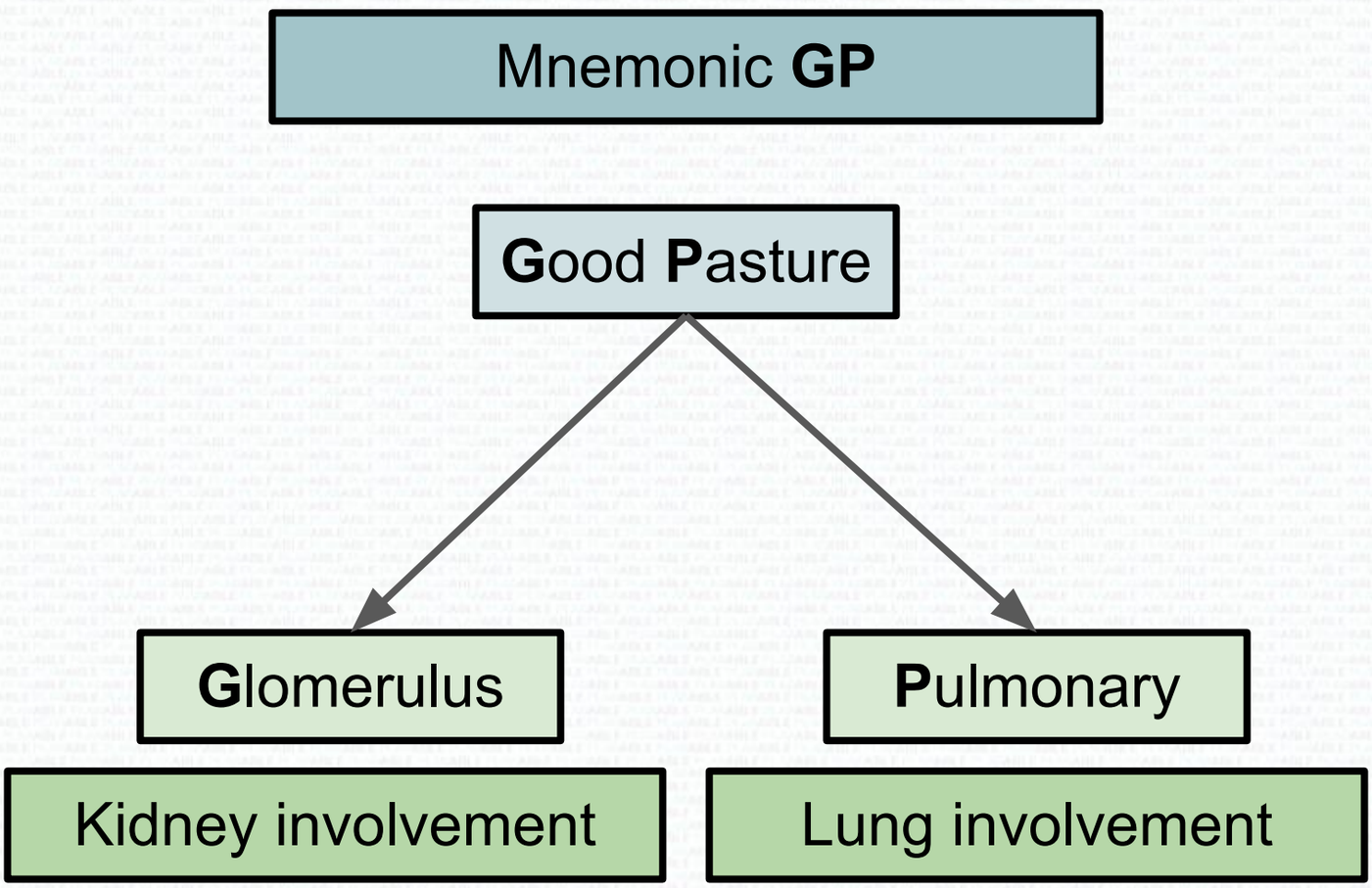
Features

- Haematuria
- Hemoptysis
- Impaired renal function test

Investigations

1. Blood test **Most initial**
   → Anti-glomerular basement membrane antibodies (anti-GBM antibodies)
2. Kidney biopsy **Most definitive**
   → Shows crescentic glomerulonephritis
3. Chest X-ray / CT scan
   → Shows patchy interstitial infiltration (intra-pulmonary bleeding)
4. Lung biopsy there are any lung involvement **Most definitive**

Goodpasture Syndrome



Goodpasture Syndrome & Differential Diagnosis

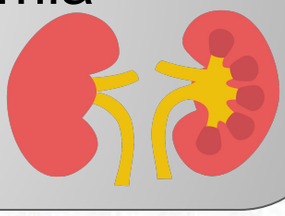
These are the differentials for pulmonary renal syndrome (AKI with pulmonary involvement)

Condition	Features	Test
Alport syndrome	• Haemaproteinuria • Haemoptysis • Abnormal U&E • Loss of sight • Loss of hearing	
Churg Strauss (Eosinophilic granulomatosis with polyangiitis)	• Asthma • Eosinophilia	p-ANCA
Wegener's granulomatosis (Granulomatosis with polyangiitis)	• Haematuria • Nasal septum perforation • Epistaxis	c-ANCA

Itching

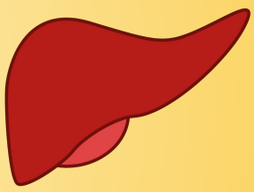
Chronic Renal Failure

- Itching → ↑ Serum urea and/or ↑ serum phosphate
- Tiredness → ↓Erythropoietin → Anaemia
- Peripheral oedema
- Hyperpigmentation



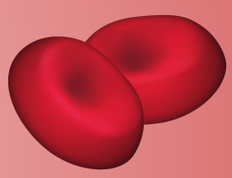
Liver Failure

- Itching → ↑ Serum bilirubin
- Ascites
- Jaundice
- Bleeding → ↓ Clotting factor production



Polycythemia rubra vera

- Itching
- Red skin → ↑ Haemoglobin
- Splenomegaly
- Burning sensation in fingers and toes
- Gout
- Stroke



Scabies

- Itching
- Line tracks on skin (burrows)

Rhabdomyolysis

Facts

It is a condition of **dying of skeletal muscles** and as a result releasing:

- **Myoglobin**
- **Potassium**
- **Creatine kinase**

Common scenarios

- Trapped for several hours under heavy object
- Fall followed by lying for long period of time on floor
- An elderly with frequent fall after acute kidney injury
- IV drug user lying on floor not moving for long
- Severe exertion or dehydration e.g. marathon
- Severe crash injury

Features

- Myoglobinuria *(dipstick would pick up blood)*
- Hyperkalaemia
- AKI - Acute tubular injury
- ↑ Creatine kinase *Usually more than 2000 U/L*

Summary

1. Prolonged immobilisation
   → Muscle ischaemia
   → Rhabdomyolysis
2. Myoglobin
   → Red colour due to haem

Rhabdomyolysis

Brain trainer:

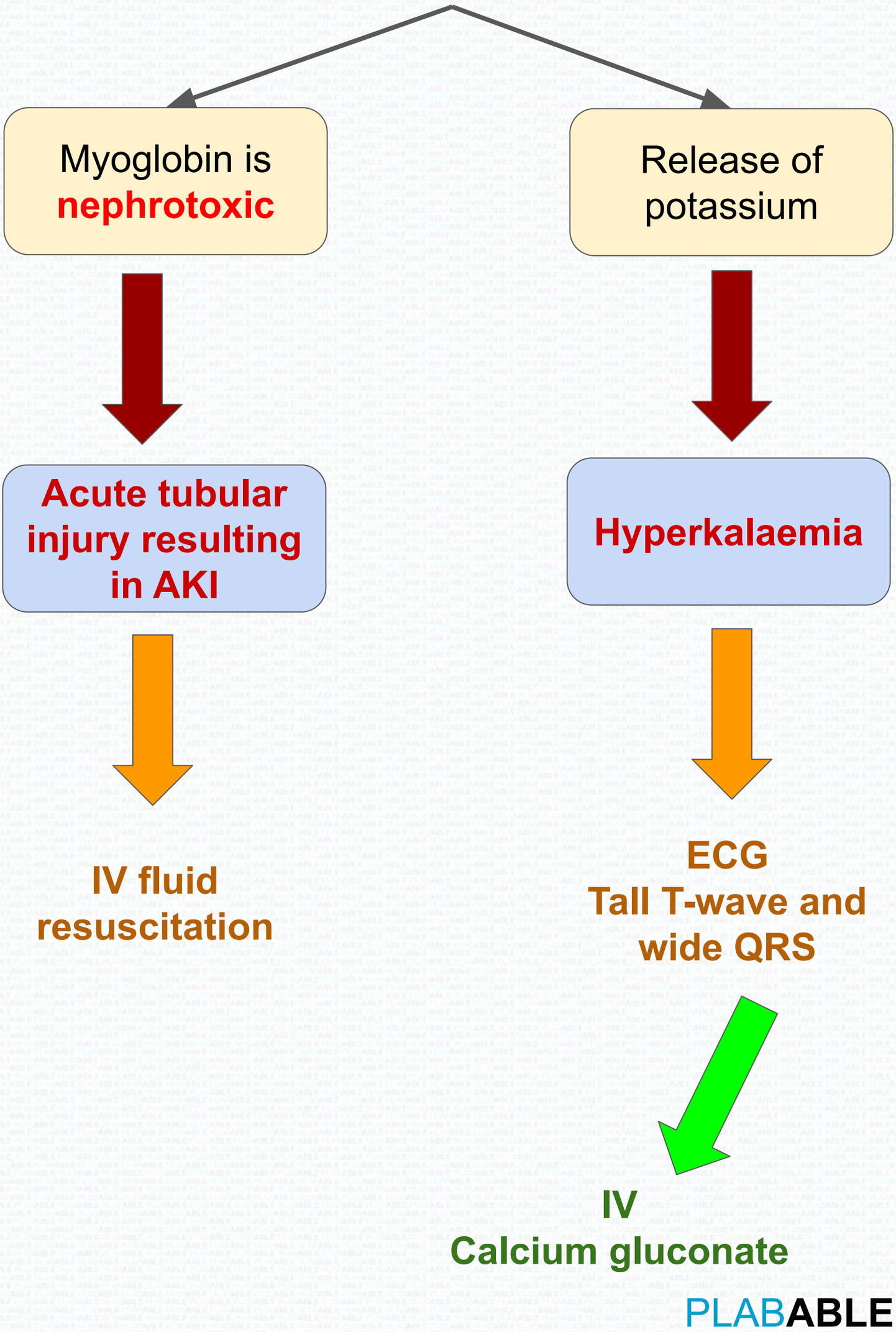
An elderly man is found on the floor of his house. It is uncertain the duration he has been unconscious on the floor. On fluid resuscitation, he gains consciousness. His bloods show:

Creatine kinase 3523 U/L (25-195)
Serum urea 25 mmol/L (2.0-7)
Serum creatinine 297 µmol/L (70-150)

What is the most likely reason for the elevated creatine kinase?

➔ **Rhabdomyolysis**

Rhabdomyolysis Management



Acute Tubular Necrosis

Causes

- Massive haemorrhage
  → Hypotensive shock
- Prolonged renal ischaemia
  → Reduced renal perfusion
  → Tubular necrosis

Management

- Maintain hydration and perfusion
- Fluid balance management

Balance input and output to avoid fluid overload

Aim to avoid being in a negative fluid balance

Interstitial Nephritis

Features:

Acute kidney injury in a euvolaemic patient

- Allergy reaction
  → Drug as most common cause
  → Common drugs:
    Penicillins
    Proton pump inhibitors
- Mild eosinophilia
- Urine dipstick - bland

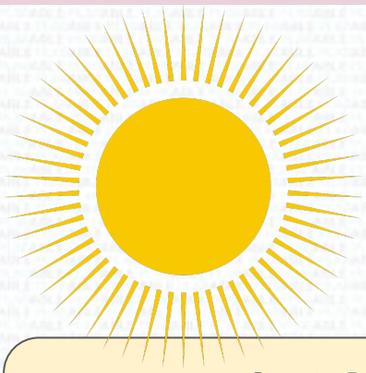
Means no protein or blood

Definitive diagnosis is done from a renal biopsy

This will show tubular inflammation with lymphocytes and eosinophils

Treatment: Oral Prednisolone

Vitamin D Deficiency in CKD

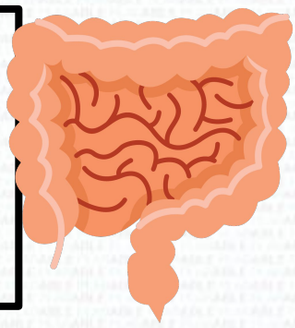


Sunlight and Skin

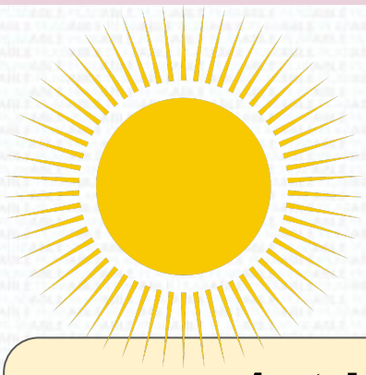
1st Hydroxylation in liver
25-Hydroxycholecalciferol

2nd Hydroxylation in kidney
1,25-dihydroxycholecalciferol
(Activated Vitamin D / Calcitriol)

Function:
Increased intestinal absorption of calcium



Vitamin D Deficiency in CKD



Sunlight and Skin

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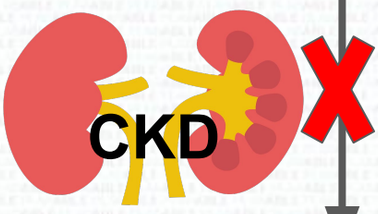
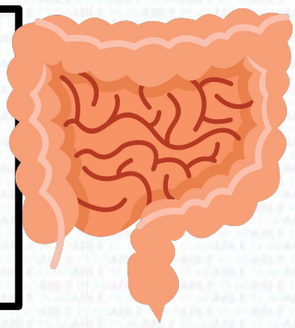


2nd Hydroxylation in kidney
1,25-dihydroxycholecalciferol
(Activated Vitamin D / Calcitriol)

Function:
Increased intestinal absorption of calcium



With CKD, absorption of intestinal calcium is reduced

Reduced serum calcium leads to increase PTH (secondary hyperparathyroidism)

Pyelonephritis

Contributing factors

Pregnancy, stone, vesico-ureteric reflux, diabetes

Symptoms

- Dysuria
- Frequency
- Urgency
- Lower abdominal pain
- Fever
- Rigors
- Loin or back pain
  (Costovertebral angle tenderness known as renal angle tenderness)

Lower UTI

Pyelonephritis

ACUTE

Sudden development:

- Fever
- Rigors
- Loin pain

CHRONIC

- Hypertension
- Repeated UTI
  → Renal scarring
- No active infection

Management Of Pyelonephritis

Investigation

- Urinalysis shows blood, protein, nitrite, leukocyte esterase
- Urine culture and sensitivity ideally **before** commencing antibiotics

In acute pyelonephritis:

Start empirical antibiotics immediately once sample has been sent.

E.Coli* = *Most common cause of UTI

Management Of Pyelonephritis

We have decided to just give you 2 antibiotics to remember which we believe is enough for the exam

Co-amoxiclav

Cefalexin

Generally a 7 day course

Proteinuria

Facts

Protein 1+ and above in dipstick test

- Can be normal (5% in healthy individuals)
- Can occur in relation to fever, post-exercise, seizure, CCF, severe acute illness, extreme cold

If **no symptoms** and **healthy**

→ Repeat the test

If still high

→ 24hrs urine collection

→ urinary albumin creatinine ratio / protein creatinine ratio

DO NOT refer to renal clinic because of a ONE 'isolated positive dipstick'

Further investigation before a referral is always required!

Nephrotic Syndrome

Features

1. Proteinuria (> 3g/ 24hr)
2. Hypoalbuminemia (< 30g/L)

Defines nephrotic syndrome

3. Oedema
4. Hyperlipidaemia
5. Hypercoagulable state - loss of antithrombin III
6. Predisposition to infection - loss of immunoglobulins

Investigations

1. Urinary protein:creatinine ratio / 24 hr urinary protein levels
2. Blood test - Albumin level
3. Renal biopsy - definitive diagnostic test

Foamy or frothy urine = High protein

Complications

- Thromboembolism
- Sepsis
- Pre-renal AKI (usually from over-diuresis)

Common Cause Of Nephrotic Syndrome

In Children
Most common → **Minimal change nephropathy**
In Adults
Most common → **Membranous glomerulonephritis**
Second most common → **Focal segmental glomerulonephritis**
Others
• Diabetic nephropathy • Myeloma cast nephropathy • Amyloidosis

Most common cause for nephrotic syndrome in adult > 40 years old is **membranous glomerulonephritis**

Minimal Change Nephropathy

Minimal change diseases always account for nephrotic syndrome

Features

- Common in children
- Nephrotic syndrome → Proteinuria > 3g/day, Oedema, Hypoalbimunaemia
- Normotensive
- Renal biopsy → Electron microscopy shows **fusion of podocytes**

We do not really do this for children as it is invasive, we just treat with steroids

Example

6 years old boy presented with progressively:

- Swelling of face, scrotum and legs
- Urine is frothy
- Fusion of podocytes shows on electron microscopy

RED are all the hints!

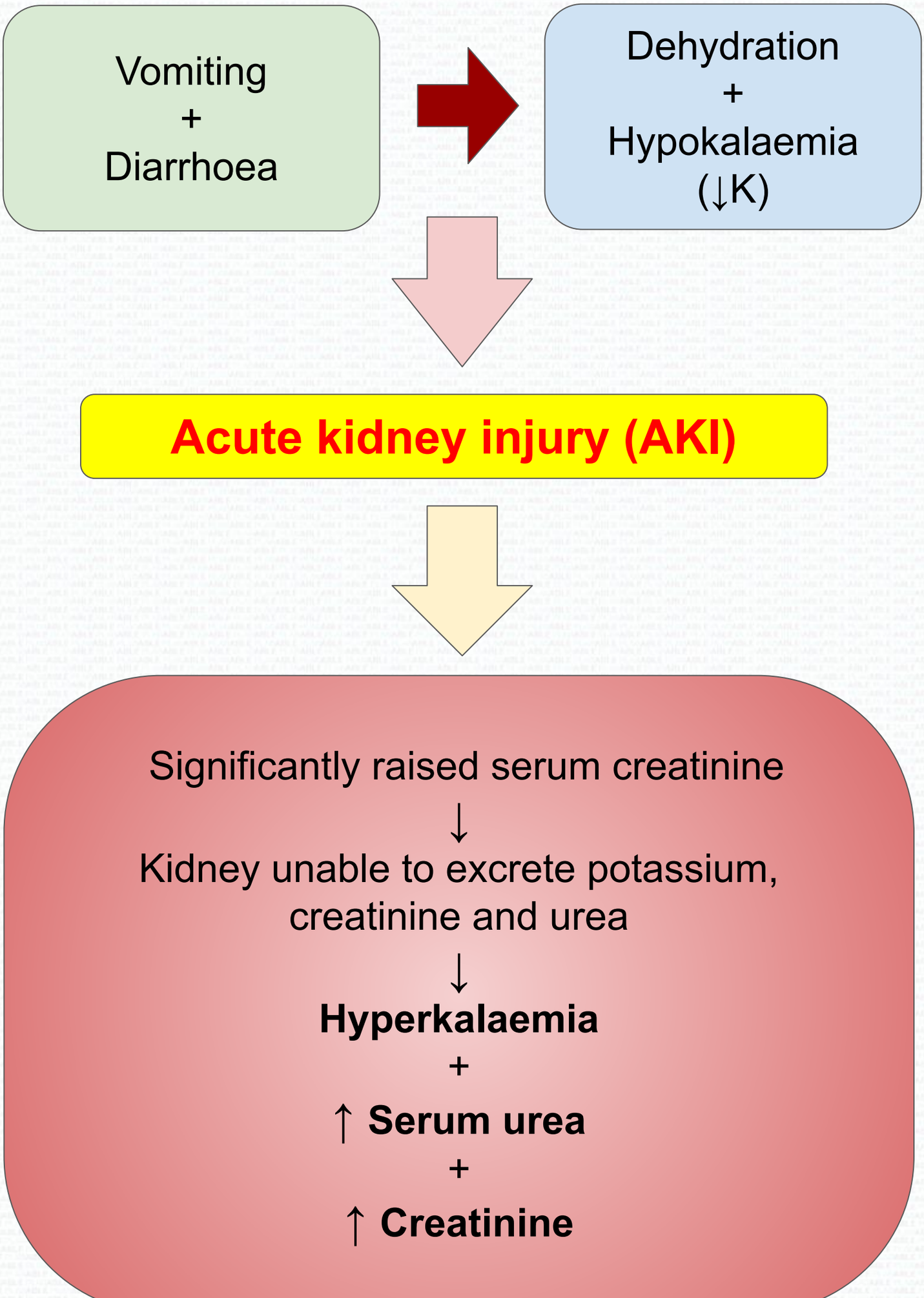
Minimal Change Disease

Brain trainer:

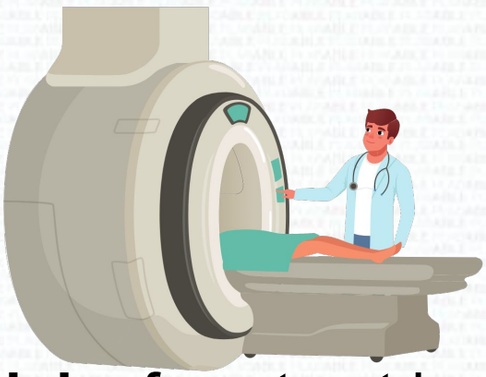
A boy presents with serum albumin 20 g/L (35-50), oedema and urine dipstick positive for protein. What should you check before referring this boy to nephrology?

➔ **Urine protein:creatinine ratio**

Hypovolaemia



Contrast Induced Nephropathy



To **reduce risk** of contrast in CT scan or any contrast study

Drink plenty of fluid

Stop nephrotoxic drugs if renal function abnormal e.g. Metformin, NSAIDs

IV fluid with normal saline (0.9% NaCl)

(Probably the same efficacy as just drinking oral fluids)

- Pre- and post-contrast
- Particularly in high risk patient
- e.g. Elderly with diabetes, CKD stage 4 and above, CCF

Blood Gas Abnormality

1

Acidaemic

pH < 7.35

Alkalaemia

pH > 7.45

2

Respiratory acidosis
$PaCO_2$ > 6.0 kPa

(Respiratory compensation for metabolic alkalosis)

Respiratory alkalosis
$PaCO_2$ < 4.7 kPa

(Respiratory compensation for metabolic acidosis)

3

Metabolic acidosis
Bicarbonate
< 22 mmol/L

(Renal compensation for respiratory alkalosis)

Metabolic alkalosis
Bicarbonate
> 26 mmol/L

(Renal compensation for respiratory acidosis)

CO_2 is an acid. Bicarbonate is an alkali

Hypertension In Chronic Kidney Disease

Patient has both **CKD** and **HTN**

Is the patient also diabetic?
(Age/ethnicity doesn't matter)

Non-Diabetic	Diabetic
START AN ACEI OR ARB IF eGFR > 30 OR	
ACR > 30	**ACR ≥ 3**

Consider the following situations:

If eGFR is < 30

- Use ACEI/ARB with caution (lower dose)

If ACR is <30 or <3

- This is **NOT** a contra-indication for ACE/ARB use
- Therefore continue use of drug if there are other indications

Types Of Glomerulonephritis

Presented with nephritic syndrome

- **Haematuria**
- **Hypertension**

Presented with nephrotic syndrome

- **Proteinuria**
- **Oedema**

Rapid progressive glomerulonephritis (Crescentic glomerulonephritis)

- Rapid onset
- Often presented as AKI
- Caused by Goodpasture
  → Haematuria
  → Hemoptysis
  Or ANCA +ve vasculitis

Minimal change diseases

- Accounted for 80% of nephrotic syndrome
- Good response to steroid
- Fusion of podocytes show in electron microscopy via renal biopsy
- Mostly idiopathic or Hodgkin's or steroid induced

Types of Glomerulonephritis

Presented with nephritic syndrome

- **Haematuria**
- **Hypertension**

Presented with nephrotic syndrome

- **Proteinuria**
- **Oedema**

IgA nephropathy (Berger's diseases)

- Young adult with haematuria 1-2 days after URTI

Membranous glomerulonephritis

- Presentation:
  → Proteinuria
  → Nephrotic syndrome
  → CKD
- Idiopathic or caused by infection, rheumatoid drugs or malignancy
- ⅓ resolved
- ⅓ response to cytotoxics
- ⅓ develops to CKD

Types of Glomerulonephritis

Presented with nephritic syndrome

- **Haematuria**
- **Hypertension**

Presented with nephrotic syndrome

- **Proteinuria**
- **Oedema**

Mesangioproliferative glomerulonephritis

- Young adult with haematuria 1-2 days after URTI

Focal segmental glomerulosclerosis

- Idiopathic or secondary to HIV/heroin
- Presentation:
  → Proteinuria
  → Nephrotic syndrome
  → CKD

When To Suspect Chronic Kidney Disease?

Anaemia	**Hypocalcaemia**
Hyperphosphatemia	**Small Kidney on ultrasound < 9 cm**

Diabetes and Chronic Kidney Disease

Brain trainer:

An elderly man with a background of hypertension, diabetes mellitus type 2 and chronic kidney disease attends the GP surgery for a check up. His BP is 180/100 mmHg. He is taking regular amlodipine. There is significant proteinuria on two separate occasions. Which medication is likely to slow down the renal disease process?

➔ **ACE inhibitor**

Hypocalcaemia

Symptoms

- Tingling
- Numbness
- Paresthesia
- Involuntary spasm/cramps

CKD can cause

1,25 dihydroxyvitamin D3 deficiency

→ ↓ Calcium absorption

→ Hypocalcemia

Autosomal Dominant Polycystic Kidney Diseases

Features

- Haematuria
- Hypertension
- Loin or flank pain

Often associated with intracranial aneurysm

Investigation

- Ultrasound kidney, ureters and bladders

Genetic testing → Best not to select in the exam as there are very specific criteria for its use in specialist centres

Autosomal dominant

= 50% of offspring (1st generation) will be affected

Can lead to progressive CKD

Haemolytic Uremic Syndrome (HUS)

In children

1. Eating undercooked contaminated food
2. E.Coli → Produce verotoxin
3. Profuse **diarrhoea**
4. **Bloody** diarrhoea
5. After 2-14 days
   → **Uremia (Acute renal failure)**
6. + Features of anaemia e.g fatigue, pallor

Features

1. Haemolytic anaemia (Haemolysis)
2. Uremia (Acute renal failure)
   → Haematuria
   → Proteinuria
   → ↑ Urea and creatinine
3. Thrombocytopenia (Low platelets)

Treatment

- IV Fluid
- ± Blood transfusion
- ± Dialysis
- Plasma exchange (in very severe case only)

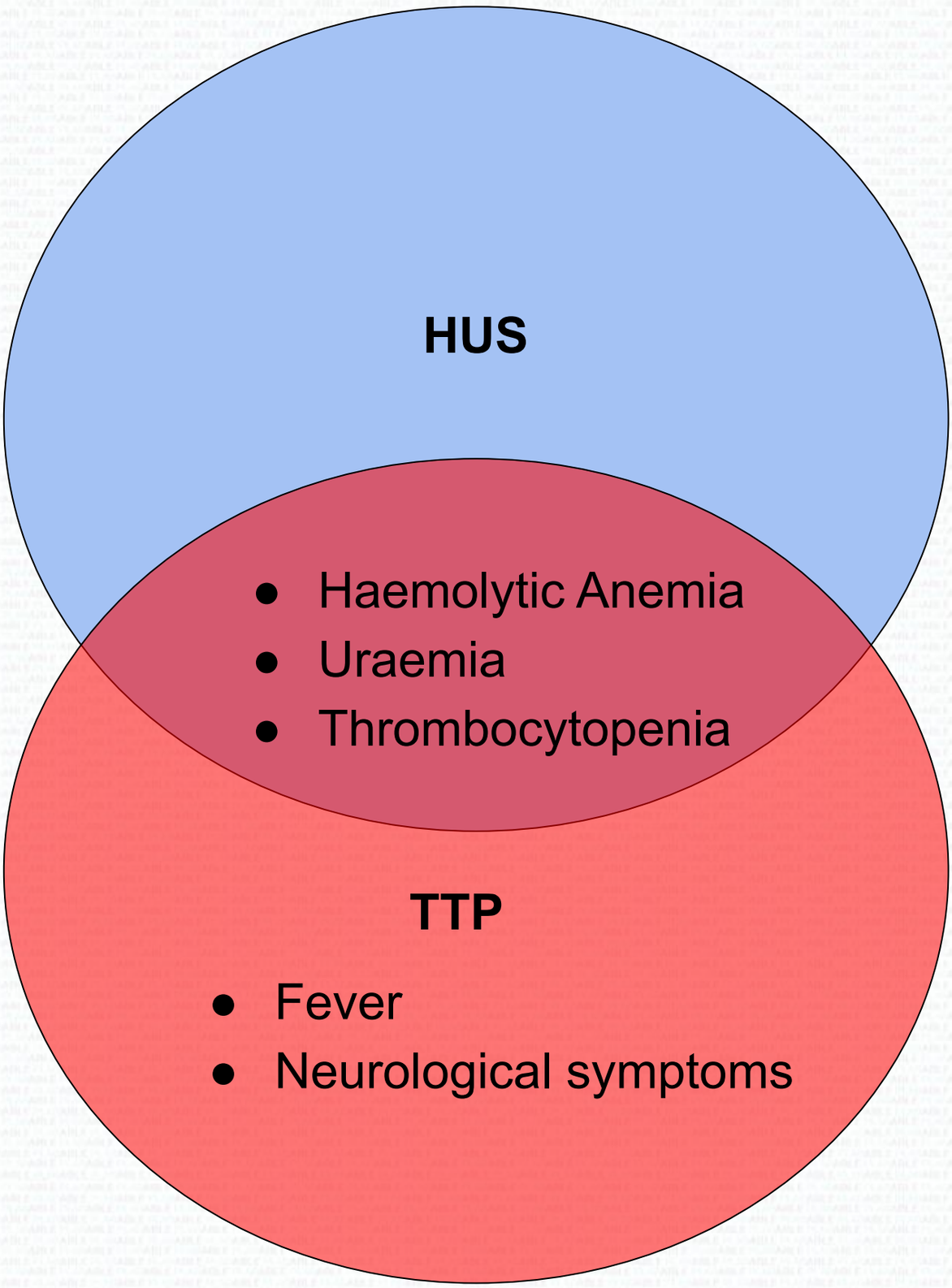
Haemolytic Uremic Syndrome (HUS)

NEVER give antibiotics as it releases more toxin by killing *E.Coli*

Suspect **thrombotic thrombocytopenic purpura** if they have features of HUS **plus fever and neurological manifestation**

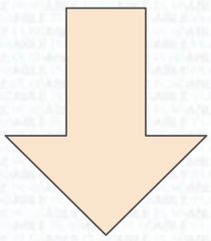
Diseases	*Features*	*Investigation*
Polycystic Kidney Diseases (ADPKD)	• Haematuria • Hypertension	Ultrasound
Goodpasture Syndrome	• Haematuria • Hemoptysis	Anti-GBM antibodies
Wegener's (Granulomatosis with Polyangiitis)	• Haematuria • Hemoptysis • Nasal/Sinus symptoms	c-ANCA
Haemolytic Uremic Syndrome (HUS)	• Haematuria • Bloody Diarrhoea	

Haemolytic Uremic Syndrome (HUS)



Suspect **thrombotic thrombocytopenic purpura** if they have features of HUS plus **fever and neurological symptoms**

Haematuria After A Upper Respiratory Tract Infection



IgA glomerulonephritis	Post-streptococcal glomerulonephritis
1-2 **days** after URTI	1-2 **weeks** after URTI
Main Features: • Haematuria	Main Features: • Proteinuria
Patient factor: • Young males	Patient factor: • ↓ Complement (C3) Level • Humps on electron microscopy in renal biopsy

Causative organism

→ Group A beta-haemolytic Streptococci (*Streptococcus Pyogenes*)

Treatment

→ Mainly supporting as it is self-limiting

Abnormal Kidney Size Causes

Large Kidney

- ADPKD
  → Multiple cysts makes kidney bigger
- Obstructive uropathy
  → Due to stone or enlarged prostate
  → Hydronephrosis
  → ↑ Size

Small Kidney

- Hypertensive renal diseases
  → Small and scarred kidney
- Bilateral renal artery stenosis
- Chronic pyelonephritis
- Chronic glomerulonephritis

Small Kidneys

While there are many causes of small kidneys. We would like you think of these few which are commonly tested.

	Findings
Hypertensive renal diseases	Long term high blood pressure
Bilateral renal artery stenosis	ACEi often worsen creatinine acutely Remember, unilateral renal artery stenosis results in only ONE kidney being small
Chronic pyelonephritis	Recurrent upper UTIs Scarring of renal parenchyma
Chronic glomerulonephritis	Look out for the absence of the other diagnostic options above + proteinuria

Abnormal Kidney Size Causes

Examples:

Patient with hypertension with elevated creatinine, u/s shows bilateral small kidneys
→ Hypertensive renal diseases

Patient with enlarged prostate presented with prostatism (urinary frequency, post-void dripping, hesitancy)
→ Obstructive uropathy + Hydronephrosis
→ Ultrasound will show LARGE kidneys

Patient with dilated pelvicalyceal system and is young
→ Reflux nephropathy

Haemodialysis

Indications:

Persistent high potassium	Acidosis
Pulmonary oedema, pericarditis	Fluid overload with anuria

Example:

Patient had renal transplant and presented with above features?

Causes:
Transplant rejection or Host-versus-graft:

❌ Treat hyperkalemia
❌ Give IV calcium gluconate followed by insulin and glucose

∵These **DO NOT** treat all the above features as kidney does not work, potassium and toxin will accumulate again.
Extra fluid can worsen fluid overload problem

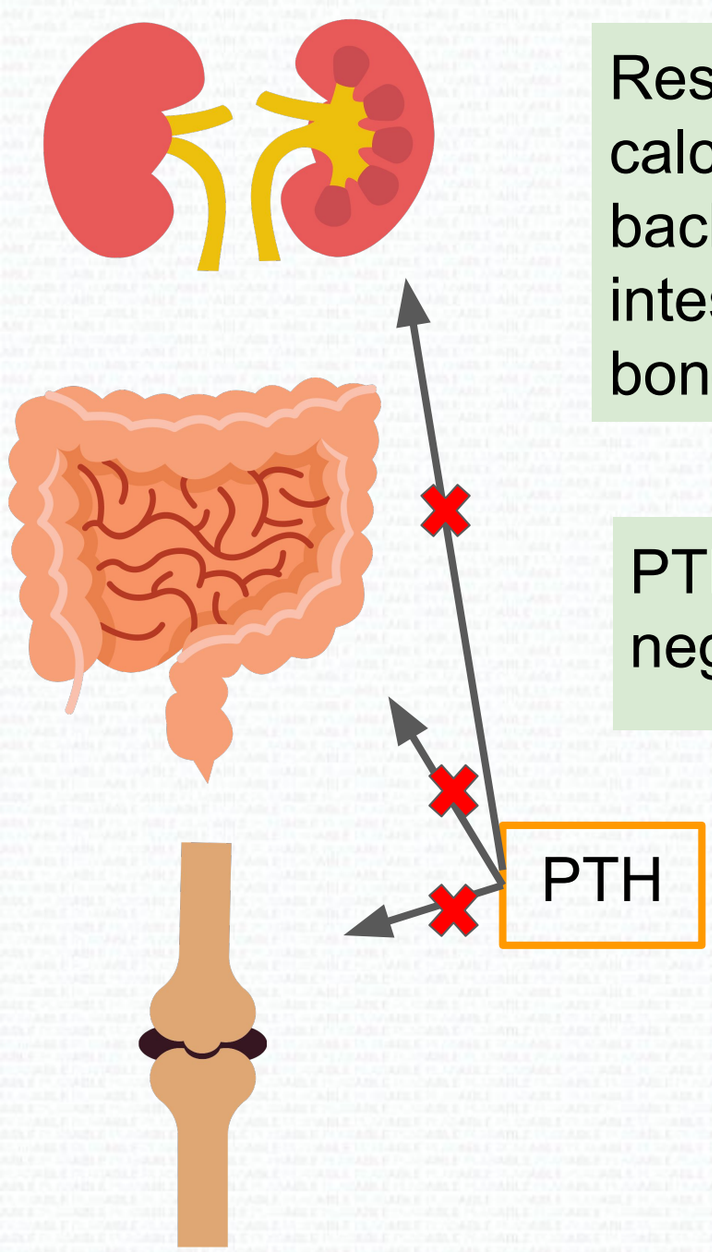
BEST treatment: Haemodialysis

Pseudohypoparathyroidism

Remember the levels!

- PTH raised
- Calcium levels low/normal
- Phosphate raised

Pseudohypoparathyroidism
= **PTH resistance** in end organ *(e.g. bone and kidneys)*



Results in not enough calcium being absorbed back into serum from intestine, kidney and bone

PTH rises because of negative feedback

Adynamic Bone Disease

Disease due to low bone turnover

- Oversuppression of PTH (e.g. overreplacement of calcium and vitamin D)

Remember the levels

- In context of end stage renal disease
  - Normal PTH
  - Normal or low calcium levels
  - Normal or raised phosphate
  - Raised ALP

Vitamin D and calcium tablets

Suppresses PTH

Reduces bone turnover

Bone pain

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