Renal Physiology, AKI and CKD MCQs

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Revise Nephrology

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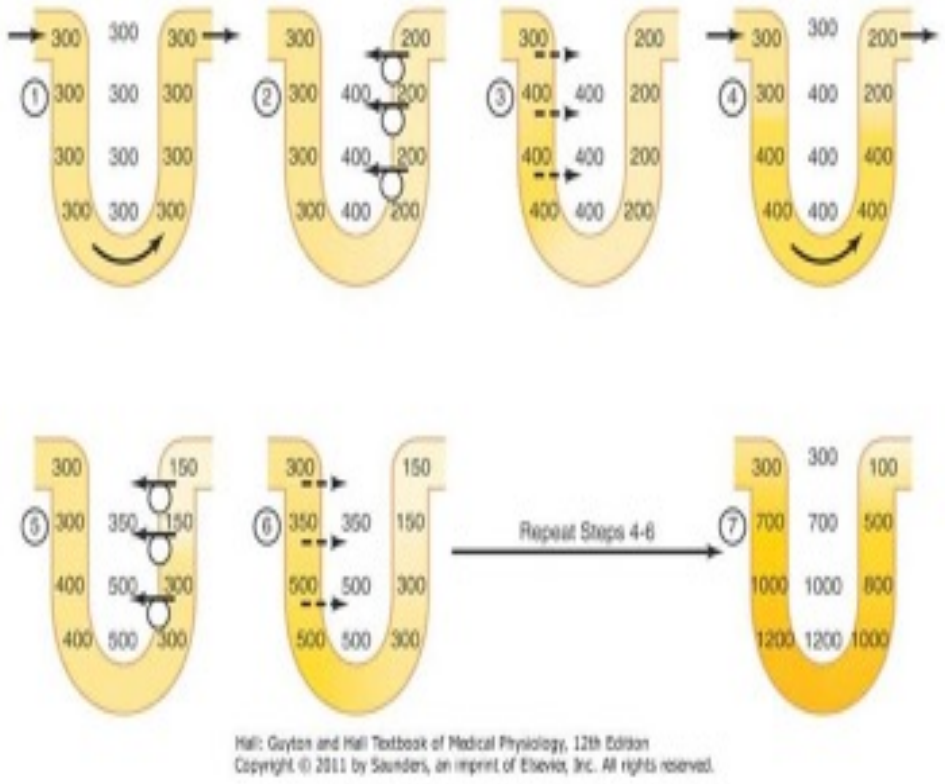
1. Which part of the renal tubule is impermeable to water?

a) Proximal convoluted tubule
b) Distal convoluted tubule
c) Cortical duct
d) Descending limb of loop of Henle
e) Ascending limb of loop of Henle

Countercurrent Mechanism



Answer E

That is the basis of the counter-current mechanism and generation of the interstitial osmotic gradient which enables ADH to do its job.

2. Normal anion gap metabolic acidosis with hypokalaemia is an indicator of either type 1 (distal) or 2 (proximal) RTA and the best way to differentiate these two is by checking:

a) Urinary Chloride
b) Urinary protein
c) Urinary anion gap
d) Urinary pH
e) Serum K concentration

ANSWER: D

- Both RTAs 1 and 2 are characterised by Normal anion gap metabolic acidosis with hypokalaemia.
  - Proximal RTA (type 2) caused by reduced ability to reabsorb bicarbonate (HCO_3) in the proximal tubules
  - Distal RTA (type 1) caused by defects in distal H ion excretion
- Remember any cause of acidosis will cause the kidney to compensate by excreting extra H^+ ions (acidic urine i.e. pH<5.5). The problem in RTA 1 is INABILITY to excrete H^+. Type 1 RTA is characterised by urinary pH >5.5 due to lack of H in urine THUS differentiating from type 2 RTA or any other cause of metabolic acidosis.

FBC - Hb 109g/L	K - 6.2mM
MCV - 92fL	Cl - 115mM
Plt - 451 x 109/L	HCO3 - 21mM
WBC - 12.5 (Neut 10.6)	Urea - 38.6mM
Lym - 1.0	Creat - 650 umol/
Eos - 0.8	Na 140mM
Urine dipstick- Nil blood and 1+ protein	

- 3. A 70-year-old man undergoes coronary stenting for worsening angina and paroxysmal AF. He is anticoagulated with warfarin following the procedure. Serum creatinine is 105 umol/L four days following his angiogram at the time of discharge (98umol/L at admission). Three weeks after discharge he presents to his local medical officer feeling increasingly fatigued. A mottled rash (livedo reticularis) is noted on his lower legs and abdomen. His blood tests are as follows

What is the most likely explanation?

a) Acute interstitial nephritis

b) Cholesterol atheroemboli

c) Membranous glomerulonephritis

d) Contrast nephropathy

Answer B

AIN though possible, is more likely to present in 5-10 days of drug exposure. The rash and timing are more supportive of cholesterol atheroemboli. Contrast nephropathy usually comes much before this period of time. Absence of haematuria rules out a GN.

4. Which of the following is an indication for urgent haemodialysis in a patient with AKI who has just presented to ED?

a) Serum creatinine of 1020 umol/L
b) K of 6.7
c) Serum HCO3 18 mM
d) Pericardial rub
e) Urea of 66 mM

Answer D

- K of 6.7 deserves medical management and ONLY if that fails could justify dialysis.
- *Indications for urgent dialysis (my rule of Ps)*
  - Low **p**H (refractory to medical management)
  - High **p**otassium (refractory to medical management)
  - **P**ulmonary oedema (refractory to medical management)
  - **P**ericarditis/pericardial effusion
- Sym**p**toms of uraemia

5. Which of the following is true about acute interstitial nephritis (AIN)?

a) The triad of myalgia, rash and eosinophilia is seen in 75 % of patients with AIN

b) Symptoms from drug induced interstitial AIN occur few months after exposure

c) The current evidence favours corticosteroids as the first line therapy of choice

d) Infections represent the most common cause of AIN

e) Cessation of presumed offending drug is the first line therapy

Answer E

- The triad of myalgia, rash and eosinophilia is now seen in <10% cases. While symptoms nay come after few months, they mostly come after 5-10 days too. The first line of management is cessation of the offending drug. A 2-3 months of low dose corticosteroids is used if no response is seen after 7 days of cessation of the offending drug.
- Causes of AIN:
  - **Drugs** (antibiotics, NSAIDs, diuretics and PPIs) – 70 to 75%
  - **Infections** (streptococcus, legionella, CMV etc.) – 4 to 10%
  - **Tubulointerstitial nephritis and uveitis (TINU) syndrome** – 5 to 10 %
  - **Systemic disease** including sarcoidosis, Sjögren's syndrome, SLE and others 10 to 20 %

6. A 46-year-old male is involved in a MVA, following which he undergoes extensive surgery including a laparotomy for suspected ruptured bowel and decompression surgery on his legs from compartment syndrome. He receives multiple antibiotics including gentamicin and ampicillin. Ten days later, after discharge to the general ward, he develops a rapidly rising serum creatinine. His urine output is more than 1L per day. Urine dipstick shows no blood and 1+ protein. Obstruction is excluded on a renal ultrasound examination. The most likely cause of his acute renal failure is:

- Glomerulonephritis
- Rhabdomyolysis
- Hypovolaemia related to his injuries.
- Aminoglycoside-related acute tubular necrosis.
- Intratubular calcium deposition

Answer D

Non-oliguric AKI from gentamicin due to ATN usually occurs 5-10 days after treatment. No RBC in urine rules out GN. There is nothing in the history to suggest hypovolemia or relapse of rhabdomyolysis.

7. The effect of aldosterone on renal H^+ secretion is-

a) It has no effect
b) Increases secretion
c) Decreases secretion
d) Can do both at different parts of the tubule
e) Reabsorb H^+

Answer B

Aldosterone is secreted by the zona glomerulosa of adrenal cortex and helps in Na^+ reabsorption and K^+ and H^+ excretion by the distal portions of the tubules. On binding to the mineralocorticoid receptor, aldosterone upregulates and activates the basolateral Na^+-K^+-ATPase in the principal cells causing lower intracellular Na^+ and at the same time up regulates epithelial sodium channels (ENaC) increasing apical membrane permeability for Na^+. The resultant intracellular movement of Na^+ causes luminal negativity leading in turn to secretion of the positively charged K^+.

The Na^+ to K^+ movement is not a strict one to one exchange and more Na^+ is reabsorbed than K^+ is lost. So, the same luminal negativity leads to H^+ secretion by the alpha- intercalated cells. The potassium-sparing diuretics (amiloride and triamterene) act by directly inhibiting ENaC channels; spironolactone acts by competing with aldosterone for binding to the mineralocorticoid receptor.

8. Dialysis related amyloidosis (DRA) classically presents with:

a) Heart failure

b) Back pain

c) Autonomic neuropathy

d) Peripheral neuropathy

e) Shoulder pain

Answer E

- DRA is almost exclusively seen in patients on dialysis. Few points to remember:
  - Tissue deposition of amyloid, particularly in bone, articular cartilage, synovium, muscle, tendons, and ligaments
  - Amyloid protein in DRA is derived primarily from beta2-microglobulin (beta2-m)
  - With the use of high-flux membranes that provide better clearance of beta2-m, less common now
  - Present with shoulder pain or carpal tunnel syndrome
  - X-rays show multiple bone cysts that enlarge over time
- Treatment: optimization of dialysis with high-flux biocompatible membranes (transplant definite cure

9. It is thought that the initial event that triggers the development of CKD MBD is:

a) Hyperparathyroidism

b) Low serum calcium

c) Hyperphosphatemia

d) Low potassium

e) High potassium

Answer C

- Pathophysiology of bone and mineral disorder in CKD involves the following:
  - **Phosphate retention (starts when GFR < 70 ml/min)- first step**
  - Decreased serum calcium
  - Decreased 1,25-dihydroxyvitamin D (calcitriol) concentration
  - Increased fibroblast growth factor 23 (FGF-23) concentration leading to decreased calcitriol production (inhibits 1-alpha hydroxylation of vit.D)
  - Repression of calcium-sensing receptors (CaSRs) in the parathyroid gland
  - Decreased expression of FGF 23 receptor 1 and co-receptor klotho in the hyperplastic parathyroid gland causes inability of FGF 23 to suppress PTH as would normally do

10. Which among the following vaccines is contraindicated in patients with CKD?

a) Pneumococcal conjugate vaccine
b) Varicella vaccine
c) Injectable polio vaccine
d) Live attenuated Influenza vaccine

Answer D

- As a rule, live vaccines are contraindicated in CKD, whereas inactivated and subunit vaccines can be given. However, MMR and varicella vaccines are attenuated viral vaccines and can be given in CKD unless the patient is on concomitant immunosuppressive therapy
- All CKD patients should receive annual vaccinations with inactivated influenza vaccine.
  - NOTE- Hepatitis B vaccine in ESRD:
  - Reduced efficacy- Compared with a response rate of >90 percent in patients without renal failure, only 50 to 60 percent of those with ESKD develop antibodies following HBV vaccination.

11. An urgent renal biopsy is urgently indicated in the evaluation of the following patients except:

a) 58-year-old hypertensive male with microhaematuria, 1g/d proteinuria and creatinine rise from 120umol/l to 350umol/l in four weeks.

b) 40-year-old type 1 diabetic female with retinopathy who has 2.2 g/d of proteinuria, benign urine sediment and serum creatinine 150umol/l

c) 28-year-old female with SLE, who has 1g/d of proteinuria, microhaematuria and creatinine 110umol/l

d) 70-year-old male with MGUS who has 3 g/d of proteinuria, benign urine sediment and serum creatinine 600umol/l

e) 33-years old previously fit male with 3.6 g proteinuria

Answer B

Renal biopsy provides accurate information about the nature of renal injury which is important in establishing the aetiology of renal disease and guiding treatment. It is essential in the evaluation of a patient with rapidly progressive renal failure to exclude crescentic nephritis

(a) and systemic disease like SLE with renal involvement

(c) where treatment decision will depend on severity of histological abnormalities. Establishing a diagnosis of myeloma cast nephropathy or MGRS will modify therapeutic options in a patient with MGUS and acute kidney injury, and biopsy is essential to guide therapy

(d). New onset nephrotic range proteinuria

(e) needs to be evaluated while in a diabetic with established microvascular disease like retinopathy and proteinuric renal impairment associated with benign urine sediment

(b), a presumptive diagnosis of diabetic nephropathy can be made with reasonable certainty.

12. Which of the following conditions may be associated with an elevated creatinine without an actual decrease in the estimated GFR?

- a. Treatment with Bactrim
- b. Treatment with penicillin
- c. Amputation
- d. Strict vegetarianism
- e. Early diabetic nephropathy

Answer A

- While normally, about 15 percent of the urinary creatinine is derived from secretion in the proximal tubule, this can go up to 40 percent in those with renal failure or nephrotic syndrome leading to overestimation of the true glomerular filtration rate (GFR) by creatinine clearance. Drugs such as trimethoprim, cimetidine and pyrimethamine can interfere with the tubular secretion of creatinine and cause a high serum creatinine.
- Penicillin can cause acute interstitial nephritis leading to elevated serum creatinine with reduced glomerular function.
- Creatinine is derived from metabolism of phosphocreatine in muscle as well as excessive dietary creatine from high meat intake or creatine supplements. Increased muscle mass and excess intake of meat therefore can lead to raised plasma creatinine and vice versa without alteration in GFR. Therefore, serum creatinine may be low in vegetarians and those with amputation.

13. Which of the following does not lead to euvolemic hyponatremia?

a) Thiazide diuretics
b) Loop diuretics
c) SSRI
d) Carbamazepine

Answer B

- Loop diuretics when suddenly introduced in a big dose or titrated upwards dosewise too rapidly can cause excessive diuresis leading to hypovolemia; these patients can develop hypovolemic hyponatremia. The question here is about euvolemic hyponatremia. SSRIs and carbamazepine are known to cause SIADH which is euvolemic hyponatremia. Blockage of DCT with thiazide diuretics cause upregulation of Na reabsorption in other parts of the tubules. Increased Na reabsorption in the TAL (in the absence of water reabsorption here) causes increased osmotic gradient, enabling ADH to work more efficiently and therefore, reabsorb extra water in the DCT leading to dilutional hyponatremia.

Revise the counter current mechanism

- Frusemide acts by interrupting with Na^+ uptake in the TAL by the Na^+-K^+ -$2Cl^-$ transporter. This interferes with the countercurrent mechanism and the generation of the medullary interstitial osmotic gradient. Remember that without this gradient, ADH cannot reabsorb water in the medullary collecting duct. Thus, frusemide leads to the excretion of a dilute urine which would prevent the development of hyponatremia.

14. A 74-year-old woman with history of well controlled hypertension, hypercholesterolemia, and smoking history of 30 pack years is found to have abnormal kidney function on a routine blood test. Her current medications consist of perindopril 10 mg daily and amlodipine 10 mg daily and her last blood pressure was 138/86 mmHg.

- Her results are as follows:

Serum creatinine 148 µmol/L [49–90]	Haemoglobin (Hb) 112 g/L [120–160]
(eGFR) 35 mL/min/1.73 m 2 [90–130]	Calcium (Ca) 2.37 mmol/L [2.20–2.55]
Sodium (Na) 136 mmol/L [134–145]	Phosphate (PO^4) 1.25 mmolL [0.78–1.43]
Potassium (K) 4.1 mmol/L [3.5–5.0]	Urine albumin: creatinine ratio (ACR) 8 mg/g [< 3.5]

In addition to monitoring kidney function, what additional strategy should be the focus of her management?

- Addition of valsartan to control the proteinuria
- Modification of cardiovascular risk factors
- Planning for dialysis access.
- Further reduction of BP
- Starting of EPO

Answer B

- Patients with stage 3 CKD are more likely to die because of cardiac disease rather than progress to ESRD. It is estimated that each 20 % reduction in GFR carries a 50% increased risk for major vascular events. Patient is already on ACEI and has good BP control which are requirements to minimise proteinuria.
- Most authorities suggest referral to a nephrologist is warranted when eGFR is less than 30 mL/min per 1.73 m^2. Patients at or below this level of eGFR are at increased risk of ESRD, and late referral in this group is associated with increased morbidity and mortality.
- Addition of ARB to ACEI is associated with significantly increased risk of hyperkalaemia, kidney failure and mortality and is not adviced. This patient's BP is reasonably well controlled, and EPO is not indicated unless Hb is below 100 g/L

15. The presence of which of the following for a period of three months does not lead to the diagnosis of chronic kidney disease?

a) 24-hour urinary albumin excretion of 30 mg

b) Persistent presence of leucocytes in urine

c) Red blood cell casts in the urine

d) Kidney transplantation

e) Enlarged kidneys with more than 10 cysts in each kidney

Answer B

- While persistent white cell casts in the urine for more than 3 months is considered a criterion for chronic kidney disease (CKD) due to the association with chronic tubulo-interstitial disease, presence of white cells in urine persistently does not lead to the diagnosis of CKD.
- CKD is defined as abnormalities of kidney structure or function, present for > 3 months, irrespective of the cause
- Diagnosis: GFR is < 60 ml/ min/ 1.73m^2 and/ or the following markers of kidney damage are present for > 3 months:
- Albuminuria: 24-hour urinary albumin excretion of 30 mg/day or higher, or urine albumin- creatinine ratio (ACR) of 30 mg/g (or 3.4 mg/mmol) or higher
- Urinary sediment abnormalities: Red or white blood cell casts may indicate the presence of glomerular injury or tubular inflammation

- Imaging abnormalities: Imaging abnormalities such as polycystic kidneys, hydronephrosis or small and echogenic kidneys
- Pathologic abnormalities: A kidney biopsy may reveal evidence of glomerular, vascular, or tubulointerstitial disease
- Kidney transplantation: Patients with a history of kidney transplantation are assumed to have CKD irrespective of presence or absence of abnormalities on kidney biopsy or markers of kidney damage

16. Which of the following factors does not contribute to diuretic resistance in patients with nephrotic syndrome?

a) Decreased loop diuretic tubular secretion

b) Enhanced tubular sodium reabsorption

c) Loop diuretics are highly protein bound

d) Albuminuria

e) Decreased activity of RAS system

Answer E

- Loop diuretics must enter the tubular fluid in order to exert their diuretic effect. Loop diuretics are highly (≥95 percent) protein bound. As a result, they primarily enter the tubular lumen by secretion by the proximal tubule, not by glomerular filtration.
- Because loop diuretics are highly protein bound, severe hypoalbuminemia (<2 g/dL) associated with the nephrotic syndrome may reduce the delivery of diuretic to the renal tubule and therefore, decrease tubular secretion. In addition, filtered albumin in nephrotic patients may bind loop diuretics in the tubular lumen, thereby interfering with their function.
- Some patients have partial or relatively complete resistance to a loop diuretic despite adequate secretion of the diuretic into the tubular fluid. This is due to the compensatory increase in sodium reabsorption in other parts of the tubules when sodium reabsorption is blocked in the TAL by loop diuretics.
- Intravascular depletion caused by loop diuretics leads to activation of the RAS system leading to increased sodium reabsorption in the collecting duct.