CHRONIC KIDNEY DISEASE
REVISE NEPHROLOGY SYDNEY 2023

Dr. Surjit Tarafdar

Nephrologist

Blacktown Hospital, Sydney

Conjoint Senior Lecturer
Department of Medicine, Western Sydney University

TAKE HOME POINTS

- Definition of CKD
- Common complications with their pathogenesis, manifestations and management
  - FLUID, ELECTROLYTE AND ACID/BASE : *Fluid overload, hyperkalaemia, metabolic acidosis*
  - CARDIOVASCULAR **(leading cause of mortality):** *Coronary heart disease, hypertension, CCF, Strokes, Arrhythmias and Sudden Cardiac Death*
  - HAEMATOPOIETIC : *Anaemia and increased risk of bleeding from platelet dysfunction*
  - BONE AND MINERAL METABOLISM: *High turnover bone disease , low turnover bone disease(adynamic bone disease) and dialysis related amyloidosis*
  - NEUROLOGIC: *Uremic encephalopathy, dialysis disequilibrium syndrome , neuropathy and sleep disorders*
  - ENDOCRINE: *Reduced renal clearance of insulin with advanced CKD, Growth hormone resistance*
  - SKIN: *Calcific uremic arteriopathy (calciphylaxis), uremic pruritus and nephrogenic systemic fibrosis (NSF)*

DEFINITION OF CHRONIC KIDNEY DISEASE (CKD)

- **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

PREVALENCE OF CKD IN AUSTRALIA

- According to the Australian Institute of Health and Welfare (AIHW) in 2011-12:

  -An estimated 1.7 million (10%) Australian adults >18 years had CKD

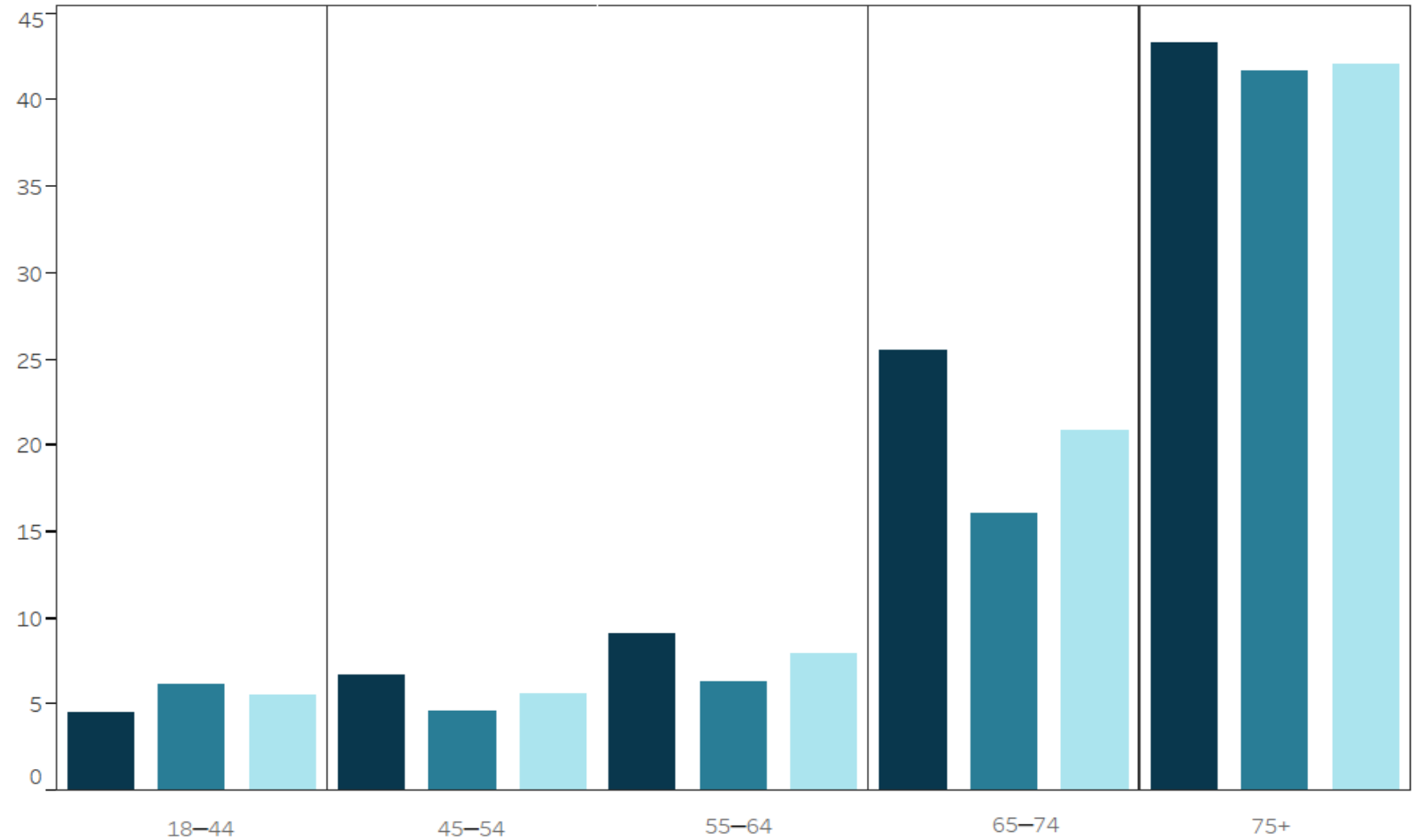
  -Was similar for men and women

  -Increased rapidly with age, with rates among those aged >75 at 42% ; for 65–74 at 21% and for 18–54 at 6%

Let us look at the chart in next slide

Men
Women
Persons

Per cent



Prevalence of CKD, among persons aged 18 and over, by age group and sex, 2011–12

Note: Based on the presence of biomedical signs of CKD detected by abnormal results of the kidney filtration rate (eGFR) and urinary albumin creatinine ratio (ACR).

Source: AIHW analysis of the ABS Microdata: Australian Health Survey (AHS): Core Content - Risk Factors and Selected Health Conditions, 2011–12. http://www.aihw.gov.au/

KIDNEY DISEASE IMPROVING GLOBAL OUTCOMES (KDIGO) 2012 GUIDELINES FOR STAGING CKD

Category	GFR (ml/min/1.73 m^2)	Description
G1	>90	Normal or high
G2	60-89	Mildly decreased
G3a	45-59	Mildly to moderately decreased
G3b	30-44	Moderately to severely decreased
G4	15-29	Severely decreased
G5	<15	Kidney failure

CARING FOR AUSTRALIAN WITH RENAL IMPAIRMENT (CARI) 2012 GUIDELINES FOR ALBUMINURIA

KIDNEY DAMAGE STAGE	URINE ALBUMIN/CREATININE RATIO (MG/MMOL)	URINE PROTEIN /CREATININE RATIO (MG/MMOL)	24 HOUR ALBUMIN (MG/DAY)	24 HOUR PROTEIN (MG/DAY)
Normoalbuminuria	<2.5 (M) <3.5 (F)	<4 (M) <6 (F)	<30	<50
Microalbuminuria (Moderately increased albuminuria)	2.5 to 25 (M) 3.5 to 35(F)	4 to 40 (M) 6 to 60 (F)	30 to 300	50 to 500
Macroalbuminuria (Severely increased albuminuria)	>25 (M) >35 (F)	>40 (M) >60 (F)	>300	>500

ETIOLOGY

- Diabetic nephropathy
- Glomerulonephritis
- Hypertension
- Autosomal dominant polycystic kidney disease
- Others e.g. cystic disease, reflux nephropathy etc.

RISK FACTORS FOR CKD

- Small for gestation birth weight
- Childhood obesity
- Diabetes mellitus
- Hypertension
- African ancestry
- Advanced age
- F/H of renal disease
- Autoimmune disease e.g., SLE
- Proteinuria
- Abnormal urinary sediment e.g., ongoing haematuria in IgA nephropathy
- Previous episode of AKI
- Structural abnormalities of the urinary tract

CONSEQUENCE OF LOSS OF RENAL FUNCTION IN CKD

- RAAS activation leads to raised glomerular blood flow and pressure and therefore raised glomerular filtration i.e., adaptive hyperfiltration in the good nephrons
- In early CKD, the raised GFR helps to maintain serum creatinine in normal range
- **Vicious cycle:** Sustained glomerular hyperfiltration leads to compensatory hypertrophy and eventually damaged nephrons

ESTIMATED GLOMERULAR FILTRATION RATE (EGFR)

- Relationship between GFR and nephron number not a simple linear relationship, being complicated by factors such as compensatory hyperfiltration, muscle mass, diet and tubular secretion of creatinine which can correspond to up to 40% of total creatinine excretion
- *Cockcroft–Gault formula:* estimates GFR based on plasma creatinine and patient age, weight and gender. Not in much use now.
- Modification of Diet in Renal Disease (MDRD) : is based on plasma creatinine, age and gender (NO WEIGHT).
- CKD-EPI equation mostly used now
  - More accurate at higher eGFR
  - Validated across more populations
- Age related issues with eGFR
  - In younger people, CKD-EPI will give a significantly higher eGFR value
  - In older people, CKD-EPI will give a slightly lower value

COMPLICATIONS OF CHRONIC KIDNEY DISEASE

- FLUID, ELECTROLYTE AND ACID/BASE : *Fluid overload, hyperkalaemia, metabolic acidosis*
- CARDIOVASCULAR **(leading cause of mortality):** *Coronary heart disease, hypertension, CCF, Strokes, Arrhythmias and Sudden Cardiac Death*
- HAEMATOPOIETIC : *Anaemia and increased risk of bleeding from platelet dysfunction*
- BONE AND MINERAL METABOLISM: *High turnover bone disease , low turnover bone disease(adynamic bone disease) and dialysis related amyloidosis*
- NEUROLOGIC: *Uremic encephalopathy, dialysis disequilibrium syndrome , neuropathy and sleep disorders*
- ENDOCRINE: *Reduced renal clearance of insulin with advanced CKD, Growth hormone resistance*
- SKIN: *Calcific uremic arteriopathy (calciphylaxis), uremic pruritus and nephrogenic systemic fibrosis (NSF)*

FLUID, ELECTROLYTE AND ACID BASE DISORDERS

- *Sodium /water homeostasis*: Prone to fluid overload and sodium intake should be <2 g/day (1 teaspoonful)
- *Hyperkalaemia*: Usually seen with decreased urine output, high-potassium diet, metabolic acidosis or drug induced hypoaldosteronism (ACEI or ARB, spironolactone)
  - Patients with DM, on CNIs (Tacrolimus and cyclosporine) more prone due to type IV RTA
  - Associated acidosis causes hyperkalaemia
- *Metabolic Acidosis*: due to increasing tendency to retain hydrogen ions
  - Hyperkalaemia potentiates metabolic acidosis
  - High anion gap metabolic acidosis in advanced CKD
  - May be normal anion gap metabolic acidosis in early (stages 1–3), in patients with diabetic nephropathy due to element of type IV RTA

CARDIOVASCULAR- COMMONEST CAUSE OF DEATH

- *Hypertension:* Data from the MDRD study showed that prevalence of HTN rose from 65 to 95 percent as the GFR fell from 85 to 15 mL/min
- *Coronary heart disease:* accounts for **40 to 50% of mortality in dialysis patients**
  - Patients often have diffuse multi-vessel involvement with coronary calcifications
  - Along with increased traditional risk factors and increased LVH, non-traditional risk factors include uremic toxins, hyperphosphatemia, anaemia, increased Ca intake, abnormalities in bone mineral metabolism
  - Invasive angiograms carry the risk of contrast-induced nephropathy
- *Congestive heart failure:* chronic volume overload due to decreasing urine output and chronic pressure overload due to long-standing hypertension and enhanced vascular stiffness
- *Strokes, Arrhythmias and Sudden Cardiac Death (SCD):* Dialysis patients have a 5-10-fold higher relative risk of stroke

  - SCD accounts for about **one-fourth of all deaths among dialysis patients**

HAEMATOPOIETIC SYSTEM

- Normocytic, normochromic anaemia: leads to fatigue, reduced exercise tolerance and dyspnoea
- Causes of anaemia:
  - **Erythropoietin deficiency: Insufficient production by diseased kidney**
  - Iron deficiency: GI blood loss, blood loss during dialysis and poor oral iron absorption
  - Increased hepcidin: Hepcidin prevents the release of iron from intestinal cells and macrophages
  - Reduced RBC life and mass
  - Hyperparathyroidism: High PTH suppress the erythroid progenitors in bone marrow and renal EPO synthesis
  - Drugs: ACEI or ARB lead to accumulation of AcSDKP which can down regulate erythropoiesis
  - Aluminium Overload: Sometimes used as phosphate binder can cause direct inhibition of erythropoiesis and disruption of RBC membrane function
  - Nutritional deficiencies: Loss of water soluble vitamins in dialysis and stringent dietary restrictions
- Increased risk of bleeding due to platelet dysfunction

BONE AND MINERAL METABOLISM

- Pathophysiology
  - **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 (FGF-23 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

TYPES OF BONE DISEASE IN CKD

- ***Low turnover bone disease (Adynamic bone disease)***
  - In patients with CKD stage 5, and on dialysis, adynamic bone disease is now the commonest renal bone disease
  - Consequence of over-suppression of PTH by zealous clinicians
  - Though mostly asymptomatic, increased risk for fractures, hypercalcaemia, vascular calcification and mortality
  - Treatment : allow PTH levels to rise by decreasing the doses of calcium-based phosphate binders, decreasing or stopping calcitriol and by using non-calcium-based phosphate binders
  - Aim for PTH levels two to seven times the upper limit of normal
  - Atraumatic bone fractures in the presence of a serum PTH < 2 times the upper limit of normal is suggestive of adynamic disease
- ***High turnover bone disease (Rare now; was very common in the past)***
  - Uncontrolled PTH levels lead to increased bone turnover and osteitis fibrosa cystica
  - Formation of cyst like brown tumors in and around bones
  - X-rays may show sub-periosteal erosions or cystic tumours
  - Treatment consists of phosphate control (discussed later), cinacalcet (calcimimetic) or sometimes parathyroidectomy

Bone biopsy is the gold standard but uncommonly used……

TYPES OF BONE DISEASE IN CKD

- *Dialysis related amyloidosis (DRA)*
  - 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)
  - Almost exclusively seen in patients on dialysis
  - 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)
- *Osteomalacia*
  - Rarer now with strict removal of aluminium from dialysis water and diminishing use of aluminium based phosphate binders
  - Characterized by defective bone mineralisation with markedly increased osteoid volumes

NEUROLOGIC MANIFESTATIONS OF CKD

- *Uremic encephalopathy*
  - Patients often have asterixis and hyperreflexia with mild cognitive disturbance to delirium, seizures, coma, and death
- *Dialysis disequilibrium syndrome (DDS)*
  - Usually seen when patients have rapid reduction in their urea levels due to urgent haemodialysis
  - Headache, nausea, confusion, blurring of vision, seizures or even coma
  - To prevent DDS dialysis started with short durations and low blood flow rates e.g. two hours of dialysis at a relatively low blood flow rate of 150 to 200 mL/min (usually 300 mL/min)
- *Uremic neuropathy*
  - Symmetric, distal sensorimotor polyneuropathy with the lower limbs affected initially and sensory symptoms usually preceding the motor manifestations
  - Mononeuropathy from the entrapment of median or ulnar nerves in dialysis-associated amyloidosis
- *Sleep disorders*
  - Sleep apnoea is more common among ESRD patients (up to 50%)
  - Restless leg syndrome (RLS) due to iron deficiency, elevated serum calcium and uremic peripheral neuropathy
  - RLS treated with levodopa and the dopamine receptor agonists pergolide, pramipexole and ropinirole

ENDOCRINE MANIFESTATIONS IN CKD

- *DM and CKD*
  - Insulin requirements typically show a **biphasic** course in diabetic patients with CKD
  - In the early CKD, increased insulin requirement due to insulin resistance (uremic toxins and excess PTH cause insulin receptor defects)
  - Normally, combination of glomerular filtration and tubular secretion leads to renal clearance of insulin at 200 mL/min (compared to GFR of 120 mL/min)
  - As GFR falls below 15 to 20 mL/min, reduction in renal clearance of insulin- patients either need smaller doses of insulin/oral hypoglycemics or sometimes do not need them anymore
  - Once dialysis is initiated the need for insulin/hypoglycemics comes back

DERMATOLOGICAL MANIFESTATIONS OF CKD – PRURITUS, CALCIPHYLAXIS AND NEPHROGENIC SYSTEMIC FIBROSIS

- ***Uremic pruritus***
  - Can be focal or generalised, and can be precipitated by external heat, sweat and stress
  - Possible association with hyperparathyroidism
  - Treatment consists of improving dialysis efficacy with bio-incompatible haemodialysis membranes and optimizing nutrition
  - Topical treatments, including skin emollients and capsaicin cream, antihistamines, gabapentin and possible role for μ opioid receptor antagonists such as naltrexone

CALCIFIC UREMIC ARTERIOPATHY (CALCIPHYLAXIS)

- A serious complication of CKD and prevalence up to 4% of all patients on dialysis, seen in predialysis as well
- High morbidity and mortality, with estimated six-month survival of approximately 50 percent
- Systemic medial calcification of the arterioles leading to ischemia and subcutaneous necrosis
- Spectrum of CKD-MBD where changes in serum calcium, phosphate, PTH and vitamin D metabolism lead to vascular and soft-tissue calcification
- Risk factors: obesity, DM, female sex, white ethnicity, increased serum phosphate and PTH, hypercoagulable states such as protein C and S deficiency and antiphospholipid syndrome, hypoalbuminemia, longer dialysis vitage and the use of drugs such as warfarin, vitamin D, calcium-based phosphate binders and systemic glucocorticoids
- Excruciatingly painful lesions tend to occur in areas with large amounts of subcutaneous fat such as thigh, abdomen and buttock *(can be anywhere so have a very low threshold of suspicion)*

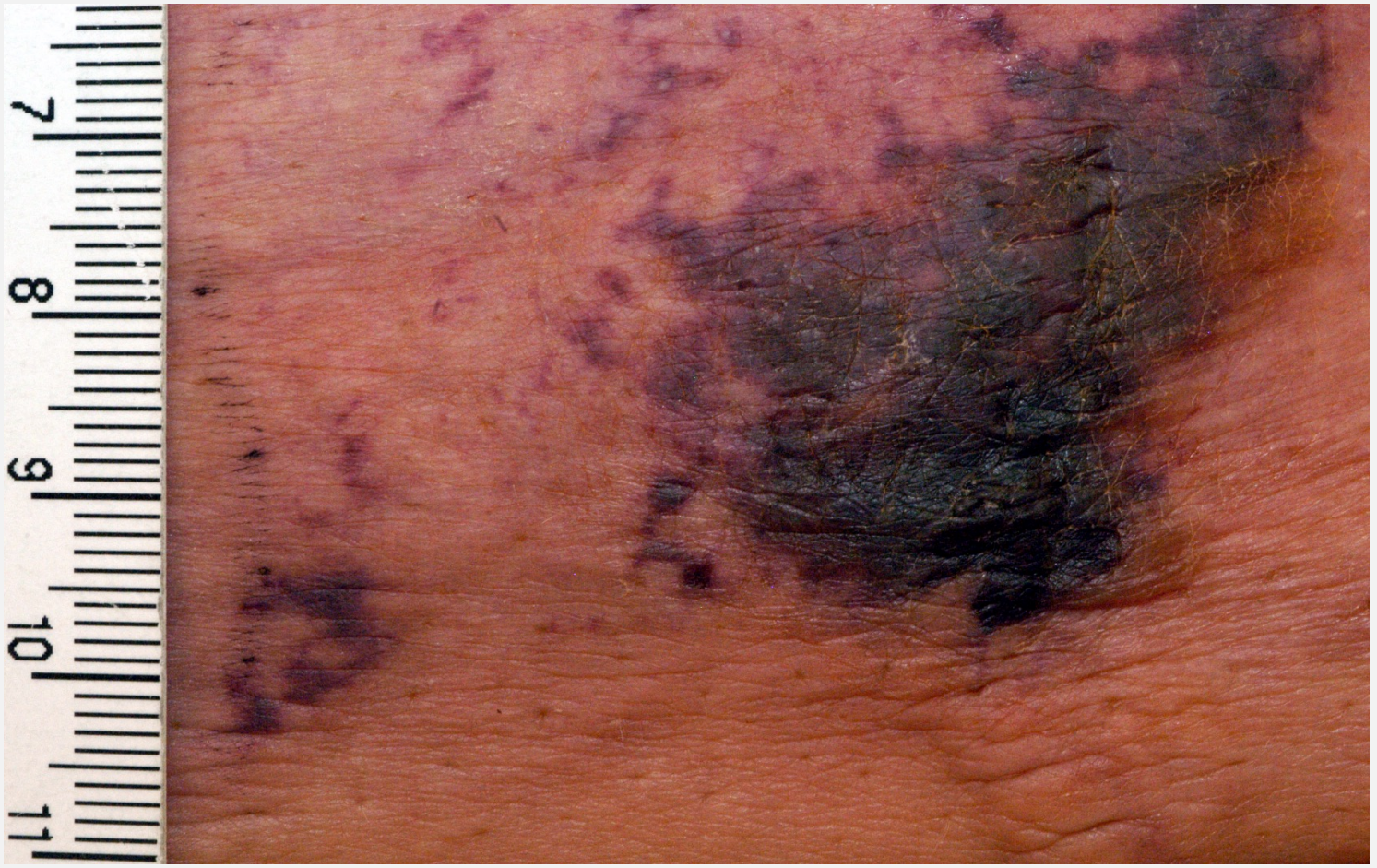
PATHOGENESIS OF CALCIPHYLAXIS

- Skin lesions: result from reductions in the arteriolar blood flow
- Reduced blood flow: caused by calcification, fibrosis, and thrombus formation involving the dermo-hypodermic arterioles
- Hyperparathyroidism and vitamin D*:* Elevated plasma calcium x phosphate product (Ca x P) due to high P and/or high Ca, high PTH, calcitriol and calcium-based phosphate binders' use
- Deficiency of the following two inhibitors of vascular calcification
  - Fetuin-A normally keeps Ca and P bound together; levels are low in haemodialysis patients
  - Matrix GLA protein (MGP)is a Vitamin K2 dependent calcium binding protein that inhibits vascular mineralisation; it is inhibited by warfarin

DIAGNOSIS OF CALCIPHYLAXIS

- Suspected in patients who present with classic painful ulcerated lesions that are covered by a black eschar or painful subcutaneous nodules or plaques; and/or cutaneous necrosis, particularly on the thigh and other areas of increased adiposity
- Additional suspicious features include warfarin use, obesity, high Ca or P, and elevated PTH
- Classic presentation with painful lesions covered by eschar in the appropriate clinical setting may not need biopsy
- Punch biopsy of skin shows arteriolar calcification, subintimal fibrosis, and thrombotic occlusion

CALCIPHYLAXIS



TREATMENT OF CALCIPHYLAXIS

- Sodium thiosulphate: chelates calcium and induces endothelial nitric oxide synthesis, which helps to improve tissue oxygenation
  - Given thrice weekly ((12.5–25 g IV, during dialysis)
  - Associated with high anion gap metabolic acidosis in one-third of patients
  - Nausea and vomiting in one-quarter of patients
- Optimise dialysis
- Cease warfarin
- Treat hyperphosphatemia and **avoid** calcium-containing phosphate binder
- Wound care and pain control are critical
- Wound infection is very common and needs aggressive antibiotic therapy and surgical debridement
- Hyperbaric oxygen therapy improves tissue perfusion

NEPHROGENIC SYSTEMIC FIBROSIS (NSF)

- Scleroderma-like disorder seen in patients with CKD, AKI and failing kidney transplant following exposure to gadolinium (Gd3+) containing agents used in MRI scans
- Additional risk factors: high-dosage EPO therapy, high PTH, hypothyroidism, and antiphospholipid syndrome
- Normally MRI contrast agents are chelated compounds that are excreted unchanged by the kidney
- Free Gd3+ may dissociate from the chelate with prolonged exposure to gadolinium in those with renal failure
- Free Gd3+ gets absorbed into tissues by swapping places with endogenous metals such as zinc and copper
- Gd3+ is phagocytized by macrophages, which in turn attracts circulating fibrocytes positive for CD34
- These fibrocytes transform to fibroblasts and subsequently cause fibrosis

NSF

- Although the usual time period between exposure to Gd3+ and manifestation of NSF is 2 to 4 weeks, cases have presented after years
- Skin thickening develops bilaterally in a distal to proximal pattern in both upper and lower limbs
- Bilateral flexion joint contractures can occur in up to 70 percent of patients
- Fibrosis can affect internal organs like the lung and heart
- No known treatment
- Gd3+containing contrast should be avoided with GFR< 30 ml/min
- If Gd3+ use indicated very strongly or given mistakenly to someone with advanced CKD or severe AKI, then patient should have haemodialysis immediately after exposure and a repeat session within 24 hours

MANAGEMENT OF CKD

- Reversible factors in AKI on CKD
  - Correct renal hypo-perfusion e.g. diarrhoea/vomiting/nephrotoxic medications etc.
  - Exclude urinary tract obstruction (USG)
- Therapeutic life style changes: smoking cessation, moderate exercise and reduced salt intake
- Referral to nephrologist when eGFR < 30 mL/min and/or proteinuria > 0.5 g/24 hours
- Good HTN management with either ACEI or ARB especially in the presence of proteinuria
- In those with proteinuria and oedema, initial therapy usually consists of both angiotensin inhibition and loop diuretic with addition of thiazide diuretic in resistant cases
- Good glycaemic control aiming for HbA1c < 7.0%, good lipid control, metformin should not be used when the GFR is less than 30 ml/ min/ 1.73m^2
- Dipeptide peptidase-4 (DPP-4) inhibitor linagliptin is one of the few DM medication that does not need dose reduction
- SGLT2 inhibitors believed to reduce the risk of CKD progression and cardiovascular deaths among diabetic and non diabetic patients (avoid in eGFR < 25 mL/min)

'Canagliflozin and Renal Outcomes in type 2 Diabetes and Nephropathy' Perkovic V et al; N Engl J Med. 2019;380(24):2295. Epub 2019 Apr 14

MANAGEMENT OF COMPLICATIONS OF CKD

- MANAGEMENT OF HAEMATOLOGICAL COMPLICATIONS
- Anemia
  - Serum ferritin < 500 ng/ml and/or transferrin saturation < 30% should receive parenteral iron
  - Erythropoiesis stimulating agents (EPO) started after ensuring adequate iron stores when Hb < 100 g/L
  - Hold EPO when Hb > 130g/L as at greater risk for increased cardiovascular mortality and stroke
- Uremic bleeding
  - Desmopressin used preventively in patients undergoing surgery and other invasive procedures including renal biopsy
  - Cryoprecipitate for uremic bleeding

ACE INHIBITORS OR ARBS IN CKD

- ACEI or ARBs reduce protein excretion by approximately 30 to 35% in patients with nondiabetic or diabetic CKD

- DM associated proteinuria
  - **Please remember the importance of good DM/BP control and lifestyle modifications**
  - Multiple trials show anti-proteinuric effects of ACEI/ARBs in both types 1 and 2 DM
  - *Please do not combine ACEI and ARB*

USE OF ACEI AND ARB IN ADVANCED CKD

- Ramipril Efficacy In Nephropathy (REIN) trial
- Patients with nondiabetic CKD were randomly assigned to ramipril or placebo plus other antihypertensive therapy to attain a diastolic pressure below 90 mmHg
- At baseline, the mean serum creatinine was 212 mmol/L and mean protein excretion was 5.3 g/day
- Renal benefit of ramipril:
  - With baseline GFR 11 to 33 mL/min- decreased rate of GFR decline by 20% and incidence of ESRD by 33%
  - With baseline GFR 33 to 51 mL/min- decreased rate of GFR decline by 22% and incidence of ESRD by 37%
  - With baseline GFR 51 to 101 mL/min- decreased rate of GFR decline by 35 % and incidence of ESRD by 100%

MY PRACTICE OF DOS AND DON'TS WITH ACEI/ARB

- Start low dose e.g., 1.25/2.5 mg of perindopril or 20 mg valsartan
- Check EUC in 5-7 days and if creatinine > 20 units over baseline then cannot tolerate
- If can tolerate the initial dose, then cautious up titration
- If initial K over 5, then consider K lowering strategy (below) for few weeks and then introduce ACEI/ARB
- Have K lowering plan at the same time as initiation of therapy:
  - Low K diet (print out of foods to avoid)
  - Frusemide or thiazide diuretic (lower K)
  - Occ use resonium 15-30 g maybe 2-3 times a week (ensure not CONSTIPATED)
  - Use sodium biacarbonate tablets in those with HCO3<18 as helps to lower K indirectly
  - Patiromer (Veltassa) 8.4 g OD may be titrated up to 3 tablets (NOT ON PBS)

SGLT2 INHIBITORS

- Dapagliflozin and Prevention of Adverse Outcomes in Chronic Kidney Disease (DAPA-CKD) trial
  - 4304 individuals with eGFR 25 to 75 mL/min/1.73 m^2 and urine ACR 200 to 5000 mg/g randomly assigned to dapagliflozin (10 mg) or placebo
  - 2/3rd had type 2 diabetes and 98% on ACEI or ARB
  - At 2.4 years, dapagliflozin reduced all-cause mortality (4.7 versus 6.8%), and incidence of ESKD (5.1 versus 7.5%)
- Canagliflozin Cardiovascular Assessment Study (CANVAS) program shown renoprotective benefit in DM patients with and without albuminuria

TREATMENT OF CKD MBD

- **4 Goals:** Reversal of hyperphosphatemia; optimising Vit D and Ca balance; prevention of high PTH and vascular calcification; and maintenance of bone health
- *Phosphate binding agents*
  - Ca containing binders: Potential for hypercalcaemia and soft tissue calcification, calcific uremic arteriopathy
  - Non-calcium containing binders : sevelamer, lanthanum carbonate, and sucroferric oxyhydroxide.
  - Calcitriol, the active form of vitamin D (1,25 hydroxyvitamin D3) used to reduce PTH (beware that can raise serum calcium)

HIGH PTH

- *Calcimimetic*
  - Cinacalcet : mimics the action of increased Ca on the Ca sensing receptor (CaSR) on the parathyroid gland and therefore inhibit PTH secretion
  - Use associated with hypocalcaemia and adynamic bone disease due to excess suppression of PTH
- *Parathyroidectomy in:*
    - Persistent hypercalcemia
    - Persistent hyperphosphatemia
    - Persistently elevated PTH despite adequate treatment
    - Progressive extra skeletal calcifications including calciphylaxis
    - Persistent pruritis
  - Kidney transplant candidates with persistently elevated PTH and parathyroid hyperplasia; persistently elevated PTH with hypercalcemia and unexplained worsening of allograft function

MANAGEMENT OF CKD

- TREATMENT OF ACIDOSIS
  - Metabolic acidosis increases the rate of progression of CKD and mortality
  - Patients with serum bicarbonate <20 meq/L should receive alkali supplementation
  - Alkali supplementation is associated with slower decline of GFR
- VACCINATION IN CKD
  - Generally reduced response to vaccination
  - All CKD patients with GFR < 30 ml/min should be vaccinated against pneumococci, hepatitis B and influenza
  - Annual inactivated influenza vaccine (live influenza vaccine is contraindicated in CKD)

PREPARATION FOR RENAL REPLACEMENT THERAPY

- Multidisciplinary care with access to dietary counselling, education and counselling about different dialysis modalities, transplant, vascular access surgery and psychosocial care
- Forearm veins should be preserved by avoiding venepunctures and cannulations
- As per the United States Renal Data System (USRDS) 2018 report, for patients starting dialysis in 2011, the adjusted five-year survival was 52 % for patients on PD and 42 % for those on hemodialysis
- **Observed survival is best in patients treated with home hemodialysis:**
  - 89 percent at 5 years
  - 74 percent at 15 years in nondiabetics
  - 50 percent at 15 years overall

THANK YOU

Imagination is more important than knowledge

Albert Einstein