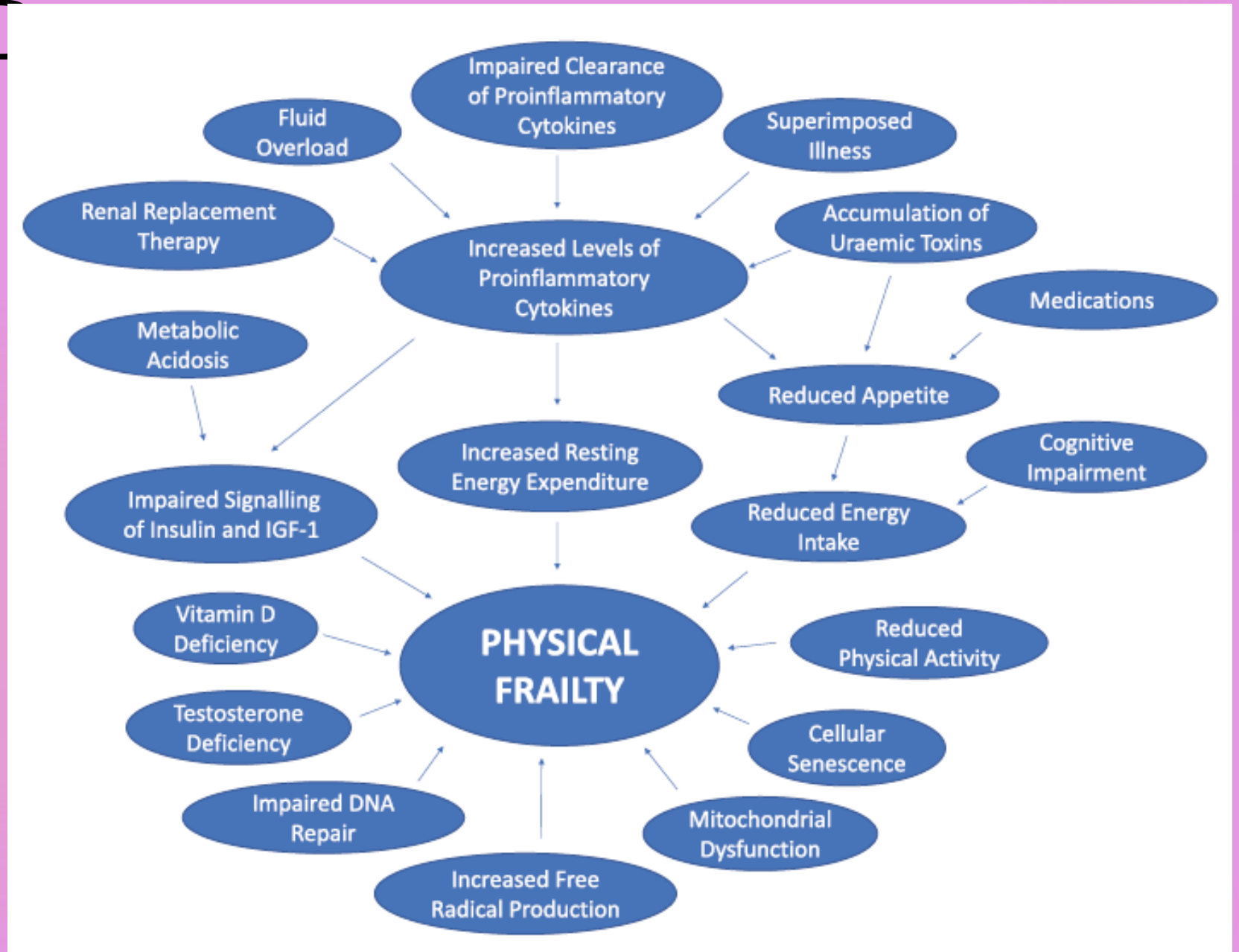
Predialytic assessment ,advise and post dialysis care of a patient of CKD on Maintenance Haemodialysis

Introduction

- Chronic kidney disease (CKD) is a global public health problem.
- The prevalence of CKD is rising, with the increased incidence of obesity, diabetes and arterial hypertension.
- CKD progression and its associated morbidity can be reduced with optimal care. Late detection and treatment contribute to poor results.
- The risk of progression of CKD is high in patients with poor glycemic and blood pressure control, and high levels of proteinuria

Benjumea A et al. Rev. Colomb. Nefrol. 2015; 2(2): 110 -117.

Pathophysiology of physical frailty in CKD



Nixon AC et al. Clin Kidney J. 2018 ;11(2):236-245

Signs and symptoms of patients with CKD attributable to advanced renal failure

- Fatigue
- Lethargy
- Cognitive dysfunction
- Symptoms of neuropathy
- Uremic pruritus
- Sleep disturbances
- Anorexia, nausea
- Restless legs
- Depressive symptoms

Cabrera VJ et al. Clin J Am Soc Nephrol.2017; 12: 687–693

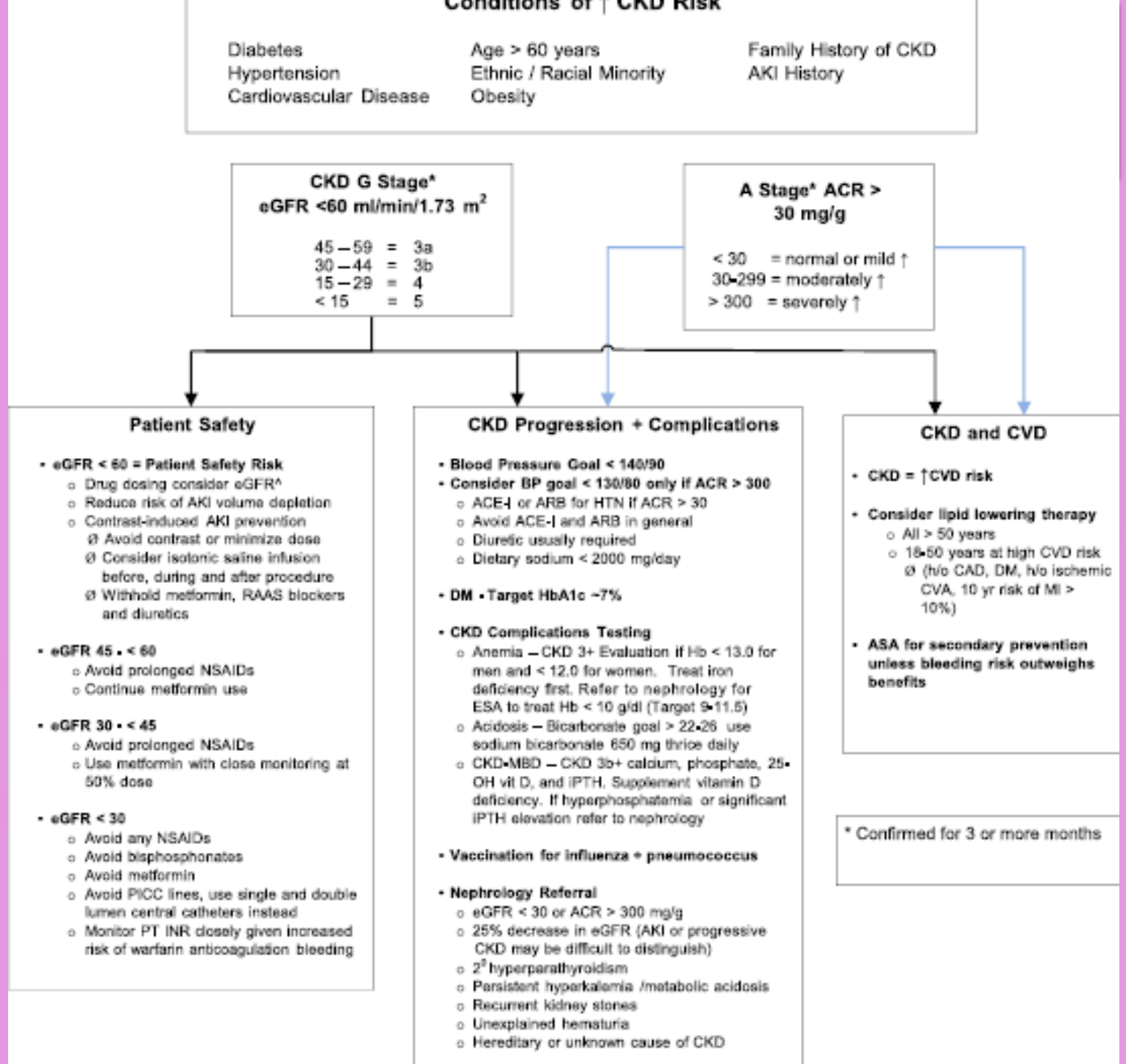
Stages of CKD

GFR category	GFR (mL/min per 1.73 m2)	Description
G1	≥90	Normal or ↑ GFR
G2	60–89	Mild ↓ GFR
G3a	45–59	Mild-to-moderate ↓ GFR
G3b	30–44	Moderate-to-severe ↓ GFR
G4	15–29	Severe ↓ GFR
G5	<15 or dialysis	Kidney failure

Tang SC et al. Nephrology (Carlton).2019 Mar;24 Suppl 1:9-26

Increased CKD risk

chronic kidney disease (CKD).
ACE-I -angiotensinconverting enzyme inhibitor;
ACR albumin-to-creatinine ratio;
AKI - acute kidney injury;
ARB- Angiotensin receptor blocker;
ASA - acetylsalicylic acid/aspirin;
A stage - albuminuria category
CAD - coronary artery disease;
CKD - chronic kidney disease;
CKD- MBD - chronic kidney disease mineral and bone disorder
CVA - cerebrovascular accident;
CVD - cardiovascular disease;
DM - diabetes mellitus;
eGFR - estimated glomerular filtration rate;
ESA - erythropoietin-stimulating agent; G stage - GFR category;
Hb hemoglobin; HTN - hypertension; iPTH - intact parathyroid hormone;
25-OH -25-hydroxy vitamin D;
PICC -peripherally inserted central catheter line;
PT INR - prothrombin time international normalized ratio;
RAAS -renin angiotensin aldosterone system



Vassalotti JA et al. Am J Med. 2016 Feb;129(2):153-162

Markers of kidney injury

- Albuminuria (albumin excretion rate (AER) ≥30 mg/24 h
- albumin-creatinine ratio (ACR) ≥30 mg/g (≥3 mg/mmol))
- Urine sediment abnormalities, especially renal tubular cells, red blood cells (RBC)/white blood cell casts, dysmorphic RBC
- Electrolyte and other abnormalities due to tubular disorders
- Abnormalities detected by histology
- Structural abnormalities detected by imaging
- History of kidney transplantation

Tang SC et al. Nephrology (Carlton).2019 ;24 (1):9-26

Albuminuria categories in CKD

Albuminuria category	AER (mg/24 h)	ACR (approximately) in mg/mmol	ACR (approximately) in mg/g	**Description**
A1	<30	<3	<30	Normal or mild ↑
A2	30-300	3-30	30-300	Moderate ↑
A3	>300	>30	>300	Severe ↑

Tang SC et al. Nephrology (Carlton).2019;24 (l) 1:9-26

Number of annual visits for monitoring

CKD stage	FGe (ml/min/1,73 m²)	Albuminuria stage		
		A1 (< 30mg/g)	A2 (30-300mg/g)	A3 (Proteinuria) (>300mg/g)
1	> 90	1 if CKD	1	2
2	60-89	1 if CKD	1	2
3a	45-59	1	2	3
3b	30-44	2	3	3
4	15-29	3	3	4 or more
5	< 15	4 or more	4 or more	4 or more

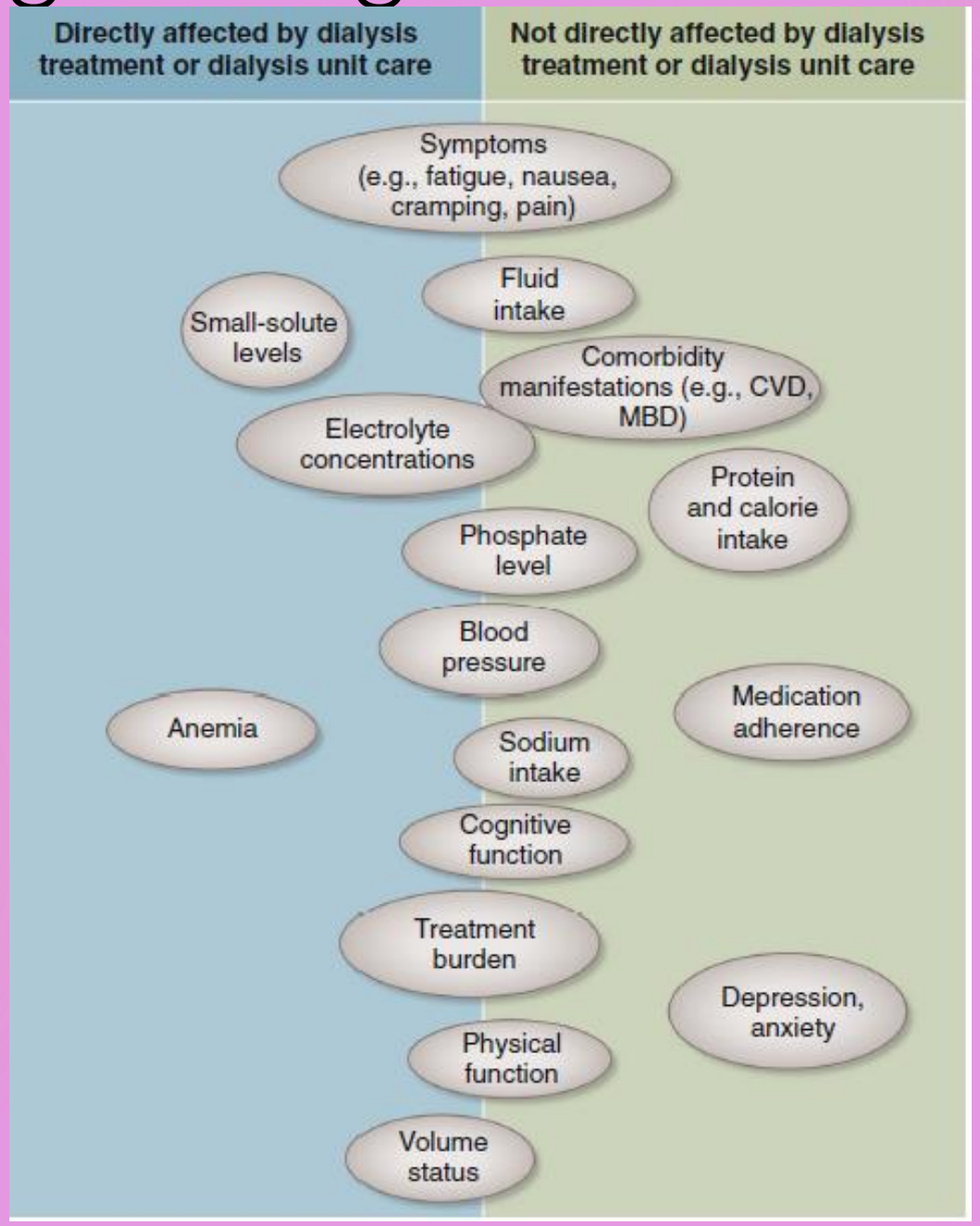
■ Monitoring by Nephrology.

■ Monitoring by Primary Care or other specialties

CKD: chronic kidney disease, eGFR: estimated glomerular filtration rate.

Martinez Castelao A et al. Nefrologia. 2014;34(2):243-62

Potential targets for goal-directed dialysis care



Chan CT et al. Kidney International.2019; 96 : 37–47

Preparing for Haemodialysis

- For patients with chronic kidney disease, preparations for hemodialysis should be made at least several months before it will be needed.
- **Vascular access** — There are three major types of access (fistula/shunt): primary arteriovenous (AV) fistula, synthetic AV bridge graft, and central venous catheter.
- The access should be created before hemodialysis begins because it needs time to heal before it can be used.
- **Primary arteriovenous fistula** — A primary AV fistula is the preferred type of vascular access for most patients.
- **Synthetic bridge graft** - If veins are not suitavle, flexible, rubber-like tube to create a path between an artery and vein.
- **Central venous catheter** — It is recommended if dialysis must be started immediately and the patient does not have a functioning AV fistula or graft.

Bernes JS. Patient education: Hemodialysis (Beyond the Basics). https://www.uptodate.com/contents/hemodialysis-

Best Timing of Dialysis Prior to Surgery

- If a patient undergoes maintenance dialysis on Tuesday, Thursday, Saturday schedule, surgery should not be scheduled on Monday.
- Preferable timing of dialysis would be on the day before surgery.
- Additional dialysis session prior to surgery does not improve outcomes.
- If the surgery is emergent and dialysis needs to be done on the same day of surgery, then heparin should not be administered during dialysis.

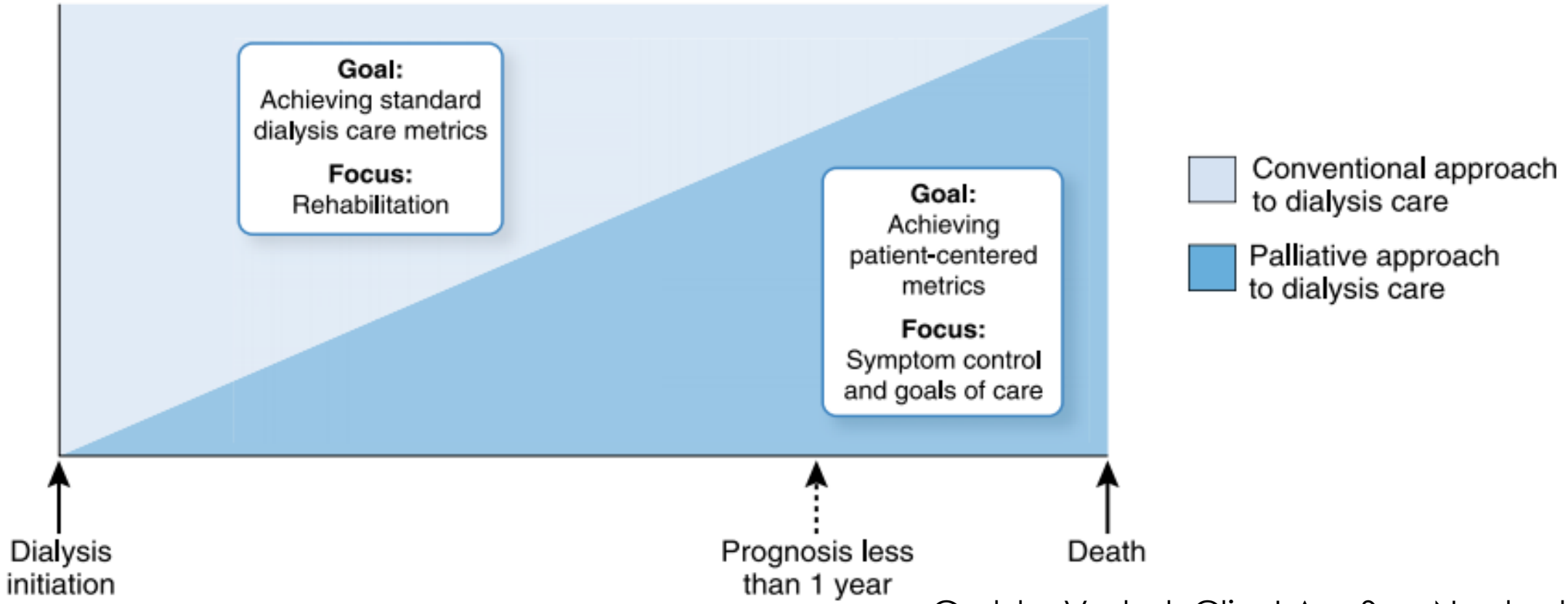
Nasr R et al. Health Services Insights. 2017;10:1–4.

Best Timing of Dialysis Prior to Surgery

- Laboratory values, including serum calcium, potassium, serum urea nitrogen, creatinine, magnesium, bicarbonate, and phosphorus, should be carefully monitored and adjusted.
- Regarding ultrafiltration, it should be adjusted to make sure the patient is close to dry weight before surgery.
- Dialysis patients should be adequately dialyzed, be euvolemic, and have near-normal electrolyte panel before undergoing surgery.

Nasr R et al. Health Services Insights. 2017;10:1–4.

Approach to dialysis care



Grubbs V et al. Clin J Am Soc Nephrol .2014;c9: 2203–2209 .

Approaches to common issues among maintenance dialysis patients

Issue	Current Disease-Focused Metrics for Conventional Delivery of Dialysis Care	A Patient-Centered Palliative Approach to Dialysis Care
Vascular access	Creation and maintenance of an AV fistula	Central venous catheter acceptable
Dialysis adequacy	Target small solute clearance based on current standards (Kt/V>1.2 for HD and Kt/V>1.7 for PD), intensifying the dialysis prescription as needed to achieve targets	Lower clearance acceptable if changes in dialysis prescription increase demands inconsistent with patient preference
Cardiovascular disease	Treat CV risk factors, potentially targeting BP and dyslipidemia	Tolerate hypertension to avoid symptoms; no indication for dyslipidemia treatment
Mineral and bone disorder	Dietary counseling; binders to control hyperphosphatemia; vitamin D analogues with or without calcimimetics for secondary hyperparathyroidism	Limited restrictions; more permissive hyperphosphatemia and hyperparathyroidism
Nutrition	Encourage dietary protein intake while limiting potassium (if HD), sodium, and phosphorus intake	Reduce dietary restrictions
Laboratory monitoring	Routine monthly laboratory tests	Minimal necessary

AV, arteriovenous; HD, hemodialysis; PD, peritoneal dialysis.

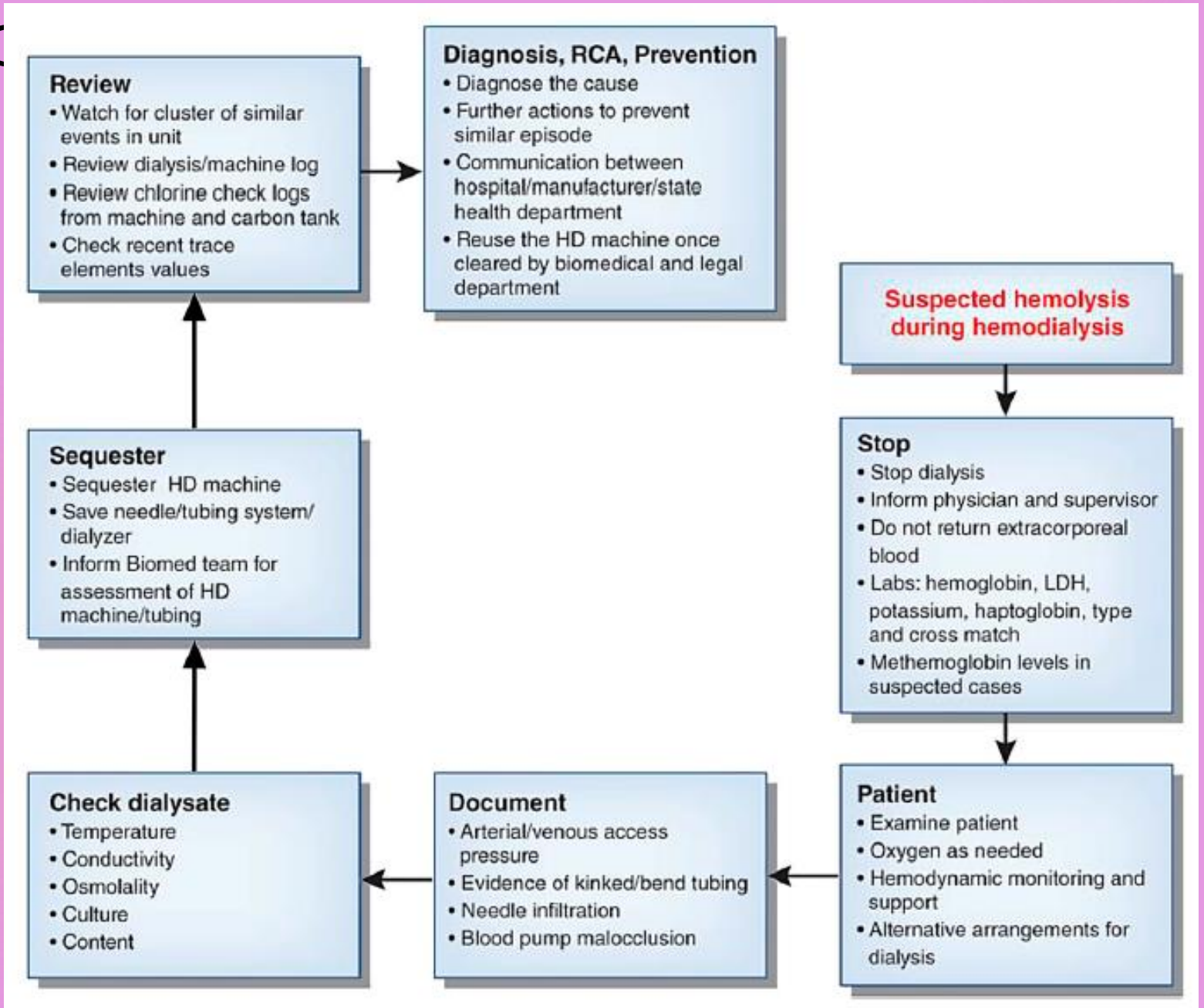
Grubbs V et al. Clin J Am Soc Nephrol .2014;c9: 2203–2209 .

Haemolysis

- Red blood cells (RBCs) undergo shear stress when they circulate through the HD circuit, and are, therefore, at risk for fragmentation.
- Blood osmotic changes, dialysate contaminants, or hyperthermia enhance hemolysis
- As blood flow is higher at the center of a laminar flow than at the edges (wall) of the extracorporeal circuit, the RBC membrane is exposed to a differential force , thereby causing a shear stress.

Saha M et al. Clin J Am Soc Nephrol. 2017; 12: 357–369.

Approach to suspected case of hemolysis during hemodi



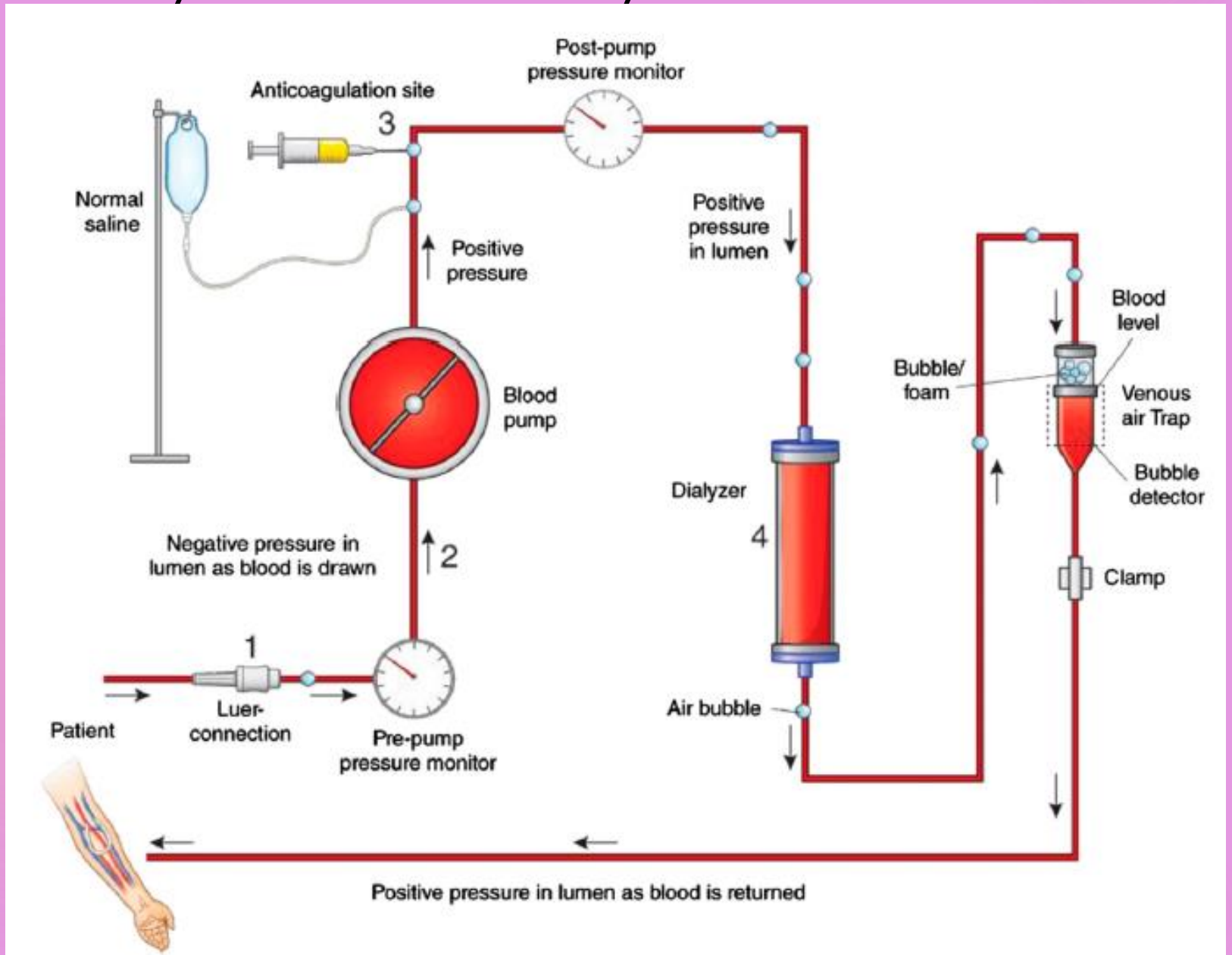
Saha M et al. Clin J Am Soc Nephrol. 2017; 12: 357–369.

Air Embolism

- Venous air embolism (VAE) during HD is thought to be rare, but careful vigilance and high suspicion are required for the diagnosis.
- Air bubbles trapped in the systemic (pulmonary or cerebral) microcirculation cause local ischemia, circulatory arrest, activation of complement and coagulation system, localized inflammation, and vascular endothelial cell damage .
- Most microbubbles ,50 mm in diameter and many microbubbles between 50 and 200 mm pass through the venous bubble catcher without triggering an alarm
- The rate of microbubble formation is dependent on the blood flow rate and negative arterial pressure

Saha M et al. Clin J Am Soc Nephrol. 2017; 12: 357–369.

Venous air embolism may arise from 4 possible areas of air entry into the dialysis circuit



Saha M et al. Clin J Am Soc Nephrol. 2017; 12: 357–369.

Dialysis Disequilibrium Syndrome

- Dialysis disequilibrium syndrome (DDS) is a rare syndrome occurring in patients with severe azotemia undergoing their initial HD session.
- It is characterized by nausea, vomiting, headache, encephalopathy, and seizures
- DDS is attributed to the faster decline of urea concentration in the blood than in the brain during the dialysis session.
- This lag (reverse urea effect) creates an osmotic gradient that promotes net water shift from the blood into the brain, leading to cerebral edema and its associated manifestations

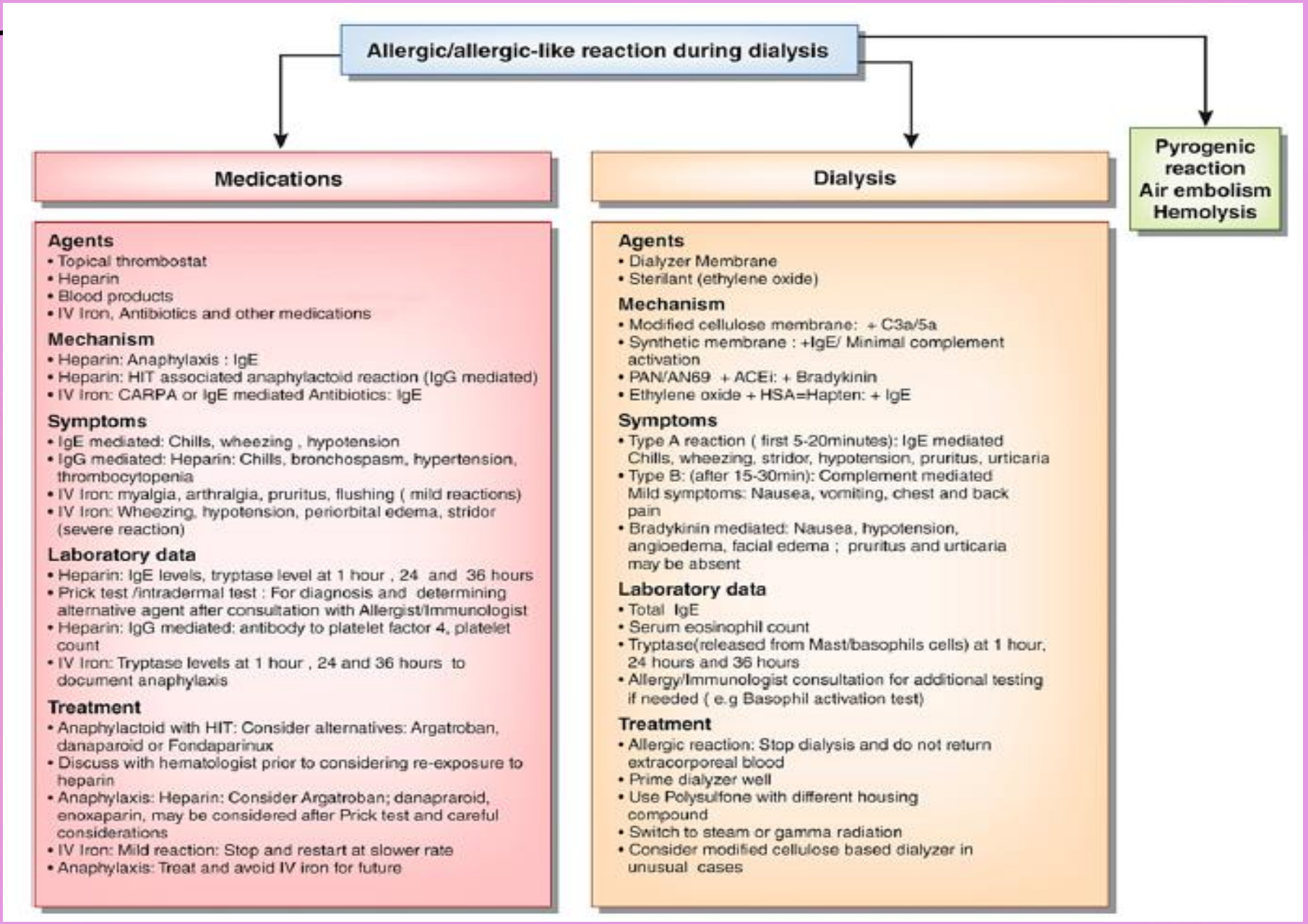
Saha M et al. Clin J Am Soc Nephrol. 2017; 12: 357–369.

Potential strategies to prevent dialysis disequilibrium syndrome in high-risk patients

- (1) Limit the first HD session to 2–2.5 h
- (2) Limit the blood flow to 200–250 ml/min
- (3) Sodium modeling or a high-sodium dialysate
- (4) Consider intravenous mannitol (1 g/kg)
- (5) Consider CRRT in patients at high risk for DDS (traumatic brain injury, intracerebral hemorrhage, intracranial mass).

Saha M et al. Clin J Am Soc Nephrol. 2017; 12: 357–369.

Causes of allergic or allergic-like reactions during hem



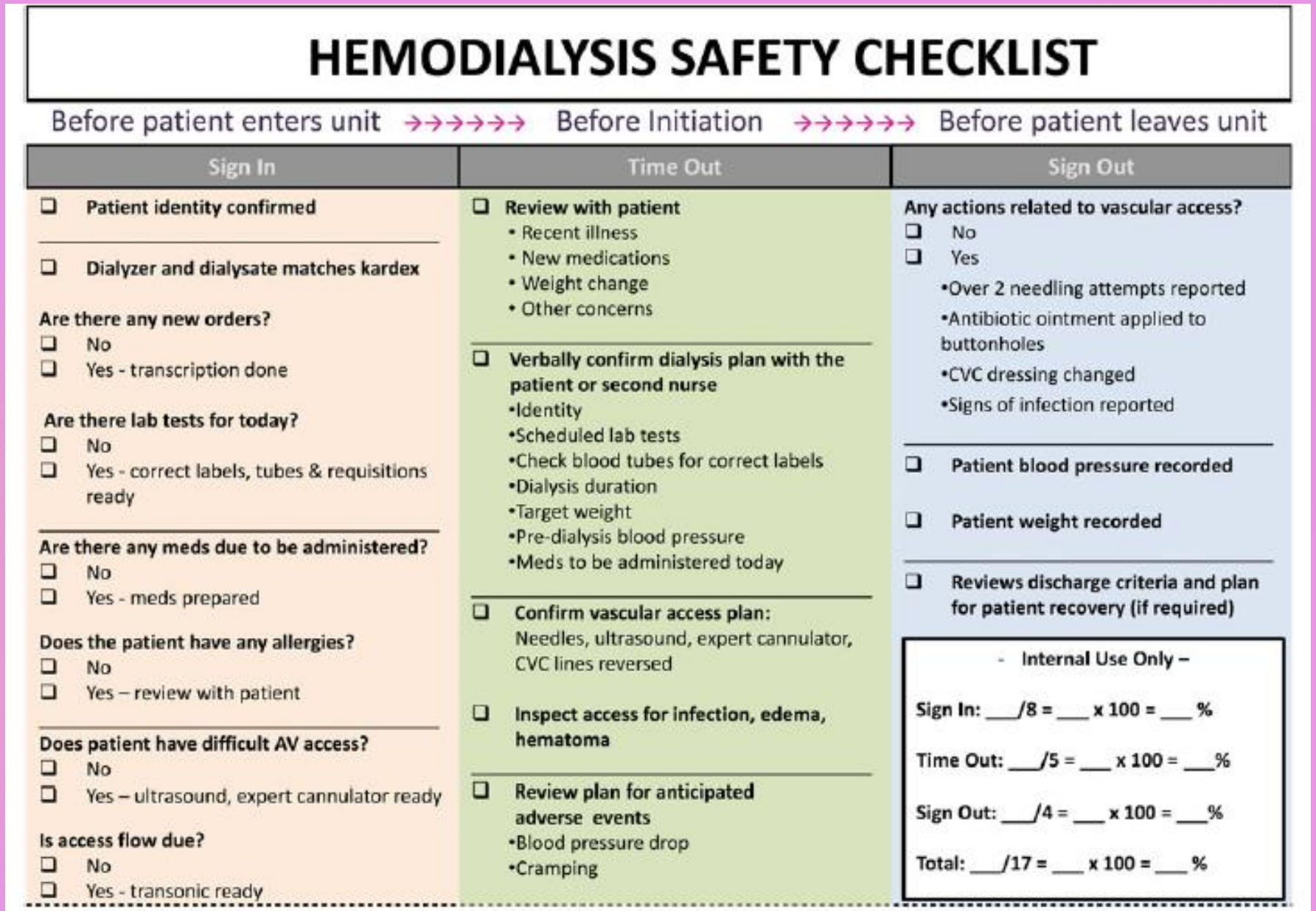
Saha M et al. Clin J Am Soc Nephrol. 2017; 12: 357–369.

Measures to minimize an allergic reaction to a dialyzer

- (1) Prime the dialyzer well
- (2) Switch from ethylene oxide sterilization to g- or steam-sterilized dialyzer
- (3) In the event of a hypersensitivity reaction, do not return the blood, because this may aggravate the allergic reaction
- 4) Treat with antihistamines, corticosteroids, and epinephrine for a hypersensitivity reaction
- (5) Rule out other conditions that may simulate an allergic reaction (air embolism, hemolysis, pyrogenic reaction)

Saha M et al. Clin J Am Soc Nephrol. 2017; 12: 357–369

Hemodialysis safety checklist



HEMODIALYSIS SAFETY CHECKLIST

Before patient enters unit →→→→→ Before Initiation →→→→→ Before patient leaves unit

Sign In

- ❑ **Patient identity confirmed**

- ❑ **Dialyzer and dialysate matches kardex**

Are there any new orders?
- ❑ No
- ❑ Yes - transcription done

Are there lab tests for today?
- ❑ No
- ❑ Yes - correct labels, tubes & requisitions ready

Are there any meds due to be administered?
- ❑ No
- ❑ Yes - meds prepared

Does the patient have any allergies?
- ❑ No
- ❑ Yes – review with patient

Does patient have difficult AV access?
- ❑ No
- ❑ Yes – ultrasound, expert cannulator ready

Is access flow due?
- ❑ No
- ❑ Yes - transonic ready

Time Out

- ❑ **Review with patient**
  - Recent illness
  - New medications
  - Weight change
  - Other concerns

- ❑ **Verbally confirm dialysis plan with the patient or second nurse**
  - •Identity
  - •Scheduled lab tests
  - •Check blood tubes for correct labels
  - •Dialysis duration
  - •Target weight
  - •Pre-dialysis blood pressure
  - •Meds to be administered today

- ❑ **Confirm vascular access plan:** Needles, ultrasound, expert cannulator, CVC lines reversed

- ❑ **Inspect access for infection, edema, hematoma**

- ❑ **Review plan for anticipated adverse events**
  - •Blood pressure drop
  - •Cramping

Sign Out

Any actions related to vascular access?
- ❑ No
- ❑ Yes
  - •Over 2 needling attempts reported
  - •Antibiotic ointment applied to buttonholes
  - •CVC dressing changed
  - •Signs of infection reported

- ❑ **Patient blood pressure recorded**

- ❑ **Patient weight recorded**

- ❑ **Reviews discharge criteria and plan for patient recovery (if required)**

- Internal Use Only –

Sign In: ___/8 = ___ x 100 = ___ %

Time Out: ___/5 = ___ x 100 = ___%

Sign Out: ___/4 = ___ x 100 = ___%

Total: ___/17 = ___ x 100 = ___ %

Thomas A et al. Clinical Kidney Journal.2016;9(3): 335–342

Ergocalciferol supplementation regimen for vitamin D insufficiency or deficiency in patients with CKD stage 3–4, according to

Serum 25(OH)D levels	**Dose**
Serum 25(OH)D <5 ng/mL	50,000 IU/wk orally × 12 weeks; then monthly 50,000 IU as single I.M. dose
Serum 25(OH)D 5–15 ng/mL	50,000 IU/wk × 4 weeks; then 50,000 IU/month orally
Serum 25(OH)D 16–30 ng/mL	50,000 IU/month orally

Cardoso MP et al. Nefrologia. 2019 Jan - Feb;39(1):18-28

General management strategies

- The management of progression of CKD is aimed at tackling a myriad of factors known to be associated with progression.
- These measures have been shown to modify cardiovascular health and CKD concomitantly or separately.
- Addressing CV risk factors may indirectly and directly impact CKD progression, and vice-versa.
- Strategies include general lifestyle measures, salt restriction, BP control and blockade of the renin-angiotensin-aldosterone system.
- In addition, control of other metabolic parameters such as blood sugar, lipid, anaemia, bone metabolism, uric acid and acidosis are also important

Tang SC et al. Nephrology (Carlton).2019 ;24 (1):

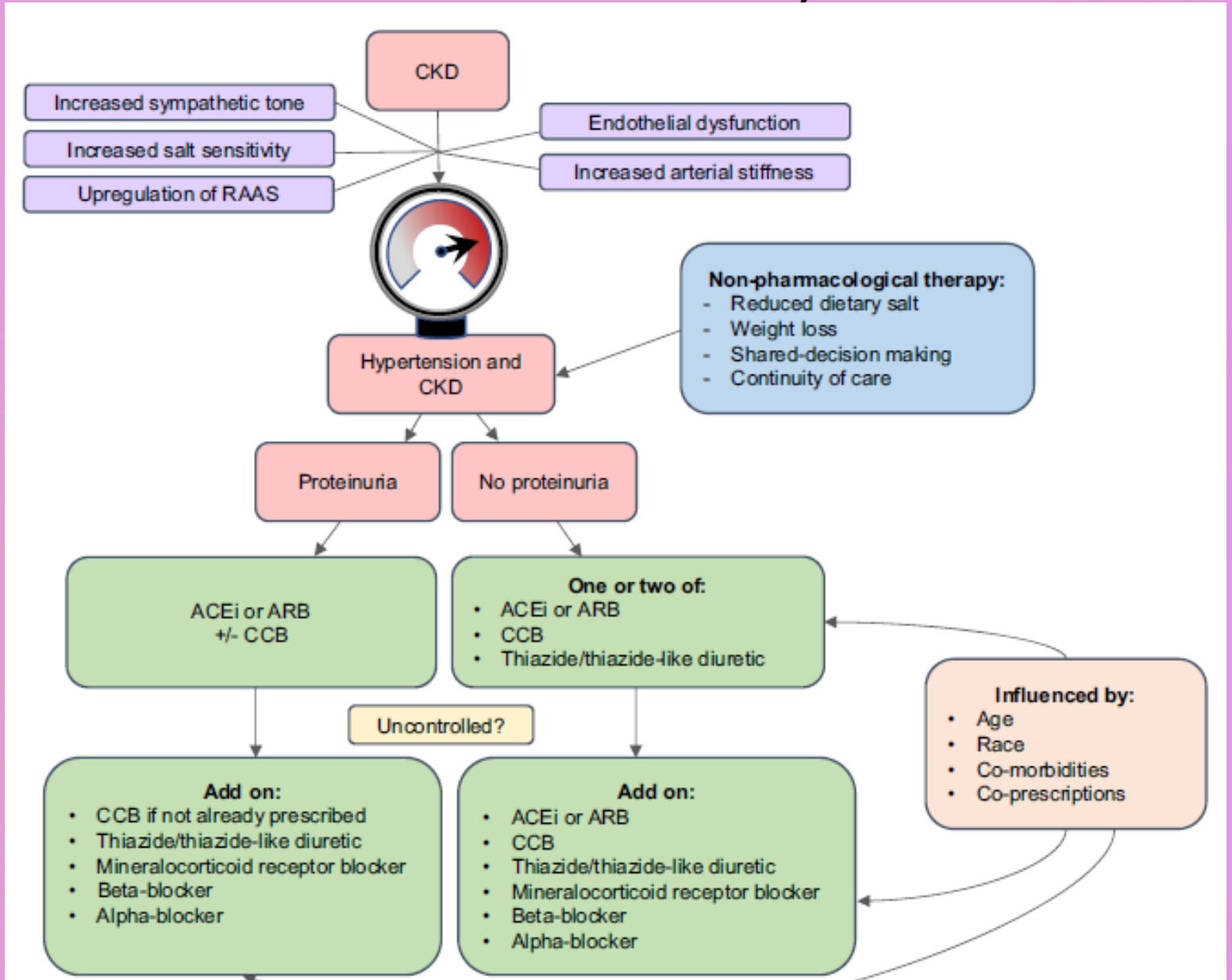
Protein Intake Recommendations

Stage 1 CKD	There are no protein restrictions unless the patient has diabetes.
Stage 2 CKD	The Academy recommends no protein restriction while filtration is less than 50; the KDOQI recommends beginning protein restriction when the rate is less than 70.
Stage 3 to 4 CKD	The Academy recommends protein intake of 0.6 to 0.8 g/kg; the KDOQI recommends 0.6 to 0.75 g/kg. There is strong evidence to support maintaining recommendations for protein intake of roughly 0.7 g/kg to prevent malnutrition and kidney disease progression. Patients with diabetes should not be given a protein intake below 0.8 to 0.9 g/kg, as 0.7 g/kg can result in hypoalbuminemia.[7]
Stage 5 CKD (dialysis)	Hemodialysis patients should have a protein intake of 1.1 to 1.2 g/kg; peritoneal dialysis patients should have a protein intake of 1.2 to 1.3 g/kg, which can go as high as 1.5 g/kg because of losses caused by dialysis changes.[3] All protein should be 50% to 75% high biological value, or the proportion of absorbed protein in food.[7]

Phosphorous guidelines

Stages 1 to 2 CKD	Phosphorus intake should be 1.7 g/day.
Stages 3 to 5 CKD	Phosphorus intake should be 0.8 to 1 g/day if serum levels increase in the following situations: above 4.6 mg/dL in stage 3 and 4 CKD patients and above 5.5 mg/dL in stage 5 patients. If serum phosphorus levels are normal but the PTH is above 70 pg/dL in stage 3 CKD patients or above 110 pg/dL in stage 4 patients on two consecutive measurements, phosphorus intake should be restricted, with vitamin D sterol treatments initiated if the restriction fails.
Hypophosphatemia after transplant	Monitor serum phosphorus levels daily for the first week after transplant. Supplement for phosphorus levels that fall below 2.5 mg/dL.[7]

Pathogenesis and management flow-chart of hypertension in chronic kidney disease



Pugh D et al. Drugs 2019; 79(4): 365–379

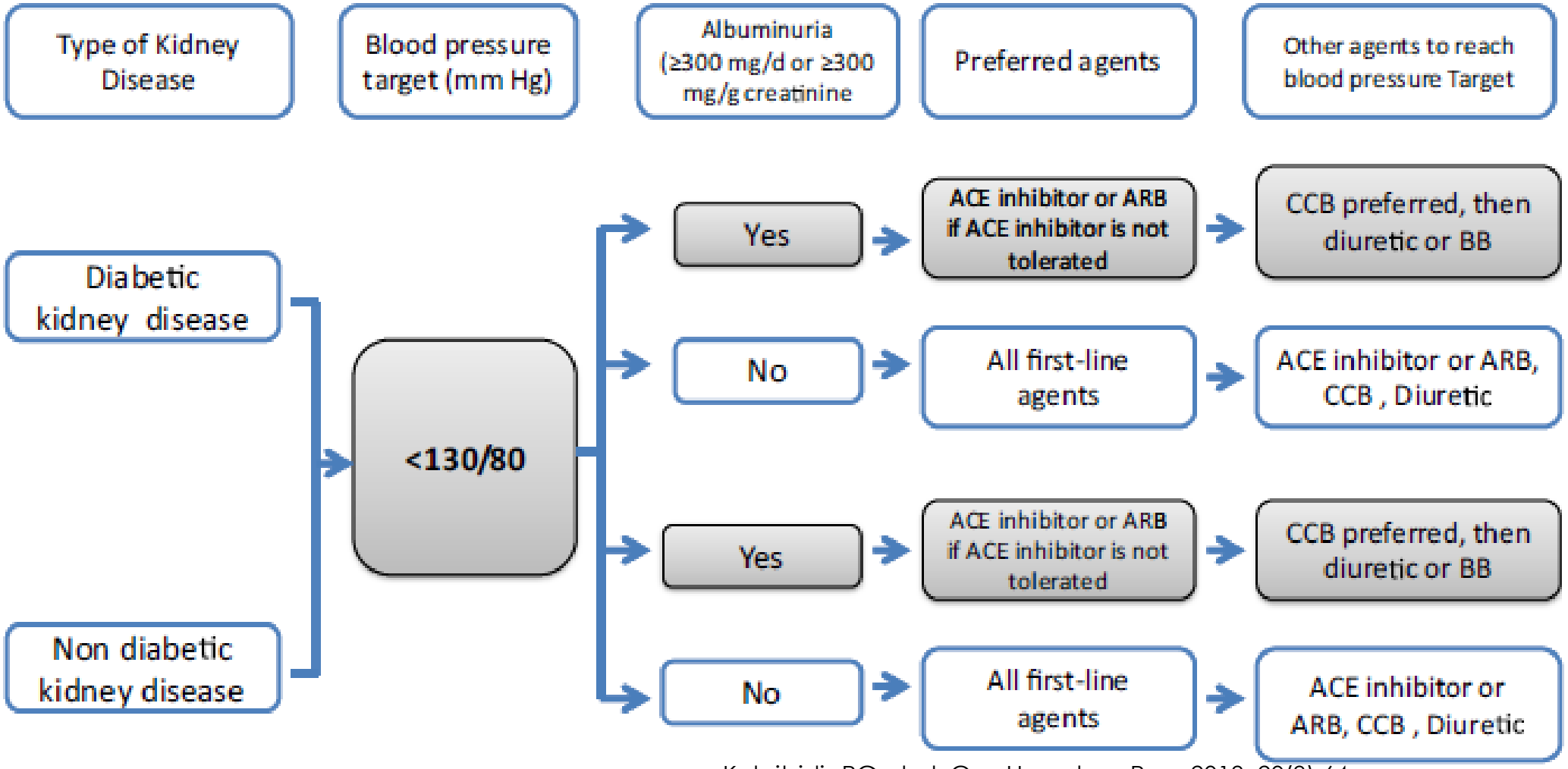
Major recommendations of treatment guidelines to manage hypertension in patients with CKD and c

	2017 ACC/AHA	2013 ESH/ESC	2018 ADA	2012 NKF KDOQI
Type of CKD considered	Albuminuria ≥ 300 mg/d or ≥ 300 mg/g creatinine	Overt proteinuria	Urinary albumin-to-creatinine ratio ≥ 300 mg/g creatinine or 30–299 mg/g creatinine	Urine albumin excretion of 30 to 300 mg or > 300 mg per 24 h
Recommended BP target (mm Hg)	Lowering < 130/80	Lowering SBP to < 140 Lowering < 130/80 mmHg in individuals with overt proteinuria	Lowering < 140/90 Lowering < 130/80 mmHg, for individuals at high risk of cardiovascular disease	Lowering ≤ 130/80
Recommended initial antihypertensive treatment	ACE inhibitor or ARB if ACE inhibitor is not tolerated	ACE inhibitor or ARB	ACE inhibitor or ARB If one class is not tolerated, the other should be substituted	ACE inhibitor or ARB
Other comments	A 10 to 25% increase in serum creatinine may occur in some patients with CKD as a result of RAAS therapy	RAS blockade is more effective in reducing albuminuria than other antihypertensive agents and is also effective in preventing incident microalbuminuria	Patients and clinicians should engage in a shared decision-making process to determine individual BP targets Bedtime dosing: moving at least one antihypertensive medication to bedtime.	The antihypertensive and antialbuminuric effects ACE inhibitor or ARB are complemented by dietary sodium restriction or administration of diuretics.

ACC/AHA American College of Cardiology/American Heart Association; ACE inhibitors, angiotensin-converting enzyme inhibitors; *ADA*, American Diabetes Association; *ARBs*, angiotensin II receptor blockers; *CKD*, chronic kidney disease; *ESH/ESC*, European Society of Hypertension/European Society of Cardiology; *RAS*, renin angiotensin system; *NKF*, National Kidney Foundation

Kalaitzidis RG et al. Curr Hypertens Rep. 2018

Accepted combinations of antihypertensive agent for BP



Kalaitzidis RG et al. Curr Hypertens Rep. 2018 ;20(8):64

Blood pressure control

- BP targets should be tailored according to age, tolerability and the level of proteinuria.
- An angiotensin receptor blocker (ARB) or angiotensin converting enzyme (ACE)-I is suggested for both diabetic and non-diabetic patients with CKD and urine albumin excretion >300 mg/24 h (or equivalent)
- RAAS inhibitors are not used if there is intractable hyperkalaemia.
- For diabetic and non-diabetic patients with AER less than 30 mg/24 h (or equivalent), the suggested BP target is ≤140/90 mmHg.
- For diabetic and non-diabetic patients with UAE ≥30 mg/24 h (or equivalent), the suggested BP target is ≤130/80 mmHg.

Tang SC et al. Nephrology (Carlton).2019 ;24 (1):9

Anti proteinuric measures

- The level of proteinuria has been shown to correlate with renal prognosis in both diabetic and non-diabetic CKD.
- Every attempt should be made to lower proteinuria.
- Treatment with a RAS blocker (ACEi or ARB) appears to be the only proven therapeutic option.
- Combination of ACEi/ARB, ARB/mineralocorticoid receptor blocker or ARB/direct renin inhibitor is in general not recommended due to potential adverse events, mainly AKI, hyperkalaemia or hypotension

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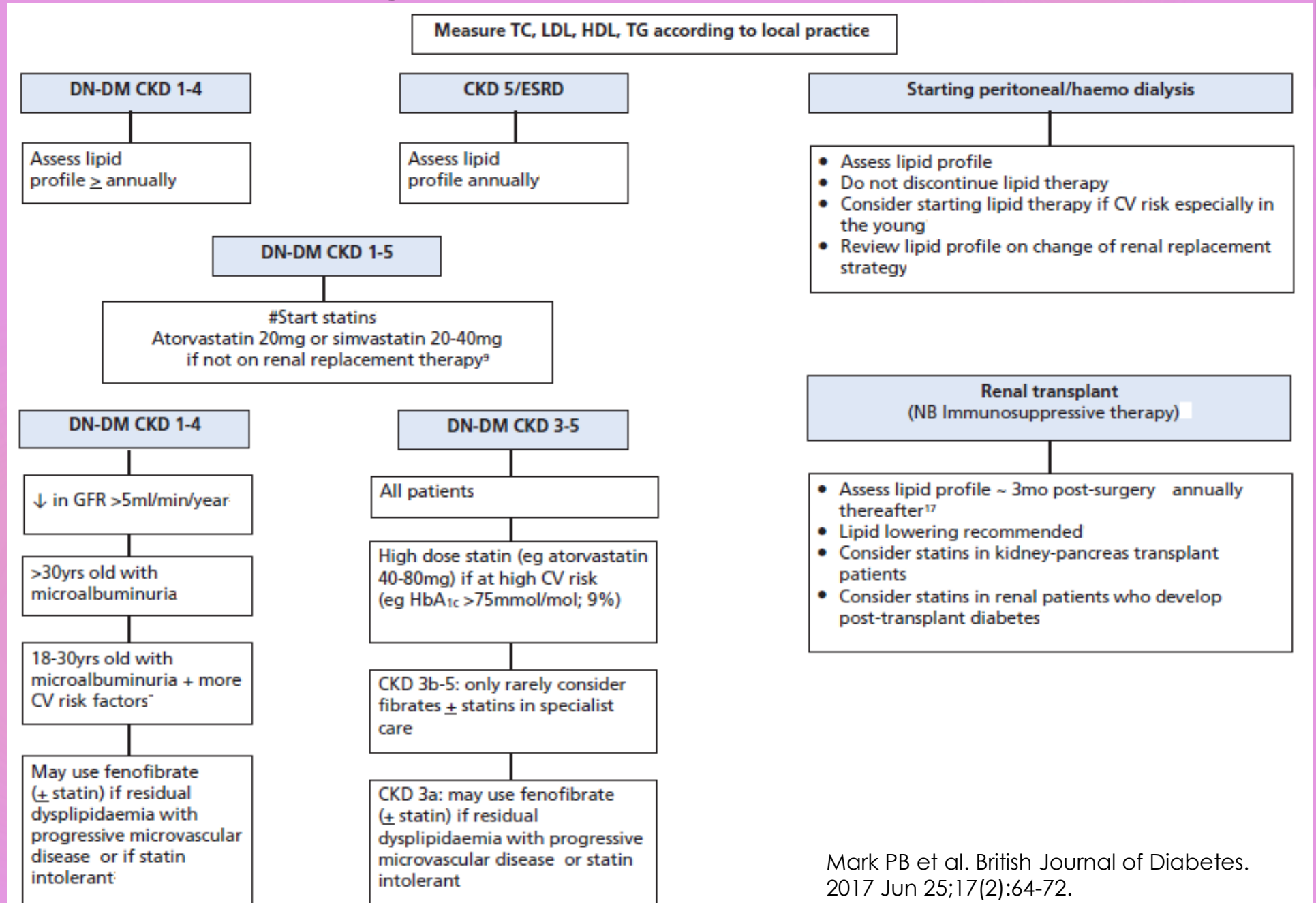
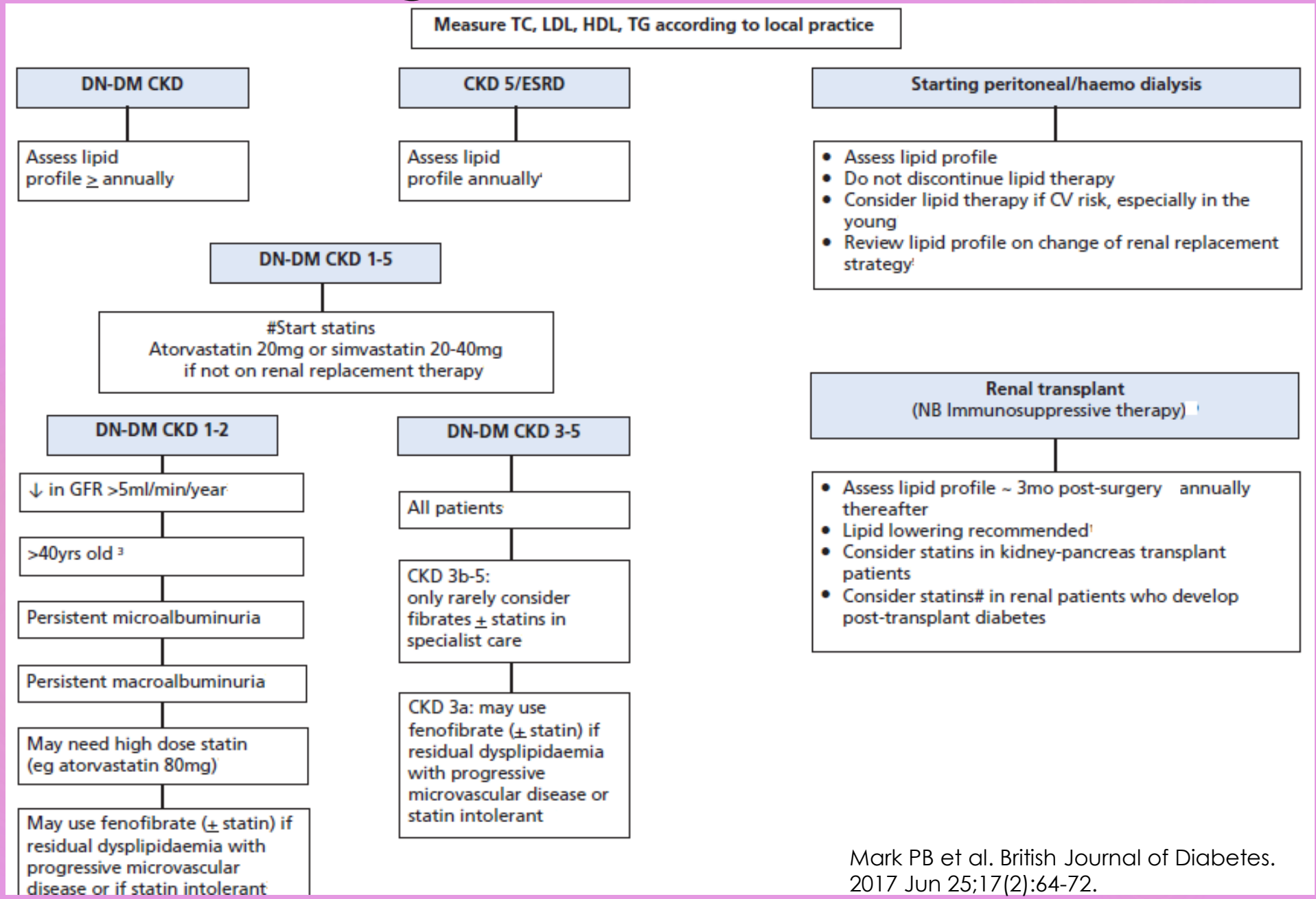
Lipid management in type 1 diabetes



Mark PB et al. British Journal of Diabetes. 2017 Jun 25;17(2):64-72.

Lipid management in type II diabetes



Mark PB et al. British Journal of Diabetes. 2017 Jun 25;17(2):64-72.

Key Recommendations for anaemia treatment

Group	Title	Key recommendations
National Institute for Health and Care Excellence	Anaemia Management in Chronic Kidney Disease: Partial Update 2015	Initiation of IV iron therapy: • Serum ferritin should not exceed 800 ng/mL. Review dose of iron when ferritin reaches 500 ng/mL Evaluation of iron status: • Do not use TSAT or serum ferritin measurement alone to assess iron deficiency status in people with anaemia of CKD
European Renal Best Practices (ERBP)	Kidney Disease: Improving Global Outcomes guidelines on anaemia management in chronic kidney disease: a European Renal Best Practice position statement	Initiation of IV iron therapy in patients not on ESA: • Initiate a trial of IV iron if there is absolute iron deficiency (TSAT <20%, ferritin <100 ng/mL) or if TSAT <25%, ferritin <200 ng/mL in CKD-ND patients, or TSAT<25%, ferritin <300 ng/mL in patients on dialysis • TSAT 30% ferritin 500 ng/mL should not be intentionally exceeded • Initiate ESA and IV iron together in patients with ferritin >300 ng/mL Initiation of IV iron therapy in patients on ESA: • Use oral iron as a first step if tolerated • Initiate IV iron if TSAT <30%, ferritin <300 ng/mL • Do not exceed ferritin 500 ng/mL, especially if TSAT >30%
Kidney Disease Outcomes Quality Initiative (KDOQI)	KDOQI US commentary on the 2012 KDIGO Clinical Practice Guideline for Anaemia in CKD	Initiation of IV iron therapy in patients on ESA: • Initiate a trial of IV iron if TSAT <30%, even if ferritin is > 500 ng/mL Cautions regarding iron therapy: • High molecular weight iron dextran should be avoided • Have resuscitative facilities and personnel available when administering IV iron IV iron and systemic infections: • No evidence that IV iron exacerbates infection; iron deficiency may worsen ability to respond to infection

Berns JS et al. Clin Kidney J. 2017

Key Recommendations for anaemia treatment

Group	Title	Key recommendations
Canadian Society of Nephrology	Canadian Society of Nephrology Commentary on the 2012 KDIGO Clinical Practice Guideline for Anaemia in CKD	Initiation of IV iron therapy: • Increase in Hb is less likely when TSAT >30% and ferritin >500 ng/mL Iron status evaluation: • Be mindful of the half-life of iron products administered; time testing of iron status accordingly Cautions regarding iron therapy: • 30 min of monitoring postadministration is probably sufficient • Important to distinguish between allergic reactions and reactions to high amounts of free iron
KDIGO Controversies Conference	Iron management in chronic kidney disease: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference	Initiation of IV iron therapy: • Doses >3 g/year are more likely to cause positive iron balance; if high doses seem necessary, look for causes of increased iron loss Iron status evaluation: • Current methods to assess iron status are insufficient • Elevated ferritin does not always correlate with high liver iron Cautions regarding iron therapy: • Important to distinguish between allergic reactions and reactions to large amounts of free iron • High molecular weight iron dextran should be avoided, lower molecular weight formulations should be used IV iron and systemic infections: • RCT evidence is lacking • Observational studies may be confounded

Berns JS et al. Clin Kidney J. 2017 ;10(1):i3-i8

Recommended Dietary and Nutrient Intake in Adults, according to the CKD Stage

Dietary Constituent	Normal Kidney Function with Increased CKD Risk	Mild-to-Moderate CKD†	Advanced CKD†	Transition to Dialysis†	Ongoing Dialysis or Any Stage with Existing or Imminent PEW
Protein (g/kg/day)	<1.0; increase proportion of plant-based proteins	<1.0 (consider 0.6–0.8 if eGFR <45 ml/min/1.73 m^2 or rapid progression)	0.6–0.8, including 50% HBV protein, or <0.6 with addition of EAA or KA	0.6–0.8 on nondialysis days and >1.0 on dialysis days	1.2–1.4; may require >1.5 if hypercatabolic state develops
Sodium (g/day)‡	<4 (<3 in patients with hypertension)§	<4; avoid intake of <1.5 if hyponatremia likely	<3; avoid intake of <1.5 if hyponatremia likely	<3	<3
Potassium (g/day)¶	4.7 (same as recommended for general population)	4.7 unless frequent or severe hyperkalemia excursions likely	<3 if hyperkalemia occurs frequently during high-fiber intake	<3 if hyperkalemia occurs frequently during high-fiber intake	<3; target high-fiber intake
Phosphorus (mg/day)‖	<1000; minimize added inorganic phosphorus in preservatives and processed foods	<800; minimize added inorganic phosphorus and encourage consumption of more plant-based foods	<800; minimize added inorganic phosphorus and encourage consumption of more plant-based foods	<800; minimize added inorganic phosphorus; consider phosphorus binder	<800; minimize added inorganic phosphorus; add phosphorus binder as needed
Calcium (mg/day)	1000–1300 (adjusted for age)	800–1000	800–1000	800–1000 or less	<800
Fibers, alkali, and plant-based foods (g/day)	25–30; target higher proportion (>50%) of plant-based foods (e.g., DASH diet)	25–30 or more; higher proportion (>50%) of plant-based foods	25–30 or more; consider >70% plant-based foods	25–30 or more	25–30 or more; suggest avoiding strict vegan diet
Energy (kcal/kg/day)**	30–35; adjust to target weight reduction if BMI >30††	30–35; increase proportion with LPD	30–35; increase proportion with LPD	30–35	30–35; target higher intake if PEW present or imminent
Fats	Mostly monounsaturated and polyunsaturated lipids, including n–3 fatty acids	Mostly monounsaturated and polyunsaturated lipids, including n–3 fatty acids; increase proportion with low-protein intake	Mostly monounsaturated and polyunsaturated lipids, including n–3 fatty acids; increase proportion with low-protein intake	Mostly monounsaturated and polyunsaturated lipids, including n–3 fatty acids	Mostly monounsaturated and polyunsaturated lipids, including n–3 fatty acids

Kalanter Zadeh K et al. N Engl J Med.2017;377(18):1765-1776

Caution for Prescribing in People with Chronic Kidney Disease

Agents	Cautionary Notes for Common Outpatient Medications
RAAS antagonists (ACE-I, ARB, aldosterone antagonist, direct renin inhibitor)	• Used in caution in patients with renal artery stenosis • Started at lower dose in patients with GFR <45 mL/min/1.73 m_2 • GFR and serum potassium assessed1-2 weeks after starting or escalating dose • Temporarily withholding drug during IV contrast administration, or any potential cause of volume depletion (bowel preparation prior to colonoscopy, acute illness, and surgery) • Not to discontinue when GFR <30 mL/min/1.73 m2 because they may remain nephroprotective.
Beta blockers	• Dose of hydrophilic b-blockers (acebutolol, atenolol, bisoprolol, and nadolol) to be reduced by 50% when GFR <30 mL/min/1.73 m2
Digoxin	• Dose to be reduced according to plasma concentrations

Vassalotti JA et al. The American Journal of Medicine .2016; 129 :153-162

Caution for Prescribing in People with Chronic Kidney Disease

Agents	Cautionary Notes for Common Outpatient Medications
NSAIDs	• To be avoided when GFR <30 mL/min/1.73 m2 • Prolonged therapy is not recommended when GFR <60 mL/min/1.73 m2 • To be avoided when taking RAAS-blocking agents or lithium
Opioids	• Dose of renally excreted agents (morphine, hydrocodone, codeine) to be reduced when GFR <60 mL/min/1.73 m2
Macrolides	• Reduce dose by 50% when GFR <30 mL/min/1.73 m2
Fluoroquinolones	• Reduce dose by 50% when GFR <15 mL/min/1.73 m2
Tetracyclinnes	• Reduce dose when GFR <45 mL/min/1.73 m2; can exacerbate uremia
Antifungals	• Reduce maintenance dose of fluconazole by 50% when GFR <45 mL/min/1.73 m2 • Reduce dose of flucytosine when GFR <60 mL/min/1.73 m2
Trimethoprim	• Reduce dose by 50% when GFR <30 mL/min/1.73 m2

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Caution for Prescribing in People with Chronic Kidney Disease

Agents	Cautionary Notes for Common Outpatient Medications
Sulfonylureas	• To avoid drugs excreted mainly renally (eg, glyburide/glibenclamide) • Agents mainly metabolized by the liver may need reduced dose when GFR <30 mL/min/1.73 m2 (eg, gliclazide)
Insulin	• Partly renally excreted and may need reduced dose when GFR <30 mL/min/1.73 m2
Metformin	• To be avoided when GFR <30 mL/min/1.73 m2, but to consider risk-benefit ratio if GFR is stable • Review use when GFR <45 mL/min/1.73 m2 • To with held in patients during acute illness or before intravenous radiocontrast
Statins	• No increased toxicity for simvastatin 20 mg/d when GFR <30 mL/min/1.73 m2 • Dose reduction/increased toxicity for GFR <30 mL/min/1.73 m2 for lovastatin, pravastatin and rosuvastatin

Vassalotti JA et al. The American Journal of Medicine 2016; 129 :153-162

Caution for Prescribing in People with Chronic Kidney Disease

Agents	Cautionary Notes for Common Outpatient Medications
Low-molecular-weight heparins	• Dose to be reduced by 50% when GFR <30 mL/min/1.73 m2 • Consider switch to conventional heparin or monitor plasma anti-factor Xa in those at high risk for bleeding
Warfarin	• Increased risk of bleeding when GFR <30 mL/min/1.73 m2
Direct acting oral anticoagulants	• If GFR is <60 mL/min/1.73 m2, confirm correct dosing because recommended dose varies by indication and level of kidney function. • Additionally, assess for potential drug interactions for inhibitors or inducers of CYP34A and P-gp metabolism. • If any bleeding complications, the anticoagulant effects of these agents are more difficult to reverse compared with warfarin • Dabigatran 150 mg twice daily: 1. eGFR 30-60 mL/min/1.73 m2 reduce dose 75 mg twice daily 2. eGFR<30 mL/min/1.73 m2 avoid use • Rivaroxiban 20 mg daily:

Vassalotti JA et al. The American Journal of Medicine .2016; 129 :153-

Caution for Prescribing in People with Chronic Kidney Disease

Agents	Cautionary Notes for Common Outpatient Medications
Lithium	• Nephrotoxic and may cause diabetes insipidus with prolonged use • Monitoring GFR, electrolytes, and lithium levels every 6 months or more frequently if the dose increases or the patient is acutely ill • Avoiding use of NSAIDs • Maintaining hydration during acute illness
Bisphosphonates	• Most are not recommended when GFR <30 mL/min/1.73 m2
Gabapentin	• Altered mental status, myoclonus, and asterixis with severe CKD • GFR 30-59 mL/min/1.73 m2: 200-700 mg twice daily • GFR 15-29 mL/min/1.73 m2: 200-700 mg daily • GFR <15 mL/min/1.73 m2: 300 mg every 2 days • Extended release: GFR 30-59 mL/min/1.73m2: 600-1800 mg daily; GFR <30 mL/min/1.73m2: not recommended

Vassalotti JA et al. The American Journal of Medicine .2016; 129 :153-162

Summary

- Chronic kidney disease (CKD) affects between 8% and 16% of the population worldwide and is often underrecognized.
- Optimal management of CKD includes cardiovascular risk reduction, treatment of albuminuria, avoidance of potential nephrotoxins, and adjustments to drug dosing.
- A late referral to the nephrologist (less than 3 months before the start of dialysis) can cause anemia, mineral and bone disorder, dyslipoproteinemia and malnutrition in the patient with diabetic or hypertensive nephropathy.
- Early detection of CKD, changes in lifestyle, including smoking cessation, weight loss, a healthy diet and control of the modifiable risk factors may slow the progression of CKD and of the associated cardiovascular disease.

Benjumea A et al. Rev. Colomb. Nefrol. 2015; 2(2): 110 -117.