# CHAPTER 7
# NEPHROLOGY/UROLOGICAL DISORDERS

## 7.1 NEPHROLOGY DISORDERS

**CAUTION**
Check all medicines for possible dose adjustment based on eGFR

**Principles of dosing medication in patients with Chronic Kidney Disease (CKD) and Acute Kidney Injury (AKI)**

In the setting of kidney failure, all prescribed medications should be reviewed regularly to ensure that they are safe and at the correct dose for the estimated glomerular filtration rate (eGFR). Currently, the most reliable measure of eGFR is the CKD-EPI in adults and Schwartz equation for children. Nephrotoxic drugs should be avoided in the setting of any kidney dysfunction. Prior to starting any medication, review for previous drug allergies and adverse events. Monitoring of drug toxicity and levels is important where available (e.g. aminoglycosides).

*LoE:IVb* [i]

In AKI, the eGFR is not reliable as kidney function changes rapidly. Therefore, it is essential to monitor eGFR and doses of medications regularly.

Recommendations for medicines that require dose adjustment in renal impairment can be found in the South African Medicine Formulary (SAMF), package insert, and from many online resources e.g.: http://www.globalrph.com/index_renal/

### 7.1.1 CHRONIC KIDNEY DISEASE (CKD)

N18.1-5/N18.9

#### DESCRIPTION

Evidence of structural damage (e.g., proteinuria/haematuria) or loss of kidney function (eGFR <60 mL/min/1.73 $m^2$), present for >3 months.
Markers of kidney damage include:

- proteinuria; (UPCR = urine protein to creatine ratio; UACR = urine albumin to creatine ratio)
  - Severely increased: UPCR >0.05 g/mmol (>0.500g/g); UACR > 30mg/mol (300mg/g)

- Moderately increased: UPCR 0.015-0.05 g/mmol (0.15-0.5 g/g); UACR 3-30 mg/mmol (30-300 mg/g)
- Normal or mildly increased: UPCR <0.015 g/mmol (<0.15 g/g); UACR <3 mg/mmol (<30 mg/g)

*LoE:IVb* [ii]

- urine dipstick positive for blood and/or protein (for females with haematuria: exclude current menstrual cycle)
- increased serum creatinine or low eGFR <60 mL/min/1.73 $m^2$
- abnormal kidneys on ultrasound, e.g. polycystic, small in size and scarring
- abnormalities on kidney biopsy
- electrolyte abnormalities due to tubular disorders
- history of renal transplant

eGFR calculator online access:
https://www.kidney.org/apps/professionals/egfr-calculator

**Table 7.1: Common causes of CKD**

| Category | Example |
|---|---|
| Vascular | Hypertension, renal artery stenosis, vasculitis etc. |
| Glomerular diseases | Diabetes, autoimmune diseases (e.g. lupus nephritis), chronic systemic infections (e.g. HIV, HBV, syphilis), drugs, neoplasia |
| Tubulointerstitial diseases | UTI, drug-induced interstitial nephritis (e.g. rifampicin, allopurinol, fluoroquinolones, sulphonamides, beta-lactam antibiotics, proton pump inhibitors, non-steroidal anti-inflammatory drugs) |
| Structural | Polycystic kidneys, renal masses, obstruction (stones, strictures) |
| Others | Congenital |

Chronic kidney disease can be entirely asymptomatic
until over 75% of kidney function is lost.

**TREATMENT AND PREVENTION STRATEGIES ACCORDING TO STAGE OF DISEASE**

Adverse outcomes of CKD can often be prevented or delayed through early detection and treatment of risk factors for CKD.
In patients with CKD, the stage of disease should be assigned based on the level of kidney function according to the classification below, irrespective of diagnosis.

Adults with early CKD i.e. stages 0–3 can be managed at primary care level once the cause and plan for care has been established.
All stage 4 and 5 patients require referral/consultation with a specialist. If the patient is a candidate for long-term dialysis, referral to nephrology is advised.

**Figure 7.1: Prognosis of CKD by GFR and albuminuria categories: KDIGO 2024**

| | | | | Persistent albuminuria categories Description and range | | |
|---|---|---|---|---|---|---|
| | | | | A1 | A2 | A3 |
| | | | | Normal to mildly increased | Moderately increased | Severely increased |
| | | | | ACR* <30 mg/g <3 mg/mmol | ACR* 30–300 mg/g 3–30 mg/mmol | ACR* >300 mg/g >30 mg/mmol |
| eGFR categories (ml/min per 1.73m²) - description and range | G1 | Normal or high | ≥90 | | | |
| | G2 | Mildly decreased | 60 –89 | | | |
| | G3a | Mildly to moderately decreased | 45–59 | | | Refer |
| | G3b | Moderately to severely decreased | 30–44 | | Refer | Refer |
| | G4 | Severely decreased | 15–29 | Refer | Refer | Refer |
| | G5 | Kidney failure | <15 | Refer | Refer | Refer |

ACR: albumin to creatinine ratio in urine specimen.

Green: low risk (if no other markers of kidney disease, no CKD); yellow: moderately increased risk; orange: high risk; red: very high risk; A1, A2, A3 = categories of albuminuria; G1, G2, G3a, G3b, G4, G5 = categories of eGFR

*LoE:IVb[iii]*

## GENERAL MEASURES

» Address cardiovascular disease risk factors. See Section 3.1: Ischaemic heart disease and atherosclerosis, prevention.

» Limit total daily salt intake (including salt in food). Consult with dietician as required.

*LoE:IVb[iv]*

» Avoid nephrotoxic drugs/agents like NSAIDs, aminoglycoside antibiotics and radiocontrast media.

» Regular exercise and target BMI (BMI <25 kg/m$^2$) according to South African reference ranges.

» Screen for proteinuria.
  - If urine dipstick 1+ or greater, repeat on a properly collected midstream urine specimen on another occasion.
  - If proteinuria persists, quantify protein with a spot urine protein creatinine ratio. Significant proteinuria = spot urine PCR of >0.15 g/mmol.

  - If urine dipstick <1+, measure urine ACR.
» Patients differ in their ability to excrete a salt and water load and therefore fluid balance should be individualised.
» Refer patients to rehabilitation for multidisciplinary care and optimisation of function outcomes e.g., improved muscle strength and cardiovascular fitness, reduced blood pressure, weight management.

*LoE:IIIb*[v]

## MEDICINE TREATMENT

The following interventions may delay progression of kidney disease.

**Proteinuria reduction**

Ideal targets: UPCR <0.03 g/mmol or UACR <3 mg/mmol.
Most benefit is achieved by reducing UPCR to <0.1 g/mmol or UACR <100 mg/mmol.

- Start treatment with a low dose of ACE-inhibitor and titrate up to the maximum tolerated dose, e.g.
- Enalapril, oral.
  - Start with 5 mg 12 hourly and titrate to 20 mg 12 hourly, if tolerated. *LoE:IVb*[vi]
  - Monitor creatinine and potassium after 2 weeks if eGFR <60 mL/min/1.73 $m^2$ and after 4 weeks if eGFR >60 mL/min/1.73 $m^2$.
  - If creatinine increases by >20% from the baseline, stop ACE-inhibitor and consult a specialist.

*LoE:IIIb*[vii]

ACE-inhibitor not tolerated due to intractable cough:

- Consider an angiotensin II receptor blocker (ARB), e.g.: (specialist initiated) *LoE:IIIb*[viii]
- Losartan, oral,
  - Start with 50 mg daily and titrate to 100 mg daily, if tolerated.
  - Replacing ACE-inhibitor with ARB does not preclude the risk of angioedema. *LoE:IIa*[ix]

**CAUTION**
ACE-inhibitors and ARBs can cause or exacerbate hyperkalaemia in CKD. Check the serum potassium before starting these medicines, and monitor serum potassium on therapy.

**Hypertension**

Optimise BP control with additional antihypertensive agents. BP control results in a lowering of proteinuria and slower decline in eGFR.
Target BP for patients with hypertension: <140/90 mmHg.
Target BP for patients with hypertension and confirmed CKD and/or diabetes: <130/80 mmHg.
See Section 3.6: Hypertension.

**Hyperlipidaemia**
If hyperlipidaemia is a co-existent cardiovascular risk factor, manage according to Section 3.1: Ischaemic heart disease and atherosclerosis, prevention.

**Diabetes mellitus**
In diabetics, optimise control according to Section 8.5: Diabetes mellitus.
In diabetics with kidney disease there is an increased risk of hypoglycaemia.

Insulin is the safer option to control blood glucose in patients with eGFR<60 mL/min/1.73m$^2$.

**Note**:
» Insulin requirements will decrease as kidney disease progresses.
» Stop glibenclamide when eGFR <60 mL/min/1.73 m$^2$ because of an increased risk of hypoglycaemia.
» Reduce metformin dose when eGFR <60 mL/min/1.73 m$^2$ (maximum dose 500 mg 12 hourly).
» Discontinue metformin when eGFR <30 mL/min/1.73 m$^2$ because of the risk of lactic acidosis.

*LoE:IIIb*[x]

**Fluid overload and oedema**
- Furosemide, oral or IV, 20 to 80mg daily, as a single or divided doses, initiating at the lowest effective dose and titrating upwards. Dose may be increased to 160 mg daily (IV or oral) in divided doses.
  - First establish an effective dose and ascertain if urination occurs within 1-2 hours of intake. If urination does not occur within 1-2 hours, the dose should be increased further until urination ensues.
  - Diuretic action starts within 60 minutes of dose, hence divided doses should be given in the morning and afternoon, e.g. 8 AM and 2 PM.

*LoE:IVb*[xi]

When fluid overloaded and eGFR <60 mL/min/1.73 m$^2$, start:
- Furosemide, oral or IV, 40 mg in divided doses (e.g., 8 AM and 2 PM).
  - Titrate to a maximum of 500 mg in divided doses (e.g., 8 AM and 2 PM).
  - Furosemide is ineffective when patients are on dialysis and anuric.

**Hypocalcaemia and hyperphosphatemia**
The aim is to lower phosphate levels and maintain normal calcium levels to ensure calcium-phosphate product (i.e. Ca x $PO_4$) <4.4 mmol$^2$/L$^2$, to prevent calcium deposition in vessels and tissue which aggravates vascular disease.

Restrict dietary phosphate intake. (Dietitian consultation)
https://unckidneycenter.org/kidneyhealthlibrary/nutrition-and-kidney-disease/

**Patients with CKD stage 3–5, not on dialysis:**
Hyperphosphataemia and/or hypocalcaemia:

- Calcium (elemental), oral (calcium carbonate), 500 mg 8 hourly with meals if calcium-phosphate product <4.4 $mmol^2/L^2$.
    - Increase to approximately 1 g 8 hourly with meals if hyperphosphatemia persists.

- Aluminium hydroxide 300mg/5ml, oral, 10 mL 8 hourly with meals if calcium-phosphate product >4.4 $mmol^2/L^2$, for two weeks only, then switch to calcium carbonate.

*LoE:IVb*[xii]

Hypocalcaemia and low or normal serum phosphate:

- Calcium (elemental), oral (Calcium carbonate), 500 mg 8 hourly two hours after meals, increase to approximately 1 g 8 hourly between meals.

In patients with CKD stage 5 who are not candidates for kidney replacement therapy, the benefits of phosphate binding are unclear, and regular PTH (parathyroid hormone) monitoring is not necessary.

Patients considered suitable candidates for kidney replacement therapy:
Monitor $Ca^{++}$, $PO_4$ and PTH levels, as per Figure 7.1

For hyperphosphataemia uncontrolled on calcium carbonate:

- Aluminium hydroxide BP (300 mg/5 mL), oral, 10 mL 8 hourly (Specialist initiated).
    - To prevent dementia associated with chronic aluminium toxicity, do not use for longer than 3 months.

For hyperparathyroidism, initiate when PTH levels >2 times upper limit of normal range: (Specialist initiated)
(N25.8)

- Calciferol, oral, 50 000 IU once weekly. *LoE:IIIb*[xiii]

**OR**

- Calcitriol, oral, 0.25–4 mcg daily.

**Anaemia associated with CKD in patients on dialysis programmes**
N18.3-5†/N18.9† + (D63.8*/Z49.1-2)

Patients on chronic haemodialysis or peritoneal dialysis are often anaemic due to iron deficiency and deficiency of erythropoietin (EPO).
Simultaneous administration of iron and EPO is recommended, as **EPO should be administered in a patient with normal iron stores.** Adequate iron stores are required to assist with red blood cell production immediately after EPO administration (see Section 2.1.1: Anaemia, iron deficiency).

*LoE:IIa*[xiv]

- Iron, elemental, oral. See Section 2.1.1: Anaemia, iron deficiency, if no response, consider parenteral iron.

**AND**

- Erythropoietin Stimulating Agents (ESAs), e.g.:

- Erythropoietin alpha or beta, 40–50 IU/kg/dose, IV/SC 2–3 times weekly and assessed at 4 weekly intervals.
  - Administer IV dose over 1–5 minutes.
  - If necessary, dose may be increased by 25 IU/kg.
  - Note: There is an increased risk of cardiovascular events with haemoglobin levels >12 g/dL.

*LoE:IIa*[xv]

Definitive treatment, e.g. transplantation, usually improves anaemia. It is important to identify factors likely to aggravate anaemia, e.g. iron deficiency, infection, and vitamin $B_{12}$ and folate deficiency.

**Acidosis and hyperkalaemia**
Specialist consultation for possible kidney replacement therapy.

Check all medicines for possible dose adjustments. http://www.globalrph.com/index_renal.htm

## CONSULT WITH A SPECIALIST AT THE LOCAL REFERRAL CENTRE IF:

» Unknown cause of kidney failure.
» Rapid deterioration in kidney function.
» Resistant hypertension despite appropriate medication and adherence.
» All patients with persistent proteinuria: on urine dipstick ≥ 1+ or proteinuria >1 g/24 hours (UPCR >0.1 g/mmol).
» Patients with nephrotic-range proteinuria (UPCR >0.35 g/mmol) or nephrotic syndrome should be referred for possible kidney biopsy.

## REFERRAL

» All ESKD patients who may qualify for long term dialysis programs. See Section 7.1.5: Kidney replacement therapy.
» CKD stage 3 and above (see Figure 7.1: Prognosis of CKD by GFR and albuminuria categories).

# 7.1.2 GLOMERULAR DISEASE AND NEPHRITIC SYNDROME

N04.9/N05.9

## DESCRIPTION

Acute glomerulonephritis presents with one or more of the following: haematuria, proteinuria, an acute decrease in eGFR, fluid retention, or hypertension.

## GENERAL MEASURES

» Give oxygen, and place patient in semi-Fowler's position if patient has respiratory distress/pulmonary oedema.
» Early consultation with a specialist.

» Regulate fluid and electrolyte balance. Monitor weight closely.
» Dietary modification if severe kidney dysfunction, e.g. restrict salt, protein, potassium and phosphate intake.
» Avoid potential nephrotoxins: e.g. NSAIDs, aminoglycosides.

### MEDICINE TREATMENT

Fluid overload

- Furosemide, as a slow IV bolus, 80 mg.
  - Avoid unnecessary intravenous fluids.

If hypertension present: I12.0/I12.9
Diastolic BP >100 mmHg or systolic BP >150 mmHg:

- Amlodipine, oral, 5 mg as a single dose.

**AND**

- Furosemide, oral, 40–80 mg (if eGFR <30 mL/min/1.73m$^2$).

**OR**

- Hydrochlorothiazide, oral, 25 mg (if eGFR ≥30 mL/min/1.73m$^2$).

Check all medicines for possible dose adjustments. http://www.globalrph.com/index_renal.htm

### CONSULTATION/REFERRAL

The management of glomerular disease is individualised and management of all patients should be discussed with a specialist.

## 7.1.3 NEPHROTIC SYNDROME

N04.9

### DESCRIPTION

Glomerular disease is characterised by:
» Nephrotic-range proteinuria, i.e.: UPCR >0.35 g/mmol
**and** *LoE:IVb* [xvi]

- oedema,
- hypoalbuminaemia, and
- hyperlipidaemia.

The cause cannot be determined accurately without a kidney biopsy. With the exception of diabetic nephropathy, all other causes of nephrotic syndrome require specialist consultation.

### GENERAL MEASURES

Regulate salt and fluid intake.
Weigh regularly to assess fluid retention.
Check for postural hypotension to identify excessive diuresis.
Evaluate proteinuria with PCR:
» initially – weekly

» when discharged – monthly, until stable

Monitor potassium frequently for patients on ACE-inhibitors and/or diuretics.

### MEDICINE TREATMENT

Management should be guided by a specialist.

### CONSULTATION/REFERRAL

All patients.

## 7.1.4 ACUTE KIDNEY INJURY

N17.9

### DESCRIPTION

Kidney injury may be due to a combination of factors.

Acute kidney injury (AKI) is defined as any of the following:

» Increase in serum creatinine by ≥26.5 µmol/L within 48 hours; or
» Increase in serum creatinine to ≥1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; or
» Urine volume <0.5 mL/kg/hour for 6 hours.

### GENERAL MEASURES

A detailed history and good clinical examination are necessary to identify potentially reversible causes. Ensure volume status, perfusion and oxygenation. Monitor serum creatinine, potassium and urine output.

If radiocontrast diagnostic procedures are required, see Section 22.1: Diagnostic contrast agents and related substances.

Avoid any nephrotoxic medicines e.g. NSAIDs, aminoglycosides. Check all medicines for possible dose adjustments.

#### MEDICINE TREATMENT

**Fluid overload**

In patients with fluid overload where dialysis is not immediately available, a short trial of high dose furosemide in consultation with a specialist may be appropriate.

**Acute dialysis**

Discuss all cases with the referral centre.

Common indications for acute dialysis include:

» Pulmonary oedema refractory to medical therapy.
» Severe metabolic acidosis (pH < 7.15) refractory to medical therapy
» Severe hyperkalaemia (>7 mmol/L) refractory to medical therapy
» Uraemic complications, e.g. pericarditis, encephalopathy and bleeding.
» Medication overdose if due to dialysable toxin. See Section 19: Exposure to poisonous substances.

*LoE:IVb*[xvii]

**Note**: HIV infection is not a contra-indication for acute dialysis.

Both haemodialysis and peritoneal dialysis are acceptable modalities of therapy in the acute setting.

Peritoneal dialysis effluent is potentially infectious when used in patients with HIV and viral hepatitis.

**Hyperkalaemia**

Serum $K^+$ >6.0 mmol/L. *LoE:IVb*[xviii]

Emergency measures

Calcium gluconate 10%, slow IV bolus, 10 mL over 10 minutes. Subsequent doses should be considered if ECG changes persist after 5 minutes or recur.

**AND**

- Dextrose 50%, IV bolus, 100 mL followed by soluble insulin, 10 units administered as a push over 5 minutes.
  - Monitor blood glucose levels hourly up to 6 hours post-insulin administration.

**AND**

- Salbutamol nebulisation, 10-20 mg. *LoE:IIb*[xix]
  - Dilute Salbutamol 0.5% (5 mg/mL), solution, 1 mL (5 mg) salbutamol 0.5% solution made up to 4 mL with sodium chloride 0.9%.

These are short-term measures - patients should be dialysed or if this is not feasible:

- Sodium polystyrene sulfonate, oral, 15 g with 15 mL lactulose, 6 hourly.

**OR**

- Sodium polystyrene sulfonate, rectal, 30–60 g as an enema.
  - After 8 hours, wash out with phosphate enema.

**Note**: Rectal administration is less effective.

**Glycaemic control**

Close glycaemic control can reduce the incidence and severity of AKI.
See Section 8.5: Diabetes mellitus.

Some patients do not recover kidney function and should be treated as CKD (See Section 7.1.1: Chronic kidney disease).

## 7.1.5 KIDNEY REPLACEMENT THERAPY

Z99.2

Refer to the current National Department of Health Guidelines for renal dialysis.

**PATIENT SELECTION**

The final decision for selection of patients for kidney replacement therapy should be made by a multidisciplinary team using standardised selection criteria.
The ideal patient for kidney replacement therapy has uncomplicated CKD stage 5 (ESKD) and **must be a suitable candidate for kidney transplantation**.

Individual nephrology units have their own eligibility criteria and these may include:
» presence of systemic illnesses,
» age,
» BMI, and
» psychosocial factors.
Obtain these guidelines from the referral centre.

## 7.2 MAJOR ELECTROLYTE ABNORMALITIES

Guidance provided on potassium and sodium electrolyte imbalances.

### 7.2.1 HYPERKALAEMIA

E87.5

See Section 7.1.4: Acute kidney injury.

### 7.2.2 HYPOKALAEMIA

E87.6

#### DESCRIPTION

A serum potassium level <3.5 mmol/L.
Mild to moderate symptoms: muscle weakness (respiratory, and GIT muscles) and cramps.
Severe symptoms: rhabdomyolysis, paralysis, dysrhythmias, diaphragmatic weakness.
Signs of hypokalaemia: cardiac arrhythmias and/or ECG abnormalities (Prolonged QT interval, bradycardia).

**Identify and treat/remove the cause:** It is usually due to gastro-intestinal losses (diarrhoea) or kidney losses (diuretic therapy, hyperaldosteronism, vomiting).

#### MEDICINE TREATMENT

For chronic asymptomatic hypokalaemia, look for and manage the cause:

- Potassium chloride, oral, 600 mg, 1–2 tablets 8 hourly.
  - Each 600 mg potassium chloride tablet contains 8 mmol of potassium chloride. *LoE:IVb*[xx]
  - Titrate according to response to therapy.
  - Maximum daily dose: 6 g (i.e.10 tablets per day in divided doses).

- Review potassium levels after 4 weeks.

**OR**

- Potassium chloride solution (1g/5ml) 10-30 mL daily in divided doses PO up to 6 g. (See Appendix IV: Extemporaneous preparations for the preparation formula for adults).

**Note**: Routine supplementation with potassium chloride in patients who are on diuretics is usually inappropriate. Co-administration of ACE-inhibitors and/or spironolactone counteracts the hypokalaemia from furosemide or thiazides. In patients that develop hypokalaemia while using potassium-sparing diuretics or ACEi/ARBs, consider underlying primary hyperaldosteronism.

For mild to moderate hypokalaemia in a non-vomiting patient (potassium level usually 3–3.4 mmol/L):

- Potassium chloride, oral, 1 200 mg (2 tablets) 8 hourly.
  - Each 600 mg potassium chloride tablet contains 8 mmol of potassium chloride.
  - Titrate according to response to therapy.
  - Maximum daily dose: 6 g (i.e.10 tablets per day in divided doses).
  - Continue treatment until the serum potassium concentration is persistently above 3.5 mmol/L and symptoms or signs have resolved.

**OR**

- Potassium chloride solution (1g/5ml), oral, 10-30 mL daily in divided doses up to 6 g. (See Appendix IV: Extemporaneous preparations for the preparation formula for adults).

*LoE:IVb*[xxi]

For severe, symptomatic hypokalaemia:

- Potassium chloride, IV by peripheral line, 40 mmol in 1 L of 0.9% or 0.45% sodium chloride, mixed thoroughly.
  - Administer over 3 hours, or up to a maximum rate of 20 mmol per hour. Beware of volume overload (See Appendix II, for individual dosing and monitoring for response and toxicity).
  - Repeat as required, monitoring potassium serum levels after each replacement dose.
  - One potassium chloride 15% 10 mL ampoule contains 20 mmol potassium.
  - Maximum allowed daily dose of $K^+$ is 3 mmol/kg/day (or 400 mmol/day).

*LoE:IIIb*[xxii]

**CAUTION**
**Potassium chloride ampoules must always be diluted before infusion.**

Reduce the rate of intravenous potassium repletion or change to oral therapy once the hypokalaemia is no longer severe. Continue treatment until the serum potassium concentration is persistently above 3.5 mmol/L and symptoms or signs have resolved.

Online calculator for calculating potassium deficit:
http://www.medicinehack.com/2011/07/hypokalemia-potassium-replacement.html

If not responding to therapy, check for hypomagnesaemia as low serum magnesium may potentiate potassium loss.

## 7.2.3 HYPERNATRAEMIA

E87.0

### DESCRIPTION

A serum sodium level >145 mmol/L.

- » Mild to moderate symptoms: Lethargy, weakness, irritability
- » Severe symptoms: Convulsions, coma

In patients who develop hypernatraemia outside of the hospital, it is usually due to water losses (decreased thirst sensation or inability to drink water, e.g. (delirium/reduced consciousness), gastro-intestinal losses (diarrhoea) or renal losses (diabetes insipidus)).

In hospitalised, critically ill patients it is usually the result of sodium gain (administration of too much sodium-containing intravenous solutions).

### GENERAL MEASURES

Treat the cause.

Calculate the water deficit:

1. Calculate Total body water = correction factor X weight (kg).
   Correction factor is 0.6 for men, 0.5 for women and elderly men, and 0.45 for elderly women.

2. Calculate water deficit:
   $$Water\ deficit = Total\ body\ water\ \times (1 - \frac{140}{Na^{+}\ concentration})$$

See online calculator: https://www.msdmanuals.com/professional/multimedia/clinical-calculator/water-deficit-in-hypernatremia

### MEDICINE TREATMENT

Correction fluid:

- Oral fluids or via NGT.

If unable to give fluids orally:

- Dextrose 5%, IV infusion.
  - Monitor for hyperglycaemia. Rate of correction of hypernatraemia should be slower than 10 mmol/L over 24 hours to prevent cerebral oedema and rarely, osmotic demyelination syndrome.

Ongoing obligatory water loss through skin and stool (estimated at 30 mL/hour) must also be replaced: *LoE:IVb*[xxiii]

1. Calculate desired water replacement in the first 24 hours:

$$Water\ deficit \times 10\ mmol/L \div (Serum\ [Na^+] - 140)$$

2. Calculate hourly infusion rate =
   Desired water replacement in the first day ÷ 24 hours + 30 mL/hour.

## 7.2.4 HYPONATRAEMIA

E87.1

### DESCRIPTION

A serum sodium level <135mmol/L.

| | |
|---|---|
| Mild to moderate symptoms: | Headache, nausea, vomiting, fatigue, gait disturbances, and confusion. |
| Severe symptoms: | Seizures, obtundation, coma, and respiratory arrest. |

Acute hyponatraemia develops within hours due to self-inflicted water intoxication.

**CAUTION**

Rapid correction of chronic hyponatraemia may lead to osmotic demyelination syndrome, which is often irreversible and fatal. Sodium should be frequently monitored, and increases should be <8 mmol/L per day.

*LoE:IVb*[xxiv]

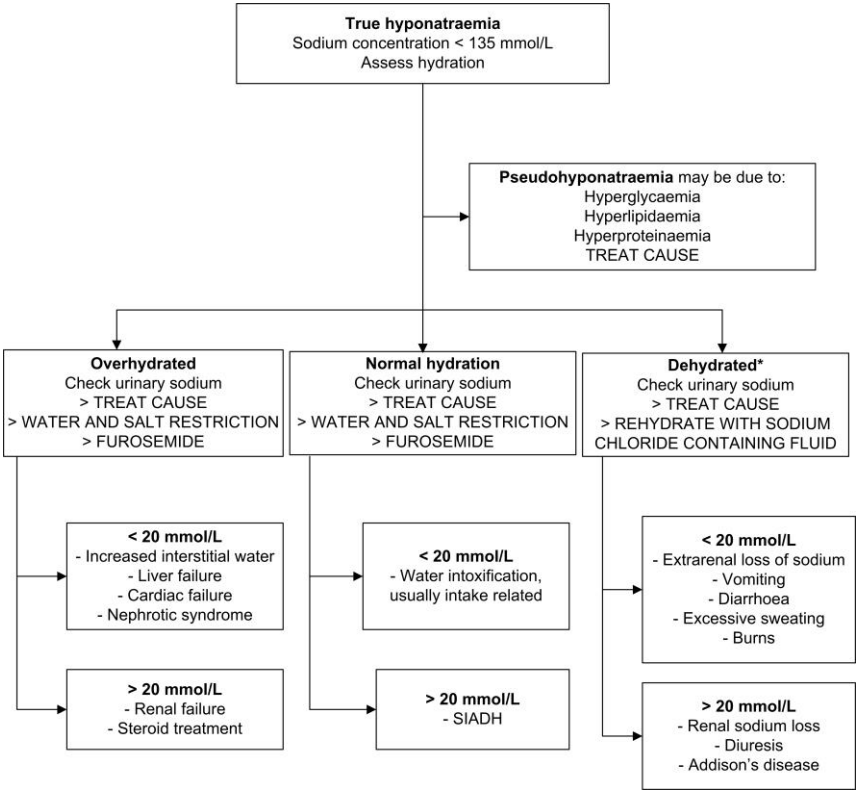


**Figure 7.2: Approach to hyponatraemia**

*LoE:IVb*[xxv]

## MEDICINE TREATMENT

In the presence of fluid overload:

- Furosemide, oral, 40 mg twice a day in divided doses.
  - Increase dose to control signs of fluid overload and to improve hyponatraemia. *LoE:IVb*[xxvi]

In the absence of fluid overload:

**Consult with a specialist before administering sodium chloride, IV infusion.**

- Sodium chloride, IV infusion (see Table 7.2 below).

**CAUTION**

Hypertonic sodium chloride should be reserved for severe acute hyponatraemia (sodium level <120 mmol/L with severe symptoms) and

exceptional circumstances. In general, each increase in TBW of 1 mmol will raise the serum sodium concentration by 1 mmol/L.

| One litre of NaCl infusate | Total Na (mmol/l) | Indication | Fluid | Aim |
|---|---|---|---|---|
| 5% NaCl<br><br>Expect an increase of 2-3 mmol/L for every 60 mL | 855 | » Sodium level <120 mmol/L<br>**and**<br>» Severe symptoms (see above)<br>**or**<br>» Acute hyponatraemia due to water intoxication | • Hypertonic sodium chloride, 5%, 60 mL as an IV bolus over 15 min<br><br>• If symptoms persist/ worsens or sodium is not improving, consult a specialist | » Symptom relief<br>» Correct hypona-traemia:<br>– 4-6 mmol/L immediately<br>**AND**<br>– Maximum 8 mmol/L in 1st 24 hrs |
| 5% NaCl<br><br>Expect an increase of 2-3 mmol/L for every 60 mL | 855 | » Sodium level <120 mmol/L with mild to moderate symptoms<br>**or**<br>» Chronic hyponatraemia | • Hypertonic sodium chloride, 5%, 30 mL as an IV bolus over 15 min | » Symptomatic relief.<br>» Correct hypona-traemia:<br>– Maximum 8 mmol/L in 1st 24 hrs |
| 0.9% NaCl | 154 | » Sodium level >120 mmol/L<br>» Dehydrated.<br>» Asymptomatic or mild symptoms | • Sodium chloride, 0.9%, IV infusion, 1L 8 hourly | » Rehydration |

**Table 7.2: Management of hyponatraemia with sodium chloride.**

*LoE:IVb*[xxvii]

To calculate the infusion rate, consult a specialist.
https://reference.medscape.com/calculator/643/sodium-correction-rate-for-hyponatremia

## 7.3 UROLOGICAL DISORDERS

Disorders of the genitourinary system.

### 7.3.1 HAEMATURIA

R31/B65.0-3/B65.8-9

#### DESCRIPTION

Bleeding from the urinary tract, which can be from the kidneys, collecting system, bladder, prostate and urethra.

*LoE:IVb*[xxviii]

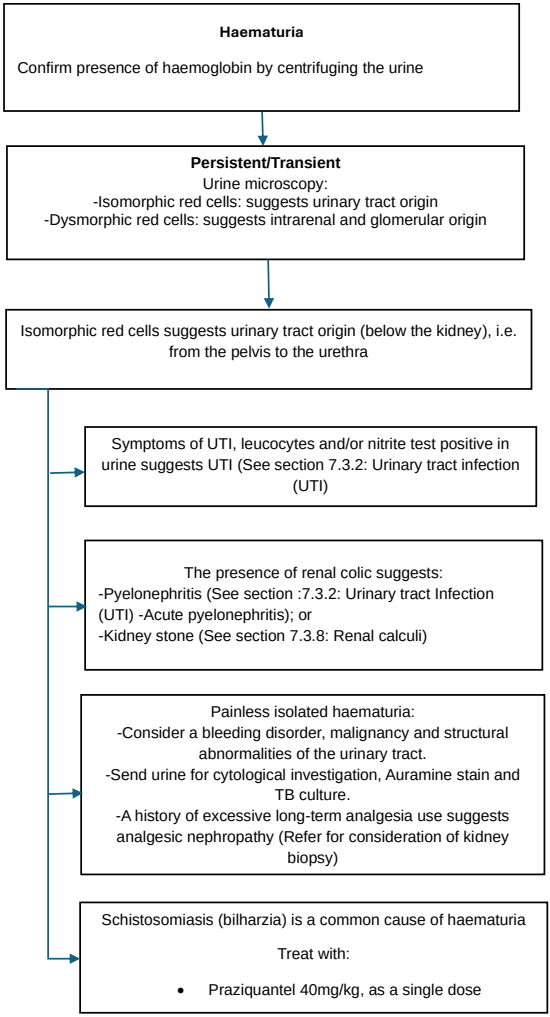


**Figure 7.3: Approach to haematuria**

## REFERRAL

Suspected glomerular disease.

## 7.3.2 URINARY TRACT INFECTION (UTI)

N10/N30.9/N39.0/O23.4

### DESCRIPTION

UTIs include cystitis (infection of the bladder/lower urinary tract) and pyelonephritis (infection of the kidney/upper urinary tract). Pyelonephritis develops when pathogens ascend to the kidneys via the ureters. Uncomplicated UTIs involve either the lower urinary tract (bladder) and/or the upper urinary tract (kidney) in non-pregnant, pre-menopausal woman with no known relevant anatomical and/or functional abnormalities within the urinary tract or any comorbidities. UTIs in other groups of patients are complicated by definition.

Features of upper UTI include:
» flank pain/tenderness,
» temperature >38°C,
» other features of sepsis, i.e. tachypnoea, tachycardia, confusion and hypotension, or
» nausea and vomiting.

In complicated, recurrent or upper UTIs, mid-stream urine should be sent for microscopy, culture and sensitivity.

### MEDICINE TREATMENT

Women with recurrent UTIs should be advised to:
» void bladder after intercourse and before retiring at night
» not postpone voiding when urge to micturate occurs
» change from use of diaphragm to an alternative type of contraception

Empirical treatment is indicated only if:
» positive leucocytes **and** nitrites on urine test strips on freshly passed urine, or
» leucocytes or nitrites with symptoms of UTI, or
» systemic signs and symptoms indicating an upper UTI and/or urosepsis.

**Note:** Alkalinising agents are not recommended, as many antibiotics require a lower urinary pH.

**Uncomplicated community acquired cystitis:** N30.9

- Fosfomycin, oral, 3 g as a single dose. *LoE:IIb*[xxix]

**OR**

- Gentamicin, IM, 5 mg/kg as a single dose.
  - **Note:** Gentamicin should not be used in renal impairment or pregnancy (see Appendix II for guidance on prescribing). Therapeutic drug monitoring is not required. *LoE:IIb*[xxx]

**OR**

- Nitrofurantoin, oral, 100 mg 6 hourly for 5 days. *LoE:IIb*[xxxi]

**Complicated community acquired cystitis** (Non-pregnant women) N30.9
- Ciprofloxacin, oral, 500 mg 12 hourly for 7 days.

*LoE:IIIb*[xxxii]

**CAUTION**

Concomitant use of fluoroquinolones with ACE-inhibitor/angiotensin receptor blocker is contraindicated in moderate to severe renal impairment (eGFR ≤ 30 ml/min/1.73m$^2$) and in the elderly. Assess renal function before initiating treatment and monitor during treatment.

Evidence suggests a risk of developing acute kidney injury with concomitant use of fluoroquinolones and renin-angiotensin receptor blockers.

*LoE:IIIb*[xxxiii]

For pregnant women: O23.4 *LoE:Ib*[xxxiv]
- Fosfomycin, oral, 3 g as a single dose.

**OR**
- Nitrofurantoin, oral, 100 mg 6 hourly for 5 days. *LoE:IIb*[xxxv]

**Acute pyelonephritis** N10

Admit all patients with vomiting, sepsis, diabetes or impaired/worsened renal function (eGFR <60 mL/min/1.73m$^2$).

Ensure adequate hydration with intravenous fluids.

If there is a poor response, perform an ultrasound on all hospitalised patients urgently as in-patients.

Adjust antibiotic according to sensitivity.

Duration of antibiotic therapy in uncomplicated pyelonephritis:
» Fluoroquinolones: 7 days
» Other antibiotics: 14 days.

Longer courses of therapy, 2–3 weeks, should be given for complicated pyelonephritis.

Patients who have features of severe sepsis or who are vomiting, initiate IV therapy and switch to oral therapy as soon as clinical condition improves:

If normal renal function:
- Gentamicin, IV, 6 mg/kg daily (see Appendix II for guidance on prescribing and monitoring).

Switch to oral therapy as soon as the patient is able to take oral fluids, according to microscopy culture and sensitivity results:
- Ciprofloxacin, oral, 500 mg 12 hourly for 7–10 days.

If impaired renal function:

- Ceftriaxone, IV, 1 g daily.

Switch to oral therapy as soon as the patient is able to take oral fluids, according to microscopy culture and sensitivity results:

- Ciprofloxacin, oral, 500 mg 12 hourly for 7 days.
  - If severe renal impairment (eGFR <10 mL/min/1.73m$^2$): 50% of normal dose.

## REFFERAL/CONSULTATION

**Urgent**

» Acute pyelonephritis in pregnant women.
» Acute pyelonephritis with:
- vomiting
- sepsis
- diabetes mellitus
- urinary tract obstruction on ultrasound

**Non-urgent**

» Failure to improve within 72 hours.
» Women beyond reproductive age.
» >3 uncomplicated UTIs within a one-year period.
» >1 complicated UTI within a one-year period.

# 7.3.3 RECURRENT UTI

N10.0/N30.9/N39.0

## DESCRIPTION

Recurrences of uncomplicated and/or complicated UTIs, with a frequency of at least three UTIs/year or two UTIs in the last six months.
Send urine for microscopy, culture and sensitivity as treatment is determined by the results.

*LoE:IVb*[xxxvi]

## GENERAL MEASURES

Women should void soon after intercourse.
Identify and treat hormone-deficient atrophic vulvo-vaginitis in the elderly.

## MEDICINE TREATMENT

**Prophylaxis** (Z29.9)

To reduce risk of recurrence in patients with >3 infections/year requires continuous prophylaxis for 6 months:

- Cotrimoxazole 80/400 mg, oral, 1 tablet at night.

**Treatment**

Treat according to microscopy, culture and sensitivity.

## REFERRAL/CONSULTATION

» Failure to respond to prophylactic treatment.

» Uncertain diagnosis.
» Recurrent infections where no facilities exist for adequate culture of urine.
» All complicated recurrent UTIs.
» STI pathogens.

## 7.3.4 PROSTATITIS

N41.1/N41.9 + (N34.2)

### DESCRIPTION

Clinical features include:
» pyrexia,
» acute pain in the pelvis and perineum,
» dysuria and frequency,
» urinary retention or difficulty, and
» acutely tender prostate on rectal examination.

**Chronic non-bacterial prostatitis**

This is a diagnosis of exclusion, i.e. failure to respond to antibiotics. It is associated with perineal, suprapubic, penile and testicular pain.

### MEDICINE TREATMENT

**Acute bacterial prostatitis**

<u>If there are features of associated urethritis (STI regimen):</u>

- Ceftriaxone, IM, 250 mg as a single dose.

**AND** *LoE:IIIb*[xxxvii]

- Azithromycin, oral, 1 g as a single dose. *LoE:Ia*[xxxviii]

<u>If there are **no** features of associated urethritis:</u>

- Ciprofloxacin, oral, 500 mg 12 hourly for 14 days. *LoE:IVb*

<u>Chronic/relapse/persistent infection:</u> N41.1

- Ciprofloxacin, oral, 500 mg 12 hourly for 28 days. *LoE:IVb*

### REFERRAL

To urologist if:
» No response to treatment.
» Urinary retention present.
» Chronic/relapsing prostatitis.

## 7.3.5 BENIGN PROSTATIC HYPERPLASIA

N40

### DESCRIPTION

Benign prostatic hyperplasia is a noncancerous (benign) growth of the prostate gland. It usually occurs in men over 50 years of age.

May be associated with both obstructive (weak, intermittent stream and urinary hesitancy) and irritative (frequency, nocturia and urgency) voiding symptoms.
Digital rectal examination reveals a uniform enlargement of the prostate.
Urinary retention with a distended bladder may be present in the absence of severe symptoms, therefore it is important to palpate for an enlarged bladder during examination.

### GENERAL MEASURES

Consult with a urologist.
Annual follow-up.
For patients presenting with urinary retention, insert a urethral catheter.
Stop medication that may aggravate urinary retention e.g. anticholinergics.

### MEDICINE TREATMENT

- Alpha blocker, e.g.:
- Doxazosin, oral, 4 mg daily. *LoE:Ia*[xxxix]
  - Initial dose: 1 mg daily.
  - Titrate dose by 1 mg every 2 weeks to clinical effect.
  - Usual maintenance dose: 4 mg daily.

## 7.3.6 OVERACTIVE BLADDER

N32.8

### DESCRIPTION

A clinical syndrome consisting of urinary frequency (day and night time) and urgency, with or without urgency incontinence,

### GENERAL MEASURES

Urine dipstick to exclude an UTI.
Health education.
Avoid caffeine containing, alcoholic and carbonated beverages.
Pelvic floor muscle training: three sets of 8-12 contractions sustained for 8-10 seconds each, performed three times a day. Patients should continue for at least 15-20 weeks.

### MEDICINE TREATMENT

<u>For detrusor hyperactivity:</u>

- Oxybutynin, oral, 2.5–5 mg 8 hourly (Specialist initiated).

*LoE:IVb*[xl]

### REFERRAL

» For confirmation of diagnosis.
» Complications.
» Not responding to medical therapy.

## 7.3.7 ERECTILE DYSFUNCTION

F52.2/N48.4 + (E29.1)

### DESCRIPTION

The inability to attain and maintain an erect penis with sufficient rigidity for sexual intercourse.
Many cases are psychogenic.
Organic causes include neurogenic, vasculogenic or endocrinological disorders; many systemic diseases; pelvic trauma/surgery; and certain medicines.

### GENERAL MEASURES

Thorough medical and psychosexual history.
Examination should exclude gynaecomastia, testicular atrophy or penile abnormalities.
Review all medicines and, if possible, withdraw medicines that may be associated with erectile dysfunction.
Identify and treat cardiovascular risk factors e.g. obesity, hypertension, and dyslipidaemia.
Advise on lifestyle modification e.g. cessation of smoking and excessive alcohol use, physical activity, and weight loss.

### MEDICINE TREATMENT

Treat the underlying condition.

In patients with proven testosterone deficiency: (E29.1)

- Testosterone. Specialist initiated.

See Section 8.3: Androgen deficiency.

### REFERRAL

To a urologist or appropriate specialist if surgical intervention is needed, e.g. penile prostheses, vascular surgery and pelvic fractures.

## 7.3.8 RENAL CALCULI

N20.0-2/N20.9/N21.0/N21.8/N21.9

### DESCRIPTION

A kidney stone or calculus which has formed in the renal tract, i.e. pelvis, ureters or bladder, as a result of urine which is supersaturated with a stone-forming salt.

Clinical features of obstructing urinary stones may include:

» sudden onset of acute colic, localized to the flank, causing the patient to move constantly,
» nausea and vomiting,
» referred pain to the scrotum or labium as the stone moves down the ureter.

Urinalysis usually reveals microscopic or macroscopic haematuria.

Stones may be passed spontaneously, or after medical or invasive treatment. If available, collect the stones and send to the laboratory for analysis.

## GENERAL MEASURES

**Acute stage:**
Oral fluids administered liberally.
Intravenous fluids to ensure adequate hydration and urine flow.

**To prevent recurrence:**
Avoid dehydration.
If recurrences occur, consult a specialist.

## MEDICINE TREATMENT

Analgesia for renal colic:

- NSAID, oral: e.g. *LoE:IIb*[xli]
- Ibuprofen, oral, 400 mg 8 hourly with meals.

**Note:** Avoid NSAIDs if renal impairment is present or suspected.

If patient is vomiting:

- Diclofenac, IM, 75 mg as a single dose**.** *LoE:IVb*

**AND/OR**

- Tramadol, IM, 50–100 mg, 4–6 hourly. *LoE:IVb*

**OR**

- Morphine, IV, to a total maximum dose of 10 mg (See Appendix II, for individual dosing and monitoring for response and toxicity).

Currently, there is no convincing evidence to support the use of hyoscine in this setting.

For vomiting:

- Metoclopramide, IM, 10 mg 8 hourly. *LoE:IVb*

## REFERRAL

» In acute setting for suspected or diagnosed obstruction and/or ongoing pain.
» Complicating urinary tract sepsis.
» Recurrent calculi.

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health
Department:
Health
REPUBLIC OF SOUTH AFRICA

**SOUTH AFRICAN ADULT HOSPITAL LEVEL ESSENTIAL MEDICINES LIST**
**AHL CHAPTER 7: NEPHROLOGICAL/ UROLOGICAL DISORDERS**
**NEMLC RECOMMEDATIONS FOR MEDICINE AMENDMENTS (2020-2024 REVIEW CYCLE)**

**Medicine amendment recommendations, with supporting evidence and rationale are listed below. Kindly review the medicine amendments in the context of the respective standard treatment guideline (STG).**

| SECTION | MEDICINE/MANAGEMENT | ADDED/DELETED/AMENDED |
|---|---|---|
| **7.1 Nephrology disorders** | Dose adjustments in CKD | New guidance added |
| **7.1.1 Chronic kidney disease (CKD)** | Description of CKD | Amended |
| | Common causes of CKD | Amended |
| | Prognosis of CKD by GFR and albuminuria categories | Reference for Figure 7.1 amended |
| | Salt intake restriction | Guidance amended |
| | Dietary Protein limit | Guidance removed |
| | Proteinuria screening | Guidance amended |
| | Furosemide,oral,IV | Dose and directions amended |
| | Calcium,oral | Retained, dose wording amended |
| | Aluminium hydroxide, oral | Short term treatment added |
| | Hyperparathyroidism | Timing of initiation of therapy retained |
| - Anaemia associated with CKD in patients on dialysis programmes | Erythropoietin Stimulating Agents (ESAs) | Added as a therapeutic class |
| | Epoetin alfa and epoetin beta | Retained as the example of class in the STG |
| | Methoxy polyethylene glycol epoetin beta | Added as a therapeutic alternative |
| | Darbepoetin alfa | Added as a therapeutic alternative |
| | Erythropoeitin IV/SC | Prescriber level retained |
| -Referral | Nephrotic-range proteinuria | Referral for possible kidney biopsy added |
| **7.1.2 Glomerular disease and nephritic syndrome** | Amlodipine,oral | Retained |
| | Furosemide,oral | Retained, moved to first-line diuretic alternative |
| | Hydrochlorothiazide,oral | Retained |
| **7.1.3 Nephrotic Syndrome** | Nephrotic-range proteinuria | Definition amended |
| **7.1.4 Acute Kidney Injury** | Acute dialysis | Indications amended |
| | Metabolic acidosis | Definition amended |
| | Hyperkalaemia | Definition and guidance on management amended |
| | Calcium gluconate 10%, slow IV | Retained, Directions for use amended |
| | Dextrose 50%, IV | Retained, Directions for use amended |
| | Salbutamol nebulisation | Retained, dose and administration guidance added |
| | Sodium polystyrene sulfonate, oral/rectal | Retained |
| | Lactulose, oral | Retained |
| | Sorbitol, oral | Not added |
| **7.2.2 Hypokalaemia:** | Description | Amended |
| | Potassium chloride, oral | Retained, Potassium chloride oral solution added |
| | Potassium, IV | Retained |
| **7.2.3 Hypernatraemia** | Description | Amended |
| **7.2.4 Hyponatraemia:** | Description | Retained, caution revised |
| **7.3.1 Haematuria** | Praziquantel, oral | Retained, dosing guidance amended |

| | | |
|---|---|---|
| **7.3.2 Urinary Tract Infection (UTI)**<br>Complicated community acquired cystitis | Ciprofloxacin, oral | Retained, treatment duration amended |
| **7.3.5 Benign prostatic hyperplasia**<br>- Dose titration to clinical effect | Alpha blocker, oral | Retained as a therapeutic class |
| | Doxazosin, oral, immediate-release (1mg) | Added as an example of class |
| | Doxazosin, oral, long-acting (4mg) | Added to the therapeutic interchange database |
| | Tamsulosin, oral (0.4mg) | Added to the therapeutic interchange database |
| | Terazosin, oral (1 and 5mg) | Added to the therapeutic interchange database |
| | Alfuzosin, oral (10mg) | Added to the therapeutic interchange database |
| | Silodosin, oral (4mg) | Added to the therapeutic interchange database |
| **7.3.5 Benign prostatic hyperplasia**<br>*-standard maintenance dose* | Alpha blocker, oral | Retained as a therapeutic class |
| | Doxazosin, oral, immediate-release (4mg) | Added as an example of class |
| | Doxazosin, oral, long-acting (4mg) | Added to the therapeutic interchange database |
| | Tamsulosin, oral (0.4mg) | Removed as an example of class and added to the therapeutic interchange database |
| | Terazosin, oral (10mg) | Retained in the therapeutic interchange database |
| | Alfuzosin, oral (10mg) | Retained in the therapeutic interchange database |
| | Silodosin, oral (8mg) | Retained in the therapeutic interchange database |

## 7.1. NEPHROLOGY DISORDERS

*Dose adjustments in CKD: New guidance added*

Some principles of dosing medication in patients with chronic kidney disease (CKD) and acute kidney injury (AKI) have been added to the STG guidance. The 2021 CKD Epidemiology Collaboration (CKD-EPI) measure of eGFR has been added as a reliable measure of eGFR in the STG. It has acceptable performance characteristics and potential consequences that do not disproportionately affect any one group of individuals[1].

The STG has been amended as follows:

**CAUTION**
Check all medicines for possible dose adjustment based on eGFR~~/CrCl~~

**Principles of dosing medication in patients with Chronic Kidney Disease (CKD) and Acute Kidney Injury (AKI)**

In the setting of kidney failure all prescribed medications should be reviewed regularly to ensure that they are safe and at the correct dose for the estimated glomerular filtration rate [eGFR]. Currently, the most reliable measure of eGFR is CKD-EPI in adults and Schwartz equation for children. Nephrotoxic drugs should be avoided in the setting of any kidney dysfunction. Prior to starting any medication, review for previous drug allergies and adverse events. Monitoring of drug toxicity and levels is important where available (e.g. aminoglycoside).

In AKI, the eGFR is not reliable as kidney function changes rapidly. Therefore, it is essential to monitor eGFR and doses of medications regularly.

[1] Inker LA, Eneanya ND, Coresh J, et al., for the Chronic Kidney Disease Epidemiology Collaboration. New Creatinine- and Cystatin C-Based Equations to Estimate GFR without Race.N Engl J Med. 2021 November 4, 385 (19):1737-1749.

~~The doses of many medicines need to be adjusted in renal impairment.~~ Recommendations for medicines that require dose adjustment in renal impairment can be found in the South African Medicine Formulary (SAMF), package insert, and from many online resources e.g.: http://www.globalrph.com/index_renal.htm

### 7.1.1 CHRONIC KIDNEY DISEASE (CKD)

*Description: Amended*

The description has been amended in line with the KDIGO 2012 CKD Guidelines[2]. New nomenclature is "kidney disease" which encompasses both acute kidney injury and chronic kidney disease. The word “chronic renal disease” has been replaced with the word “chronic kidney disease” throughout the chapter.

*Common causes of CKD:* Table 7.1 has been amended to include additional causes of CKD.

The STG has been amended as follows:

**DESCRIPTION**

Evidence of structural damage (proteinuria/haematuria) or loss of kidney function (eGFR <60 mL/min/1.73 $m^2$), present for >3 months. ~~Structural or functional kidney damage present for >3 months, with or without a decreased estimated glomerular filtration rate (eGFR).~~

Markers of kidney damage include:

- proteinuria; (UPCR = urine protein to creatine ratio; UACR = urine albumin to creatine ratio)
  - Severely increased: UPCR >0.05 g/mmol (>0.500 g/g); UACR > 30 mg/mmol (300 mg/g)
  - Moderately increased: UPCR 0.015-0.05 g/mmol (0.15-0.5 g/g); UACR 3 -30 mg/mmol (30-300 mg/g)
  - Normal or mildly increased: UPCR <0.015 g/mmol (<0.15 g/g); UACR <3 mg/mmol (<30 mg/g)
  - ~~ACR-urine (albumin creatinine ratio) ≥30 mg/g or ≥3 mg/mmol; PCR-urine (protein creatinine ratio) >0.05 g/mmol~~
- urine dipstick positive for blood and/or protein (for females with haematuria: exclude current menstrual cycle)
- increased serum creatinine or low eGFR <60 mL/min/1.73 $m^2$
- abnormal kidneys on ultrasound, e.g. polycystic, small in size and scarring
- abnormalities on ~~renal~~kidney biopsy
- electrolyte abnormalities due to tubular disorders
- history of ~~kidney~~ renal transplant

eGFR calculator online access:
https://www.kidney.org/apps/professionals/egfr-calculator

**Table 7.1: Common causes of CKD**

| Category | Example |
|---|---|
| Vascular | Hypertension, renal artery stenosis, vasculitis etc. |
| Glomerular diseases | Diabetes, autoimmune diseases (e.g. lupus nephritis), chronic systemic infections (e.g. HIV, HBV, syphilis), drugs, neoplasia |
| Tubulointerstitial diseases | UTI, drug-induced interstitial nephritis (e.g. rifampicin, allopurinol, fluoroquinolones, sulphonamides, beta-lactam antibiotics, proton pump inhibitors, nonsteroidal anti-inflammatory drugs) |
| Structural | Polycystic kidney/s ~~renal artery stenosis, small or enlarged kidneys~~, renal masses, obstruction (stones, strictures) |
| Others | Congenital |

**Level of Evidence: Low certainty**

[2] Eknoyan G, Lameire N. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl. 2013;3(1):1-150.

*Prognosis of CKD by GFR and albuminuria categories*: *Reference for Figure 7.1 amended*

The reference for figure 7.1: Prognosis of CKD by GFR and albuminuria categories has been amended to the latest version of KDIGO guidelines 2024[3]. It is to be noted that not all the sections of the STG were reviewed in line with the updated KDIGO guidelines due to the limited timelines for finalisation of the chapter for publication. Further updates are to be prioritised in the next review cycle.

The STG has been amended as follows:

**Figure 7.1: Prognosis of CKD by GFR and albuminuria categories: KDIGO 2024~~12~~**

| | | | | Persistent albuminuria categories Description and range | | |
|---|---|---|---|---|---|---|
| | | | | A1 | A2 | A3 |
| | | | | Normal to mildly increased | Moderately increased | Severely increased |
| | | | | ACR* <30 mg/g <3 mg/mmol | ACR* 30–300 mg/g 3–30 mg/mmol | ACR* >300 mg/g >30 mg/mmol |
| eGFR categories (ml/min per 1.73m²) - description and range | G1 | Normal or high | ≥90 | | | |
| | G2 | Mildly decreased | 60 –89 | | | |
| | G3a | Mildly to moderately decreased | 45–59 | | | Refer |
| | G3b | Moderately to severely decreased | 30–44 | | Refer | Refer |
| | G4 | Severely decreased | 15–29 | Refer | Refer | Refer |
| | G5 | Kidney failure | <15 | Refer | Refer | Refer |

ACR: albumin to creatinine ratio in urine specimen.

Green: low risk (if no other markers of kidney disease, no CKD); yellow: moderately increased risk; orange: high risk; red: very high risk; A1, A2, A3 = categories of albuminuria; G1, G2, G3a, G3b, G4, G5 = categories of eGFR

~~Adapted from: Levin A, Stevens PE. Summary of KDIGO 2012 CKD Guideline: behind the scenes, need for guidance, and a framework for moving forward. Kidney Int. 2014 Jan;85(1):49-61. https://www.ncbi.nlm.nih.gov/pubmed/24284513~~

## GENERAL MEASURES

*Salt intake: Guidance amended.*

Guidance to limit total sodium chloride intake (including salt in food ) in order to reduce blood pressure and improve volume control has been updated in the STG in alignment with the updated guidelines[4,5,6]. In addition, examples of nephrotoxic drugs/agents to avoid have been added.

The STG has been amended as follows:

» Limit total salt intake (including salt in food) ~~to < 2300 mg per day of sodium chloride~~. Consult with dietician as required.

[3] Stevens PE, Ahmed SB, Carrero JJ, Foster B, Francis A, Hall RK, Herrington WG, Hill G, Inker LA, Kazancıoğlu R, Lamb E. KDIGO 2024 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney international. 2024 Apr 1;105(4):S117-314.

[4] Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. Kidney Int. 2024 Apr;105(4S):S117-S314. doi: 10.1016/j.kint.2023.10.018. PMID: 38490803.

[5] 5 ways to 5 grams | Heart & Stroke Foundation | South Africa [Internet]. Heart & Stroke Foundation | South Africa. 2018 [cited 2024 Aug 1]. Available from: https://heartfoundation.co.za/topical_articles/5-ways-to-5-grams/

[6] Why should I limit the salt in my food? - MyDynamics [Internet]. MyDynamics. 2021 [cited 2024 Aug 1]. Available from: https://www.mydynamics.co.za/nutrition/why-should-i-limit-the-salt-in-my-food/

» Avoid nephrotoxic ~~medicine~~ drugs/agents like NSAIDs, aminoglycoside antibiotics and radiocontrast media.
» Regular exercise~~,~~and target BMI (BMI <25 kg/m$^2$) according to South African ~~calculations~~ reference ranges.

**Level of Evidence: Low certainty**

*Dietary Protein limit: Guidance removed*

The recommendation to limit dietary protein intake to 0.8 g/kg/day has been removed from the STG, A Systematic Review of 17 RCT's (n=2996) where 10 studies compared a low protein (0.5 to 0.6 g/kg/day) diet with a normal protein( ≥ 0.8 g/kg/day) diet in participants with CKD categories 3a and 3b (9 studies) or 4 (one study), found that there was little or no difference in the numbers of participants who died from all causes (5 studies 1680 participants: RR 0.77, 95% CI 0.51 to 1.18; 13 fewer deaths per 1000). In addition, a low protein diet was found to make little or no difference in the number of participants who reached End-Stage Kidney Disease (ESKD) compared with a normal protein diet (6 studies, 1814 participants: RR 1.05, 95% CI 0.73 to 1.53; 7 more per 1000 reached ESKD)[7].

The STG has been amended as follows:

~~» Limit dietary protein intake to 0.8 g/kg/day.~~

**Level of Evidence: Moderate certainty**

*Proteinuria screening: Guidance amended*

In the STG guidance for proteinuria screening, the definition of significant proteinuria has been amended to equal a spot urine PCR of >0.15 g/mmol in line with guideline recommendations[1]. The recommendation to perform a UACR if the spot urine protein measures less than 1+ has been retained.

The STG has been amended as follows:

» Screen for proteinuria.
  - If urine dipstick 1+ or greater, repeat on a properly collected midstream urine specimen on another occasion.
  - If proteinuria persists, quantify protein with a spot urine protein creatinine ratio. Significant proteinuria = spot urine PCR of >0.15 g/mmol.
  - If urine dipstick < 1+, ACR.

*Rehabilitation support: added*

Aligned with PHC STGs and EML, Inspiratory muscle training shown to improve inspiratory and expiratory muscles and functional capacity[8]. Multidisciplinary care likely decreases rapid progression of renal disease[9] and exercise shown to improve sleep quality amongst adults and children with end-stage kidney disease[10].

[7] Hahn D, Hodson EM, Fouque D. Low protein diets for non-diabetic adults with chronic kidney disease. Cochrane Database Syst Rev. 2020 Oct 29;10(10):CD001892. doi: 10.1002/14651858.CD001892.pub5. PMID: 33118160; PMCID: PMC8095031.

[8] de Medeiros AIC, Fuzari HKB, Rattesa C, Brandão DC, de Melo Marinho PÉ. Inspiratory muscle training improves respiratory muscle strength, functional capacity and quality of life in patients with chronic kidney disease: a systematic review. J Physiother. 2017 Apr;63(2):76-83. https://pubmed.ncbi.nlm.nih.gov/28433237/

[9] Hsu HT, Chiang YC, Lai YH, Lin LY, Hsieh HF, Chen JL. Effectiveness of Multidisciplinary Care for Chronic Kidney Disease: A Systematic Review. Worldviews Evid Based Nurs. 2021 Feb;18(1):33-41. https://pubmed.ncbi.nlm.nih.gov/33247619/

[10] Natale P, Ruospo M, Saglimbene VM, Palmer SC, Strippoli GF. Interventions for improving sleep quality in people with chronic kidney disease. Cochrane Database Syst Rev. 2019 May 26;5(5):CD012625. https://pubmed.ncbi.nlm.nih.gov/31129916/

**MEDICINE TREATMENT**

*Metformin,oral and risk of lactic acidosis: Guidance retained.*
Additional references have been included in the chapter to support the current STG guidance to discontinue metformin in avoidance of lactic acidosis when the eGFR <30 mL/minute/1.73 $m^2$ [11,12].

*Furosemide,oral,IV: Dose* and *directions amended*
For the management of fluid overload and oedema, the dose of furosemide has been amended from an oral dose of 40mg 12 hourly to a dose of 20mg upto 160mg oral/IV in divided doses[13]. Additional guidance through an external comment has also been added to first establish an effective dose of furosemide and ascertain that the prescribed dose results in urination within 1-2 hours of intake until urination ensues. In addition, guidance has been added to dose furosemide at specific times in the morning and afternoon (eg 8 AM and 2 PM) to avoid a nighttime dose.

The STG has been amended as below:

**Fluid overload and oedema**

- Furosemide, oral or IV, 20 to 80mg daily, as a single or divided doses, initiating at the lowest effective dose and titrating upwards. Dose may be increased to 160mg IV or oral daily in divided doses.
- First establish an effective dose and ascertain if urination occurs within 1-2 hours of intake. If urination does not occur within 1-2 hours, the dose should be increased further until urination ensues.
- Diuretic action starts within 60 minutes of dose, hence divided doses should be given in the morning and afternoon eg 8AM and 2PM. ~~40 mg 12 hourly~~

*LoE:IVb*[i]

When fluid overloaded and eGFR <60 mL/minute/1.73 $m^2$, start:

- Furosemide, oral or IV, 40 mg in divided doses (eg. 8 a.m. and 2 p.m.) ~~12 hourly.~~
  - Titrate to a maximum of 500 mg in divided doses (eg. 8 a.m. and 2 p.m.)
  - Furosemide is ineffective when patients are on dialysis and anuric.

**Level of Evidence: Low certainty**

*Calcium, oral*: *Retained, dose wording amended*
For the management of hypocalcaemia and hyperphosphatemia, the STG recommended dose for calcium has been amended to exclusively refer to the elemental calcium requirements in relation to calcium-phosphate product.

The STG has been amended as follows:

Calcium (elemental), oral, (Calcium carbonate),500 mg 8 hourly with meals if calcium-phosphate product <4.4 $mmol^2/L^2$.

*Aluminium hydroxide, oral: Short term treatment added*
In patients not on dialysis, an external comment, to add aluminium hydroxide if the calcium-phosphate product >4.4 $mmol^2/L^2$ for two weeks only, then switching to calcium carbonate, oral, has been accepted[14]. This aims to achieve adequate control of serum phosphorus without development of hypercalceamia and in addition, to avoid long term aluminium retention toxicity. This recommendation is based on local practice at Tygerberg Hospital.

[11] Salpeter SR, Greyber E, Pasternak GA, Salpeter EE. Risk of fatal and nonfatal lactic acidosis with metformin use in type 2 diabetes mellitus. Cochrane Database Syst Rev. 2010 Apr 14;2010(4):CD002967. doi: 10.1002/14651858.CD002967.pub4. PMID: 20393934; PMCID: PMC7138050.

[12] Orloff et al. Safety and efficacy of metformin in patients with reduced renal function: a systematic review. Diabetes Obes Metab 2021. 23(9): 2035-2047.

[13] South African Medicines Formulary, 14th Edition. Division of Clinical Pharmacology. University of Cape Town, 2022.

[14] Mudge DW, Johnson DW, Hawley CM, Campbell SB, Isbel NM, van Eps CL, Petrie JJ. Do aluminium-based phosphate binders continue to have a role in contemporary nephrology practice? BMC Nephrol. 2011 May 13;12:20. doi: 10.1186/1471-2369-12-20. PMID: 21569446; PMCID: PMC3107169.

The STG has been amended as follows:

**Patients with CKD stage 3–5, not on dialysis:**
Hyperphosphataemia and/or hypocalcaemia:

- Calcium ~~carbonate~~ (elemental), oral ~~equivalent to elemental calcium~~ (calcium carbonate), ~~approximately~~ 500 mg 8 hourly with meals if calcium phosphate product <4.4 $mmol^2/L^2$.
    - Increase to approximately 1 g 8 hourly with meals if hyperphosphatemia persists.
- Aluminium hydroxide 300mg/5ml, oral, 10 mL with meals if calcium-phosphate product >4.4 $mmol^2/L^2$, for two weeks only, then switch to calcium carbonate~~. Increase to approximately 1 g 8 hourly with meals, if hyperphosphatemia persists.~~

Hypocalcaemia and low or normal serum phosphate:

- Calcium carbonate (elemental), oral (calcium carbonate)~~,equivalent to elemental calcium~~, ~~approximately~~ 500 mg 8 hourly ~~between~~ two hours after meals, increase to approximately 1 g 8 hourly between meals.

**Level of Evidence: Very low certainty**

*Hyperparathyroidism: Timing of initiation of therapy retained*
The KDIGO guidelines recommends maintaining the PTH between 2 and 9 times ULN in dialysis patients[15]. Therefore, for hyperparathyroidism, the STG currently recommends initiating therapy when PTH levels >2 times upper limit of normal (ULN) range: (Specialist initiated). A comment to initiate therapy when the PTH level is >9 times the ULN was not accepted.
**Level of Evidence: Low certainty**

**Anaemia with CKD in patients on dialysis programmes**
Erythropoietin Stimulating Agents (ESAs): *added as a therapeutic class*
Epoetin alfa and epoetin beta: *retained as the example of class in the STG*
Methoxy polyethylene glycol epoetin beta: *added as a therapeutic alternative*
Darbepoetin alfa: *added as a therapeutic alternative*

Refer to the medicine review:

ESAs for Anaemia in CKD_Class review_A(

**Recommendation:** The NEMLC has recommended that ESAs be recommended as a therapeutic group for patients with anaemia of chronic kidney disease (*strong recommendation).*
*Rationale:* Epoetin alfa and epoetin beta; methoxy polyethylene glycol epoetin beta and darbepoetin alfa are equally effective in increasing haemoglobin and preventing blood transfusions in chronic kidney disease. Harms and cardiovascular risks are similar and dose proportional. This has been demonstrated in several systematic reviews comparing various agents in various situations.
**Level of Evidence: Moderate certainty evidence (Meta-analysis and systematic review; III Guidelines)**

**NEMLC RECCOMENDATION (MEETING OF 23 JUNE 2022):**

The NEMLC accepted the proposal that erythropoiesis-stimulating agents be recommended as a therapeutic class. Furthermore, with the final ratification of the respective nephrology/urology chapter, NEMLC recommended that a circular be disseminated guiding on comparative dosing, dose switching and relevant pragmatic issues.

[15] Eknoyan G, Lameire N. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl. 2013;3(1):1-150.

**Therapeutic Interchange database**

The following updates to the therapeutic interchange database were supported by the Committee:

| Section | Indication | Therapeutic class | Strength | Unit | Formulation |
|---|---|---|---|---|---|
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin beta | 2000 iu | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin beta | 4000 iu | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin beta | 6000 iu | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin beta | 10000 iu | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin beta | 30000 iu | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin alfa | 2000 iu/0.5ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin alfa | 4000 iu/0.4ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin alfa | 6000 iu/0.6ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin alfa | 10000 iu/ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Epoetin alfa | 40000 iu/ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Methoxy Polyethylene Glycol-Epoetin Beta | 50 mcg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Methoxy Polyethylene Glycol-Epoetin Beta | 75 mcg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Methoxy Polyethylene Glycol-Epoetin Beta | 100 mcg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Methoxy Polyethylene Glycol-Epoetin Beta | 120 mcg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Methoxy Polyethylene Glycol-Epoetin Beta | 150 mcg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Methoxy Polyethylene Glycol-Epoetin Beta | 200 mcg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Methoxy Polyethylene Glycol-Epoetin Beta | 250 mcg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Methoxy Polyethylene Glycol-Epoetin Beta | 360 mcg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 10 µg/0.4ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 20 µg/0.5ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 30 µg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 40 mcg | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 50 mcg | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 60 µg/0.3ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 80 mcg | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 100 mcg | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on | Erythropoietin Stimulating Agents | Darbepoetin alfa | 150 µg/0.3ml | INJ |

| | | | | | |
|---|---|---|---|---|---|
| | dialysis | (ESA) | | | |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 300 µg/0.6ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 100 mg/5ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 250 µg/0.5ml | INJ |
| 7.1.1 CHRONIC KIDNEY DISEASE (CKD) | Anaemia associated with CKD in patients on dialysis | Erythropoietin Stimulating Agents (ESA) | Darbepoetin alfa | 500 µg/0,4ml | INJ |

*Erythropoietin IV/SC: Prescriber level retained*

Erythropoietin Stimulating Agents (ESA) are currently recommended in the STG for patients who are on a dialysis programme and are managed by clinicians with the relevant experience. An external comment to reserve initiation of treatment for only specialists was not supported. In addition, B12 folate deficiency has been added as a factor which may aggravate anaemia.

The STG has been amended as follows:

Definitive treatment, e.g. transplantation, usually improves anaemia. It is important to identify factors likely to aggravate anaemia, e.g. iron deficiency, ~~and~~ infection, and vitamin B12 and folate deficiency.

*Nephrotic-range proteinuria: Referral for possible kidney biopsy added*

The STG has been amended, adding a recommendation for a referral to a specialist for a possible kidney biopsy in patients with nephrotic-range proteinuria (UPCR >0.35 g/mmol) or nephrotic syndrome. The indication for a biopsy was deemed to be a specialist decision after referral from the district level.

The STG has been amended as follows:

**CONSULT WITH A SPECIALIST AT THE LOCAL REFERRAL CENTRE**

» Unknown cause of kidney failure.
» Rapid deterioration in kidney ~~renal~~ function.
» Resistant hypertension despite appropriate medication and adherence.
» All patients with persistent proteinuria: on urine dipstick ≥ 1+ or proteinuria >1 g/24 hours (UPCR >0.1 g/mmol).
» Patients with nephrotic-range proteinuria (UPCR >0.35g/mmol) or nephrotic syndrome should be referred for possible kidney biopsy

**REFERRAL**

» All ESKD ~~ESRD~~ patients who may qualify for long term dialysis programs. See section 7.1.5: Kidney ~~renal~~ replacement therapy.
» CKD stage 3 and above (see ~~prognosis table~~ Figure 7.1: Prognosis of CKD by GFR and albuminuria categories).

### 7.1.2 GLOMERULAR DISEASE AND NEPHRITIC SYNDROME

*Furosemide, oral: Retained, amended to first-line diuretic alternative*
*Amlodipine, oral: Retained*
*Hydrochlorothiazide, oral: Retained*

For fluid overload if hypertension present, oral furosemide has been recommended as the first choice diuretic in combination treatment with amlodipine. Loop diuretics may provide a greater natriuretic effect than thiazide diuretics[16] [17] [18].

[16] KDIGO. Clinical practice guideline for the management of glomerular diseases.2021 Available from: https://www.kidney-international.org/action/showPdf?pii=S0085-2538%2821%2900562-7

[17] Crew R. J., Radhakrishnan J., Appel G. (2004). Complications of the nephrotic syndrome and their treatment. Clin. Nephrol. 62 245–259. 10.5414/CNP62245

[18] Jo W, Koh ES, Chung S. Therapeutic roles of thiazides and loop diuretics in blood pressure control and renal protection against chronic kidney disease. Clin Hypertens. 2023 May 15;29(1):14. doi: 10.1186/s40885-023-00238-5. PMID: 37183259; PMCID: PMC10184374.

The STG has been amended FROM:

**MEDICINE TREATMENT**

Fluid overload

- Furosemide, as a slow IV bolus, 80 mg.
  - Avoid unnecessary intravenous fluids.

If hypertension present: I12.0/I12.9

Diastolic BP >100 mmHg or systolic BP >150 mmHg:

- Amlodipine, oral, 5 mg as a single dose.

**AND**

- Hydrochlorothiazide, oral, 25 mg (if eGFR ≥30 mL/minute).

**OR**

- Furosemide, oral, 40–80 mg (if eGFR <30 mL/minute).

TO

**MEDICINE TREATMENT**

Fluid overload

- Furosemide, as a slow IV bolus, 80 mg.
  - Avoid unnecessary intravenous fluids.

If hypertension present: I12.0/I12.9

Diastolic BP >100 mmHg or systolic BP >150 mmHg:

- Amlodipine, oral, 5 mg as a single dose.

**AND**

- Furosemide, oral, 40–80 mg (if eGFR <30 mL/minute).

**OR**

- Hydrochlorothiazide, oral, 25 mg (if eGFR ≥30 mL/minute).

**Level of Evidence: Very low certainty**

### 7.1.3 NEPHROTIC SYNDROME

*Nephrotic-range proteinuria: Definition amended*

The definition of nephrotic-range proteinuria has been amended in line with guidelines [19]. In addition, a statement of emphasis included to highlight the need for specialist consultation for the diagnosis of nephrotic syndrome.

The STG has been amended as follows:

**DESCRIPTION**

Glomerular disease characterised by:

» Nephrotic-range ~~severe~~ proteinuria, i.e.: UPCR >0.3~~2~~5 g/mmol

**and**

- oedema,
- hypoalbuminaemia, and
- hyperlipidaemia.

The cause cannot be determined accurately without a kidney biopsy. With the exception of diabetic nephropathy, all other causes of nephrotic syndrome require specialist consultation.

**Level of Evidence: Low certainty**

[19] KDIGO. Clinical practice guideline for the management of glomerular diseases.2021 Available from: https://www.kidney-international.org/action/showPdf?pii=S0085-2538%2821%2900562-7

### 7.1.4 ACUTE KIDNEY INJURY

*Acute dialysis: Indications amended*

Pulmonary oedema refractory to medical treatment has been added as an indication for acute dialysis.

*Metabolic acidosis: Definition amended*

The PH definition of severe metabolic acidosis has been reduced from PH<7.2 to PH<7.15[20]. The STG has also been amended to list *severe metabolic acidosis (PH <7.15) refractory to medical therapy* and *severe hyperkaleamia (Potassium >7 mmol/L) refractory to medical therapy* as independent indications for acute dialysis.

The STG has been amended as follows:

**Acute dialysis**
Discuss all cases with the referral centre.
Common indications for acute dialysis include:
» Pulmonary oedema refractory to medical therapy ~~and anuria~~ ~~and~~
» Severe metabolic acidosis **(**pH < 7.1~~2~~5) refractory to medical therapy
» Severe hyperkalaemia (>7 mmol/L) refractory to medical therapy
» Uraemic complications, e.g. pericarditis, encephalopathy and bleeding.
» Medication overdose if due to dialysable toxin. See section 19: Exposure to poisonous substances.

*LoE:IVb[ii]*

**Level of Evidence: Low certainty**

*Hyperkalaemia: Definition amended*

The STG has been amended with a change of the definition of hyperkalaemia from Serum K+ >6.5 mmol/L to >6.0 mmol/L [21,22, 23,24]

Serum $K^+$ >6.0~~5~~ mmol/L.

**Level of Evidence: Low certainty**

**Hyperkalaemia, Emergency measures**

*Calcium gluconate 10%, slow IV:Guidance amended*

When using calcium gluconate for hyperkalaemia, additional dosing guidance was added for consideration of subsequent doses if ECG changes persist.

*Dextrose 50%, IV: Guidance amended*

The STG has been amended to recommend dextrose 50% IV and insulin sequentially as opposed to using

[20] Gaudry, S., Hajage, D., Martin-Lefevre, L. et al. The Artificial Kidney Initiation in Kidney Injury 2 (AKIKI2): study protocol for a randomized controlled trial. Trials 20, 726 (2019). https://doi.org/10.1186/s13063-019-3774-9

[21] Clase CM, Carrero JJ, Ellison DH, Grams ME, Hemmelgarn BR, Jardine MJ, Kovesdy CP, Kline GA, Lindner G, Obrador GT, Palmer BF, Cheung M, Wheeler DC, Winkelmayer WC, Pecoits-Filho R; Conference Participants. Potassium homeostasis and management of dyskalemia in kidney diseases: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. Kidney Int. 2020 Jan;97(1):42-61. doi: 10.1016/j.kint.2019.09.018. Epub 2019 Oct 10. PMID: 31706619.

[22] Humphrey T, Davids MR, Chothia MY, Pecoits-Filho R, Pollock C, James G. How common is hyperkalaemia? A systematic review and meta-analysis of the prevalence and incidence of hyperkalaemia reported in observational studies. Clin Kidney J. 2021 Dec 2;15(4):727-737. doi: 10.1093/ckj/sfab243. PMID: 35371465; PMCID: PMC8967676.

[23] Chothia MY, Chikte U, Zemlin A, Moodley D, Fitchat N, Wessels A, van Vuuren E, Davids T, Davids MR. Outcomes of hospitalised patients with hyperkalaemia at a South African tertiary healthcare centre. EClinicalMedicine. 2022 Jul 1;50:101536. doi: 10.1016/j.eclinm.2022.101536. PMID: 35818351; PMCID: PMC9270242.

[24] National kidney foundation.Best practices in managing hypekaleamia in patinets with chronic kidney disease.2016.Available from :https://www.kidney.org/sites/default/files/02-10-7259_DBH_Best-Practices-in-Managing-Hyperkalemia-in-CKD.pdf

concurrently, this is in line with clinical guidelines[12, 25].

*Salbutamol nebulisation: Dose amended*

The dose of salbutamol has been amended from 5mg to a range of 10-20mg in line with guidelines[12]. In addition, administration guidance has been added.

The STG has been amended as follows:

Emergency measures

- Calcium gluconate 10%, slow IV bolus, 10 mL over 10 minutes. Subsequent doses should be considered if ECG changes persist after 5 minutes or recur
- ~~Maximum dose: 40 mL.~~
- Dextrose 50%, IV ~~continuous~~ bolus ~~infusion~~, 100 mL followed by ~~with~~ soluble insulin, 10 units administered ~~over 15-30 minutes~~ as a push over 5 minutes.
  - Monitor blood glucose levels hourly up to 6 hours post-insulin administration.

**AND**

- Salbutamol nebulisation, 10-20 mg. *LoE:IIb[iii]*
  - Dilute Salbutamol 0.5% (5 mg/mL), solution, 1 mL (5 mg) salbutamol 0.5% solution made up to 4 mL with sodium chloride 0.9%.

**Level of Evidence: Moderate certainty**

*Sodium polystyrene sulfonate, oral/rectal: Retained*

*Lactulose, oral: Retained*

*Sorbitol, oral: Not Added*

For acute kidney injury, where dialysis is not feasible, the STG currently recommends sodium polystyrene sulfonate, oral in combination with oral lactulose or sodium polystyrene sulfonate (enema) as a short-term measure for the management of hyperkalaemia. An external comment (Expert opinion) to include monotherapy laxatives (lactulose or sorbitol) as an alternative for treating hyperkalaemia associated with acute kidney injury was not recommended due to lack of evidence in support of the comment. Lactulose has been retained in combination with oral sodium polystyrene for this indication.

The STG has been amended as follows:

These are short-term measures - patients should be dialysed or if this is not feasible:

- Sodium polystyrene sulfonate, oral, 15 g with 15 mL lactulose, 6 hourly.

**OR**

- Sodium polystyrene sulfonate, rectal, 30–60 g as an enema.
  - After 8 hours, wash out with phosphate enema.

  **Note**: Rectal administration is less effective.

**~~OR~~**

- ~~Laxatives alone e.g. oral lactulose or sorbitol (dose should be increased until diarrhoea ensues).~~

### 7.2.2 HYPOKALAEMIA

*Description: Amended*

Prolonged QT interval and bradycardia have been included as signs of hypokalaemia. Further caution has been added to identify and treat the course of hypokalaemia with potential causes of hypokalaemia added in the STG guidance.

The STG has been amended as follows:

[25] Chothia MY, Humphrey T, Schoonees A, Chikte UME, Davids MR. Hypoglycaemia due to insulin therapy for the management of hyperkalaemia in hospitalised adults: A scoping review. PLoS One. 2022 May 12;17(5):e0268395. doi: 10.1371/journal.pone.0268395. PMID: 35552566; PMCID: PMC9097985.

Signs of hypokalaemia: cardiac arrhythmias as well as ECG abnormalities (Prolonged QT interval, bradycardia ~~ST – segment changes).~~
**Identify the cause and treat/remove the cause!** It is usually due to gastro-intestinal losses (~~vomiting~~ diarrhoea) or kidney ~~renal~~ losses (diuretic therapy, hyperaldosteronism, vomiting).

*Potassium chloride oral: Retained*
*Potassium chloride oral solution: Added*
*Potassium, IV: Retained*
As the total body potassium deficit in patients with hypokalaemia may be large, in order to rapidly replenish stores, potassium chloride oral solution has been added to the STG as an alternative to potassium oral tablets. The formula for the compounding of potassium chloride solution has been included in Appendix IV: Extemporaneous preparations. Editorial amendments have also been made to the text for better clarity.

The STG has been amended as follows:

For chronic asymptomatic hypokalaemia, look for and manage the cause:
- Potassium chloride, oral, 600 mg, 1–2 tablets 8 hourly.
    - Each 600 mg potassium chloride tablet contains 8 mmol of potassium chloride.
    - Titrate according to response to therapy.
    - Maximum daily dose: 6 g. (i.e.10 tablets per day in divided doses).
    - Review potassium levels after 4 weeks.

**OR**
- Potassium chloride solution (1g/5ml) 10-30 mL daily in divided doses PO up to 6 g. (See Appendix IV: Extemporaneous preparations for the preparation formula for adults).

**Note**: Routine supplementation with potassium chloride in patients who are on diuretics is usually inappropriate. Co-administration of ACE-inhibitors and/or spironolactone counteracts the hypokalaemia from furosemide or thiazides. In patients that develop hypokalaemia while using potassium-sparing diuretics or ACEi/ARBs, consider underlying primary hyperaldosteronism.

For mild to moderate hypokalaemia in a non-vomiting patient (potassium level usually 3–3.4 mmol/L):
- Potassium chloride, oral, 1 200 mg (2 tablets) 8 hourly.
    - Each 600 mg potassium chloride tablet contains 8 mmol of potassium chloride.
    - Titrate according to response to therapy.
    - Maximum daily dose: 6 g (i.e.10 tablets per day in divided doses). ~~Maximum daily dose: 6 g.~~
    - Continue treatment until the serum potassium concentration is persistently above 3.5 mmol/L and symptoms or signs have resolved.

**OR**
Potassium chloride solution (1g/5ml), oral, 10-30 mL daily in divided doses up to 6 g. (See Appendix IV: Extemporaneous preparations for the preparation formula for adults.

For severe, symptomatic hypokalaemia:
- Potassium chloride, IV by peripheral line, 40 mmol in 1 L of 0.9% or 0.45% sodium chloride, mixed thoroughly.
    - Administer over 3 hours, or up to ~~at~~ a maximum rate of 20 mmol per hour ~~over 3 hours~~. Beware of volume overload (See Appendix II, for individual dosing and monitoring for response and toxicity).
    - Repeat as required, monitoring potassium serum levels after each replacement dose.
    - One ~~P~~potassium chloride 15% 10 mL ampoule contains 20 mmol potassium.

### 7.2.3 HYPERNATREAMIA

*Description: Amended*
A revised description for hypernatremia has been included in the STG.

The STG has been amended as follows:

In patients who develop hypernatraemia outside of the hospital, it is usually due to ~~inadequate water intake~~ water losses (decreased thirst sensation or inability to drink water (delirium/reduced consciousness), ~~or due to~~ gastro-intestinal losses (diarrhoea ~~vomiting, diarrhoea~~) or renal losses (diabetes insipidus ~~osmotic diuresis, furosemide~~).

In hospitalised, critically ill patients it is usually the result of sodium gain (administration of too much sodium-containing intravenous solutions).

### 7.2.4 HYPONATRAEMIA

*Description: Retained, caution revised*

The caution in this section has been revised highlighting to monitor the sodium levels in order to prevent the rapid overcorrection of chronic hyponatraemia. The STG now recommends minimum correction of below Na <8 mmol/L per day[26,27] in line with guidelines.

The STG has been amended as follows:

**CAUTION**

Rapid correction of chronic hyponatraemia may lead to ~~central pontine myelinolysis~~ osmotic demyelination syndrome, which is often irreversible and fatal. Sodium should be frequently monitored, and increases should be <~~9~~8 mmol/L per day.

**Level of Evidence: Low certainty**

### 7.3.1 URINARY TRACT INFECTION (UTI)

*Praziquantel oral*: *Retained, dose amended*

In line with the PHC STG, the dose for praziquantel oral, has been revised to a weight-based dosing schedule (40mg/kg, as a single dose). The title of Figure 7.3 has been amended to (Approach to haematuria)

Figure 7.3: Approach to haematuria has been amended as follows:

Schistosomiasis (bilharzia) is a common cause of haematuria
Treat with:

- Praziquantel, oral, ~~3g,~~ 40mg/kg, as a single dose

### 7.3.2 URINARY TRACT INFECTION (UTI)

*Gentamicin*: *Retained, guidance amended*

For uncomplicated community acquired cystitis, Gentamicin IM has been retained, additional text highlighting that therapeutic drug monitoring is not required has been added.

The STG has been amended as follows:

[26] Verbalis JG, Goldsmith SR, Greenberg A, Korzelius C, Schrier RW, Sterns RH, Thompson CJ. Diagnosis, evaluation, and treatment of hyponatremia: expert panel recommendations. Am J Med. 2013 Oct;126(10 Suppl 1):S1-42. doi: 10.1016/j.amjmed.2013.07.006. PMID: 24074529.

[27] Spasovski G, Vanholder R, Allolio B, Annane D, Ball S, Bichet D, Decaux G, Fenske W, Hoorn EJ, Ichai C, Joannidis M, Soupart A, Zietse R, Haller M, van der Veer S, Van Biesen W, Nagler E. Clinical practice guideline on diagnosis and treatment of hyponatraemia. Intensive Care Med. 2014 Mar;40(3):320-31. doi: 10.1007/s00134-014-3210-2. Epub 2014 Feb 22. Erratum in: Intensive Care Med. 2014 Jun;40(6):924. Hoorn, Ewout [corrected to Hoorn, Ewout J]. PMID: 24562549.

**Uncomplicated community acquired cystitis:** N30.9
Fosfomycin, oral, 3 g as a single dose.
**OR**
- Gentamicin, IM, 5 mg/kg as a single dose.
  - **Note:** Gentamicin should not be used in renal impairment or pregnancy (see Appendix II for guidance on prescribing). Therapeutic drug monitoring is not required.

**OR**
- Nitrofurantoin, oral, 100 mg 6 hourly for 5 days.

*Ciprofloxacin, oral: Retained, treatment duration amended*
In line with the PHC Chapter 8: Kidney and urological disorders, the duration of treatment for complicated community acquired cystitis has been amended from 10 days to 7 days.

The STG has been amended as follows:

**Complicated community acquired cystitis** (Non pregnant women)
- Ciprofloxacin, oral, 500 mg 12 hourly for 7~~-10~~ days.

### 7.3.5 BENIGN PROSTATIC HYPERPLASIA

**A: Dose titration to clinical effect**
Alpha-blocker, oral: *added as a therapeutic class*
Doxazosin, oral, immediate-release (1mg): *added as an example of class*
Doxazosin, oral, long-acting (4mg): *added to the therapeutic interchange database*
Tamsulosin, oral (0.4mg): *added to the therapeutic interchange database*
Terazosin, oral (1 and 5mg): *added to the therapeutic interchange database*
Alfuzosin, oral (10mg): *added to the therapeutic interchange database*
Silodosin, oral (8mg): *added to the therapeutic interchange database*

**B: Standard maintenance dose**
Alpha-blocker, oral: *retained as a therapeutic class*
Doxazosin, oral, immediate-release (4mg): *added as an example of class*
Doxazosin, oral, long-acting (4mg): *added to the therapeutic interchange database*
Tamsulosin, oral (0.4mg): *removed as an example of class and added to the therapeutic interchange database*
Terazosin, oral (10mg): *retained in the therapeutic interchange database*
Alfuzosin, oral (10mg): *retained in the therapeutic interchange database*
Silodosin, oral (8mg): *retained in the therapeutic interchange database*

In the NEMLC meeting held 31 March 2022, tamsulosin 0.4mg, was recommended to be removed as an example of the alpha-blocker therapeutic class and was replaced by doxazosin 4mg for the treatment of benign prostatic hyperplasia. Tamsulosin has been added to the therapeutic interchange database due to considerations of cost and supply security. It was noted that the standard doxazosin formulation requires to be slowly up titrated from 1 mg/day to clinical effect, to avoid first-dose orthostatic hypotension[28]. However, the long-acting formulation of doxazosin, standard dose does not. As per circular REF: 2022/03/31/EDP/02, the updated treatment protocol has been disseminated and now includes the dose titration to achieve clinical dose.

The STG amended as follows:

[28] South African Medicines Formulary. 14th Edition. Division of Clinical Pharmacology. University of Cape Town, 2022.

| Indication: Adult Hospital Level STGs and EML, 2019 | Current recommendation in STGs and EML (2019) | Updated recommendation for 2020-2024 version of the STGs and EML |
|---|---|---|
| **7.3.5 Benign prostatic hyperplasia** | ▪ Alpha blocker, e.g.:<br>○ Tamsulosin, oral, 0.4 mg daily. | ▪ Alpha blocker, e.g.:<br>• Doxazosin, oral, 4 mg daily.<br>○ Titrate dose by 1 mg every 2 weeks to clinical effect.<br>○ Initial dose: 1 mg daily.<br>○ Usual maintenance dose: 4 mg daily. |

The following titration protocol to clinical effect has been recommended.

| Alpha-blocker | Dose titration protocol |
|---|---|
| Doxazosin, immediate release | 1mg daily x14days, 2mg daily x14days, 4mg daily |
| Terazosin | 1mg x14 days, 2mg x14 days, 5mg x14 days, 10mg daily |
| Doxazosin, long-acting | n/a |
| Tamsulosin | n/a |
| Alfuzosin | n/a |
| Silodosin | n/a |

The alpha blocker therapeutic class has been amended in the AHL therapeutic interchange database as follows:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **7.3.5** | **Beningn prost** | **Dose-titratior** | **N40** | **Alpha blocker** | **G04CA** | **Doxazosin** | **1** | **mg** | **oral** |
| 7.3.5 | Beningn prosta | Dose-titration | N40 | Alpha blocker | G04CA | Doxazosin | 4 | mg | long-acting |
| 7.3.5 | Beningn prosta | Dose-titration | N40 | Alpha blocker | G04CA | Tamsulosin | 0.4 | mg | oral |
| 7.3.5 | Beningn prosta | Dose-titration | N40 | Alpha blocker | G04CA | Terazosin | 1-5 | mg | oral |
| 7.3.5 | Beningn prosta | Dose-titration | N40 | Alpha blocker | G04CA | Alfuzosin | 10 | mg | oral |
| 7.3.5 | Beningn prosta | Dose-titration | N40 | Alpha blocker | G04CA | Silodosin | 8 | mg | oral |
| **7.3.5** | **Beningn prost** | **Standard mai** | **N40** | **Alpha blocker** | **G04CA** | **Doxazosin** | **4** | **mg** | **oral** |
| 7.3.5 | Beningn prosta | Standard main | N40 | Alpha blocker | G04CA | Doxazosin | 4 | mg | long-acting |
| 7.3.5 | Beningn prosta | Standard main | N40 | Alpha blocker | G04CA | Tamsulosin | 0.4 | mg | oral |
| 7.3.5 | Beningn prosta | Standard main | N40 | Alpha blocker | G04CA | Terazosin | 10 | mg | oral |
| 7.3.5 | Beningn prosta | Standard main | N40 | Alpha blocker | G04CA | Alfuzosin | 10 | mg | oral |
| 7.3.5 | Beningn prosta | Standard main | N40 | Alpha blocker | G04CA | Silodosin | 8 | mg | oral |

**Potassium Chloride 1g/5ml oral solution (5L)**

| Ingredient | Quantity |
|---|---|
| Potassium Chloride powder | 1 kg |
| Concentrated Chloroform Water AQ | 125 mL |
| Distilled water up to | 5 L |

*(Adapted with permission from Tygerberg Academic Hospital Department Of Pharmaceutical Services)*

***Note**: Different volumes can be prepared. Recalculate based on the above proportions.*

**Method**

1. Weigh off Potassium Chloride powder.
2. Place in a mixing bowl of a small mixer.
3. Heat 2.5 litres distilled water and add to powder.
4. Mix at low speed.
5. Add 1,5 litres of cold water to mixture.
6. Measure off 125ml concentrated Chloroform water and add to mixture.
7. Place in a 5 litre container prepared for the manufacture of Potassium Chloride.
8. Make up to 5 litres with distilled water.
9. Print stickers and fill in packing card.
10. Pack in 100 ml glass amber bottles.

**Storage:** store in a glass amber bottle for up to 1 month.

**Directions for use**: Dilute every 5mL with 60mL of fluid (Juice or water)

**How to prepare concentrated Chloroform Water B.P (125ml)**

| **Ingredient** | **Quantity** |
|---|---|
| Alcohol 96 % | 75 mL |
| Chloroform Liquid | 12,5 mL |
| Distilled water up to | 125 mL |

Method:

1. Measure alcohol 96 % in glass cylinder and pour into amber glass bottle prepared for the manufacture of Chloroform water.
2. Measure chloroform liquid in a glass cylinder and add to the alcohol. Perform this step expeditiously as Chloroform evaporates.
3. Make up the volume with distilled water.
4. Label bottle with Batch number and date of manufacture.

**South African National Essential Medicines List**
**Adult Hospital Level Medication Review Process**
**Component: Nephrology**

**MEDICINE CLASS REVIEW OF ERYTHROPOIESIS-STIMULATING AGENTS**
**Date:** 21 April 2022

**Key findings**

- This review was to determine therapeutic equivalency amongst erythropoiesis-stimulating agents (ESA), and not to expand the indication from the current guidance of ESA for anaemia of chronic kidney disease in patients on dialysis to all patients.
- We searched PubMed and the Cochrane Library for published systematic reviews and meta-analyses of comparisons of erythropoietins against placebo as well as compared against each other, in patients with chronic kidney disease.
- Epoetin alfa and epoetin beta; methoxy polyethylene glycol epoetin beta and darbepoetin alfa have all demonstrated efficacy versus placebo in increasing haemoglobin and reducing need for transfusion.
- Haemoglobin increase was greater with erythropoietins than with placebo or no treatment, mean difference 1.90 g/dL, 95% CI 1.47 to 2.34: I2 =30%). Erythropoietins decreased need for transfusion compared with placebo: Recombinant erythropoietins (epoetin alfa and Beta and darbepoetin) (3 studies, 111 participants) relative risk (RR) of transfusion was 0.32, 95% CI 0.12 to 0.83; I2 = 0%) versus placebo, NNT = 5. Darbepoetin alfa (1 study with 4038 participants) reduced need for one or more blood transfusions, RR 0.60, 95% CI 0.53 to 0.69) versus placebo, NNT = 10.
- The evidence for improvements in Quality-of-Life measures was less certain, both for the ESA versus placebo and for ESAs versus each other.
- There was little difference in magnitude of improvement in quality-of-life measures between ESA options.
- There was little difference in safety profiles with respect to adverse events, all-cause mortality, and cardiovascular mortality, although comparative data was quite low quality.
- Dosing comparisons were difficult given that this review has summarised several different systematic reviews which included initiation at different clinical points and included different clinical dosing regimens. However, comparative recommended starting and switching doses are available.
- All options appear to be equally effective and international guidelines make no preferential recommendations for which ESA to prescribe.

**PHC/ADULT HOSPITAL LEVEL EXPERT REVIEW COMMITTEE PROPOSAL:**

| Type of recommendation | We recommend against the option and for the alternative **(strong)** | We suggest not to use the option **(conditional)** | We suggest using either the option or the alternative **(conditional)** | We suggest using the option **(conditional)** | We recommend the option **(strong)** |
|---|---|---|---|---|---|
| | | | | | **X** |

**Recommendation:** The PHC/Adult Hospital Level Committee proposes that erythropoiesis-stimulating agents be recommended as a therapeutic group for patients with anaemia of chronic kidney disease (*strong recommendation).*
*Rationale:* Epoetin alfa and epoetin beta; methoxy polyethylene glycol epoetin beta and darbepoetin alfa are equally effective in increasing haemoglobin and preventing blood transfusions in chronic kidney disease. Harms and cardiovascular risks are similar and dose proportional. This has been demonstrated in several systematic reviews comparing various agents in various situations.
**Level of Evidence: Moderate certainty evidence (Meta-analysis and systematic review; III Guidelines)**

**NEMLC RECCOMENDATION (MEETING OF 23 JUNE 2022):**
The NEMLC accepted the proposal that erythropoiesis-stimulating agents be recommended as a therapeutic class. Furthermore, with the final ratification of the respective nephrology/urology chapter, NEMLC recommended that a circular be disseminated guiding on comparative dosing, dose switching and relevant pragmatic issues.

**Monitoring and evaluation considerations:**
- Dosing is patient specific and dependent on response
- There are recommended Hb limits in place which should not be exceeded because of the risk of adverse effects

**Research priorities**

**EXECUTIVE SUMMARY**

**Date: 14 February 2022**
**Medicine (INN):Other antinaemic agents** (Erythropoetin alfa and erythropoetin beta; darbepoetin alfa ; methoxy polyethylene glycol epoetin beta)
**Medicine (ATC):** B03XA (B03XA01, B03XA02 and B03XA02)
**Indication (ICD10 code):** Treatment of anaemia in chronic renal failure (N18.1-5†/N18.9† + (D63.8*/Z49.1-2)
**Patient population:**
Adults aged 18 years or older with anaemia due to chronic kidney disease (CKD).
- with or without dialysis
- all stages of CKD

**Prevalence of the condition:**
**Level of Care:** Secondary
**Prescriber level:** Medical Officer
**Current Standard of Care:** Currently erythropoetins are recommended in the Hospital level Standard Treatment Guidelines for anaemia associated with CKD in patients on dialysis programmes. Patients on chronic haemodialysis or peritoneal dialysis are often anaemic due to iron deficiency and deficiency of erythropoietin (EPO). Simultaneous administration of iron and EPO is recommended, as EPO should be administered in a patient with normal iron stores. Adequate iron stores are required to assist with red blood cell production immediately after EPO administration.
**Findings:**
There is not a significant difference in the several different ESA erythropoietin agents in terms of efficacy, as indicated by quality-of-life measures, haemoglobin responses or prevention of the need for transfusion. There was also no indication of any difference in safety profiles, as indicated by adverse events, all-cause mortality and cardiovascular mortality, although comparative data is often quite low quality.
Guideline recommendations on choice of ESA recommend this is dependent on factors such as availability and cost. None of the reviewed guidelines made specific recommendations or preferences for any of the agents over the other, although there are some specific recommendations for pharmacovigilance for biosimilars.
**Reviewers:** Ms Shelley McGee, Dr Simba Takuva
**PTC affiliation: n/a**
**Funding support:** None

## 2. NAME OF REVIEWERS

Ms Shelley McGee; Dr Simba Takuva

## 3. AUTHOR AFFILIATION AND CONFLICT OF INTEREST DETAILS

- Ms Shelley McGee: National Operations Manager at the Ophthalmological Society of South Africa, Combined PHC/Adult Hospital Level Committee member (2020-2023)
- Dr Simba Takuva: Perinatal HIV Research Unit, Faculty of Health Sciences, University of the Witwatersrand and School of Health Systems and Public Health, Faculty of Health Sciences, University of Pretoria, Combined PHC/Adult Hospital Level Committee member (2020-2021)

SM and ST have no interests to declare relating to epoetins.

## 4. INTRODUCTION/BACKGROUND

Recombinant erythropoietin and its synthetic derivatives (epoetin alfa, epoetin beta, darbepoetin alfa, methoxy polyethylene glycolepoetin beta; collectively known as erythropoiesis-stimulating agents (ESAs)), are widely used to treat anaemia.

Erythropoietin is a glycoprotein made by peritubular cells in the kidney (with an additional smaller contribution from liver cells (15% total)) and is released in response to low tissue oxygen levels (hypoxia) through the actions of hypoxia-inducible factor to stimulate the formation and viability of red blood cells in the bone marrow (erythropoiesis)(1).

In the case of chronic renal failure, there is a reduced production of erythropoietin in the kidneys in response to hypoxia. This is associated with left ventricular dysfunction and heart failure, in addition to a reduction in exercise capacity and quality of life.

Symptoms caused by insufficient oxygen delivery to tissues in anaemia include weakness and fatigue, breathlessness, light-headedness, and palpitations. Observational cohort data show that anaemia in people who have chronic disease is also consistently associated with negative effects on quality-of-life role function and survival.

The use of iron therapies and erythropoiesis stimulating agents (ESAs) has allowed improvement in patients with anaemia of CKD.

Currently epoetins are recommended in the Hospital level Standard Treatment Guidelines for anaemia associated with CKD in patients on dialysis programmes (N18.1-5†/N18.9† + (D63.8*/Z49.1-2).

Patients on chronic haemodialysis or peritoneal dialysis are often anaemic due to iron deficiency and deficiency of erythropoietin (EPO). Simultaneous administration of iron and EPO is recommended, as EPO should be administered in a patient with normal iron stores. Adequate iron stores are required to assist with red blood cell production immediately after EPO administration.

The purpose of this therapeutic review was to identify whether there are any notable differences in the various available agents in terms of efficacy and safety, with a view to determining whether the agents may be considered a class, for the purpose of tendering.

## 5. PURPOSE / OBJECTIVE

**PICO question:** Therapeutic review. The objective of this analysis was to compare the existing ESA's in patients with anaemia of chronic renal failure. Although patients not yet on dialysis were included in the population group, it was not the intention of this comparison to expand on the current standard of care in the Standard Treatment Guidelines Hospital level (which addresses only patients on dialysis).

**Population**: Adults aged 18 years or older with anaemia due to chronic kidney disease (CKD).

- with or without dialysis
- all stages of CKD

**Intervention:** Erythropoiesis-Stimulating Agents (ESA) -

- epoetin alfa, epoetin beta, darbepoetin beta, methoxy polyethylene glycol-epoetin beta, OR biosimilar)
- any dose and administered via any route

**Comparison**: No treatment, Placebo, different dose of ESA

**Outcomes**:

| **Efficacy** | **Safety** |
|---|---|
| Primary outcomes:<br>- Health-Related Quality of Life measures<br>- Achievement of haemoglobin target level<br>- Preventing blood transfusion<br>Secondary outcomes:<br>- Clinical anaemia i.e., fatigue, dyspnoea etc | - All-cause mortality<br>- All SAEs<br>- End-stage kidney disease<br>- Cardiovascular mortality<br>- Worsening cardiovascular condition (i.e., worsening hypertension)<br>- alloimmunisation |

## 6. METHODS AND FINDINGS

Electronic searches for systematic reviews and meta-analyses were conducted on 04 October 2021 in PubMed and the Cochrane Library. The search strategies are shown in Appendix 1. Records were screened for relevance, and duplicates removed. Titles and abstracts were evaluated for relevance and only finally selected articles were sought in full text for evaluation (Prisma Flow Diagram Figure 1).


**Figure 1. Prisma flow diagram of search results**

13 Systematic Reviews and Meta-analyses met the inclusion criteria. These are summarized in full in Appendix 2.

IN addition, in response to requirements of the EML Expert Review Committee in October 2021, we sought out several international guidelines which make recommendations about ESAs in the treatment of anaemia in chronic renal disease, to understand whether these guidelines recommend one agent above others or distinguish between the different erythropoietin in any way in the treatment of chronic kidney disease.

Six international guidelines were included for evaluation, including an AGREE II assessment, with three demonstrating relatively high scores on evaluation. These are summarized with key recommendations in Appendix 3.

## i. EFFICACY OF ESAs IN ANAEMIA IN CKD

### A) Health Related Quality of Life Measures

Overall, the information available on the improvement of all agents on quality-of-life measures remains weak. Although most of the systematic reviews included in this analysis, examined quality of life as an outcome measure, few were able to report any convincing results. Little improvement was demonstrated against placebo, and no differences could be shown between one agent and another, nor in terms of different dosing regimens.

#### A.1) ESAs versus placebo

The systematic review and meta-analysis by Cody et al(2) was not able to demonstrate improvements in quality of life measures in a systematic way. Only a single study included in the review reported on quality of life improvement, and although it showed a statistically significant difference favouring treatment recombinant human erythropoeitin (rHuEPO), the study was far too small (N=14) to make a comparison.

Collister et al(3) were similarly unable to show that higher hemoglobin(Hb) targets resulted in statistically or clinically significant differences in SF-36 or KDQ (Kidney Dialysis Questionnaire) domains, in patients receiving or not receiving dialysis. Differences in HRQOL were further attenuated in studies at low risk of bias and in subgroups of dialysis recipients.

Johansen et al(4) found only one trial which examined the impact of EPO versus placebo in a randomized controlled trial, which also looked at high Hb and lower Hb patient subgroups. This study found a 22% increase in KDQ fatigue scale in the lower Hb treatment arm and a 26.2% increase in the higher Hb treatment arm compared to only a little change (2.3%) over 6 months in the placebo arm.

Palmer et al (5) examined darbepoetin versus placebo and against other ESAs. One large study (n=3531) included in the meta-analysis examined impact of darbopoetin on the SF-36 scale (as well as the physical functioning score of the SF-36) but found no significant differences versus placebo - Mean Difference, 95% CI: 0.5[-0.15,1.15] for SF-36 and Mean Difference, 95% CI for physical functioning: 0.2[-0.39,0.79]. Measurement of fatigue demonstrated a significant difference. Mean difference in the FACT-Fatigue score was: 1.4[0.71,2.09] (95% CI).

**A.2) ESAs versus each other**

Hahn et al(6) examined various dosing regimens of ESAs in predialysis patients. Only one study (PROMPT Study 2005) performed quality of life (QOL) assessments and reported no statistical differences in the final QOL scores between groups receiving epoetin once weekly or two weekly.

In a broader comparison of ESAs, Palmer at al (1) found that directly comparative data for the effectiveness of different ESA formulations based on patient-centred outcomes (such as quality of life, fatigue, and functional status) are sparse and poorly reported and current research studies were unable to inform care.

Saglimbene et al(7) found no trials which examined quality of life where MIRCERA was compared with other epoetins.

**B) <u>Achievement of Haemoglobin Target Levels</u>**

**B.1) ESAs versus placebo**

Cody et al(2) demonstrated that rHuEPO significantly increased Hb compared to placebo or no treatment (4 studies, 237 participants): Mean difference 1.90 g/dL, 95% CI 1.47 to 2.34; I2 =30%). This review did not differentiate between different rHuEPOs.

Palmer et al (5) examined darbepoetin versus placebo and against other ESAs, but did not report on achievement of Hb targets as an outcome.

**B.2) ESAs versus each other**

Alsalimy and Awaisu(8) analysed trials of Methoxy polyethylene glycol-epoetin beta versus darbepoetin alfa. They demonstrated that in CERA treatment changes in hemoglobin level from the baseline were clinically non-inferior to darbepoetin alfa.

Amato et al(9), comparing originator epoetin alfa with biosimilars found the mean Hb level at the end of the study in the intervention groups was 0.08 higher (from −0.05 lower to 0.2 higher). A comparison of epoetin alfa versus darbepoetin alfa found that the mean Hb level at the end of the study in the intervention groups was −0.54 lower (−1.54 lower to 0.46 higher). For epoetin beta versus methoxy polyethylene glycol-epoetinβ, the mean Hb level at the end of study in the intervention groups was 0.21 higher (−0.41 lower to 0.82 higher). No meaningful differences were found in any of the comparisons.

Hahn et al (10) in examining different dosing regimens of epoetin alpha and beta, found: there were no significant differences in final Hb levels when dosing every two weeks was compared with weekly dosing (4 studies, 785 participants: MD -0.20 g/dL, 95% CI -0.33 to -0.07), when four weekly dosing was compared with two weekly dosing (three studies, 671 participants: MD -0.16 g/dL, 95% CI -0.43 to 0.10) or when different total doses were administered at the same frequency (four weekly administration: one study, 144 participants: MD 0.17 g/dL 95% CI -0.19 to 0.53). Five studies evaluated different interventions. One study compared epoetin theta with epoetin alpha and found no significant differences in Hb levels (288 participants: MD -0.02 g/dL, 95% CI -0.25 to 0.21).

Palmer et al (5) compared mean change in haemoglobin (mg/dL) in patients (with CKD but not necessarily on dialysis) on darbepoetin or other ESAs. The analysis included one study in which the Hb target in the darbepoetin alfa arm was higher than in the epoetin arm, darbepoetin alfa increased Hb levels at the end of treatment (1 study, 84 participants): MD 1.33 g/dL, 95% CI 0.84 to 1.82) whereas in the study reporting treatment effects on end of treatment Hb values in which target values were similar for both darbepoetin alfa and darbepoetin alfa arms, end of treatment values were similar (1 study, 363 participants): MD -0.07 g/dL, 95% CI -0.27 to 0.13). The mean change in Hb was similar for

darbepoetin alfa and epoetin treatment in adults (3 studies, 1060 participants): MD 0.06 g/dL, 95% CI -0.08 to 0.19; IQ = 0%).

**C) Preventing blood transfusion**

**C.1) ESAs versus placebo**

Cody et al (2) found that the number of patients requiring blood transfusions was significantly less in the rHuEPO group than those in the placebo or no treatment group (3 studies, 111 participants): RR 0.32, 95% CI 0.12 to 0.83; I2 = 0%), NNT = 6 (95% CI 5 to 7).

Palmer et al found that Darbepoetin alfa versus placebo (One large study at generally low risk of bias, 4038 participants), darbepoetin alfa reduced need for one or more blood transfusions (RR 0.60, 95% CI 0.53 to 0.69); NNT = 10. However in this single trial prevention of blood transfusion was not a primary outcome of the analysis

Kouloridis et al(11) found that the total-study-period mean ESA dose was associated with a lower rate of transfusion requirement (IRR, 0.73; 95% CI, 0.68–0.79) versus no treatment.

**C.2) ESAs versus each other**

Amato et al(9) demonstrated that the relative risk of blood transfusion was not significantly less with darbepoetin alfa than with epoetins. At 12 months follow-up the relatively risk of a transfusion was 0.73 (95% CI 0.44–1.21) or 15 less per 1000 (from 30 less to 11 more). (3 studies, 1823 patients). This evidence was considered low quality due to risk of bias.

Hahn et al (10)showed:

- Epoetin alpha every two weeks versus every four weeks using same total dose of epoetin - There were no significant differences in the number requiring transfusions (2 studies, 470 participants): RR 1.26, 95% CI 0.53 to 2.98).
- Epoetin alpha weekly versus every two weeks using same total dose of epoetin - There were no significant difference in the number requiring transfusion (3 studies, 580 participants): RR 1.56, 95% CI 0.71 to 3.45).
- Epoetin alpha different doses given every four weeks - There was no significant difference in patients requiring transfusions.

In Palmer et al, Darbepoetin alfa versus epoetin results were less certain (2 studies, 483 participants) - darbepoetin alfa had uncertain effects on need for blood transfusions compared to epoetin.

In studies comparing darbepoetin alfa with methoxy polyethylene glycol-epoetin beta, darbepoetin alfa had inconclusive effects on need for blood transfusion therapy (2 studies, 799 participants): RR 0.82, 95% CI 0.58 to 1.17; IQ = 0%).

Intravenous versus subcutaneous treatment IV darbepoetin alfa therapy had uncertain effects on need for blood transfusions (2 studies, 183 participants): RR 1.15, 95% CI 0.30 to 4.38),

Palmer et al(1) also demonstrated that all ESA agents significantly reduced blood transfusions versus placebo, but that no agent, when compared to any of the other agents, managed to significantly reduce requirements for blood transfusion. In network analyses, there was moderate to low confidence that epoetin alfa (OR 0.18, 95% CI 0.05 to 0.59), epoetin beta (OR 0.09, 95% CI 0.02 to 0.38), darbepoetin alfa (OR 0.17, 95% CI 0.05 to 0.57), and methoxy polyethylene glycolepoetin beta (OR 0.15, 95% CI 0.03 to 0.70) prevented blood transfusions compared to placebo. The authors could not discern whether all ESAs were similar or different in their effects on preventing blood transfusions and confidence in the comparative effectiveness of different ESAs was generally very low.

CERA failed to show benefits on blood transfusion versus epoetin alfa or beta (5 trials, 1824 patients) Risk Ratio (IV, Random, 95% CI) 1.02 [0.72, 1.46](7).

**ii. ADVERSE EFFECTS OF ESAs IN ANAEMIA IN CKD**

**A) All-cause mortality**

**A.1) ESAs versus placebo**

Cody et al (2) demonstrated no significant increase in mortality in ESA-treated patients versus placebo RR, 95% CI: 0.6[0.13,2.88]. However, the four trials in the analysis were small with a combined N = 182.

There were no significant increases in all-cause mortality from any of the agents examined by Palmer et al(1), against placebo, nor against each other.

**A.2) ESAs versus each other**

Amato et al (11), comparing originator epoetin alfa with biosimilars found no significant difference in all-cause mortality (8 studies, 2294 patients) RR.94 (0.52–1.7) or 3 less per 1000 (from 23 less to 34 more). A comparison of epoetin alfa versus darbepoetin alfa found similarly little difference (7 studies, 1265 patients) RR: 1.11 (0.6–2.06) or 4 more per 1000 (from 13 less to 35 more).

In Hahn et al for Epoetin alpha weekly versus every two weeks using same total dose of epoetin, there was no significant difference in all-cause mortality (4 studies, 838 participants): RR 0.89, 95% CI 0.38 to 2.07). Epoetin alpha every two weeks versus every four weeks using same total dose of epoetin, there was no significant difference in all-cause mortality (3 studies, 724 participants): RR 0.95, 95% CI 0.33 to
2.75). Epoetin alpha versus other epoetins or biosimilars no significant differences were noted in all-cause mortality (288 participants): RR 2.46, 95% CI 0.29 to 20.77).

In Koulouridis et a(11)l, in the unadjusted analysis, higher first- 3-month mean ESA dose (per epoetin alfa–equivalent 10,000-U/wk increment) was associated with a higher rate of all-cause mortality (IRR, 1.42; 95% CI, 1.10–1.83).This association persisted after adjustment for the first-3-month achieved mean hemoglobin level (IRR, 1.48; 95% CI, 1.02–2.14). After adjustment for the target hemoglobin level, the association strengthened in magnitude but lost statistical significance (IRR, 1.71; 95% 10 CI, 0.90–3.24). A similar association was observed in the unadjusted analysis for the association of the total-study-period mean ESA dose and all-cause mortality (IRR, 1.09; 95% CI, 1.02– 1.18).

Palmer et al (5) found that Darbepoetin alfa had uncertain effects on all-cause mortality (3 studies, 1122 participants): RR 0.89, 95% CI 0.53 to 1.51; IQ = 3%).

**B) <u>Cardiovascular mortality</u>**

**B.1) ESAs versus Placebo**

The odds of cardiovascular mortality were uncertain for epoetin beta (2 studies, 260 participants): OR 0.45, 95% CI 0.06 to 3.75, IU = 0%) and darbepoetin alfa (1 study, 4038 participants): OR 1.05, 95% 0.87 to 1.26) when compared to placebo.(1) The odds of cardiovascular mortality were uncertain for epoetin beta (3 studies, 430 participants): OR 0.28, 95% CI 0.08 to 1.03; IU = 0%) when compared with no treatment.

**B.2) ESAs versus each other**

In the comparison darbepoetin α vs. methoxy polyethylene glycol-epoetin β (3 studies 938 patients), there was no significant difference – RR: 0.7 (0.33–1.46) or 11 less per 1000 (from 24 less to 17 more).
In the comparison epoetin α vs. darbepoetin α (2 studies, 487 patients) there was also no significantly different risk. RR 2.12 (0.32–14.23) or 8 more per 1000 (from 5 less to 91 more).(9)

In another systematic review the relationship between mean ESA dose and cardiovascular mortality was also not statistically significant(11).

When compared to placebo, Darbepoetin alfa had little or no effect on cardiovascular mortality (RR 1.04, 95% CI 0.89 to 1.23)(5). Versus epoetin, Darbepoetin alfa had uncertain effects on cardiovascular mortality in adults (2 studies, 487 participants): RR 0.47, 95% CI 0.07 to 3.17; IQ = 0%). Versus methoxy polyethylene glycol-epoetin, effects were also uncertain.

The relationship between mean ESA dose and cardiovascular mortality was in the same direction as with overall mortality, albeit not statistically significant. In unadjusted analyses, IRRs of the first-3-month and total-study-period mean ESA dose (per epoetin alfa–equivalent 10,000-U/wk increment) were 1.31 (95% CI, 0.92–1.86) and 1.07 (95% CI, 0.97–1.17), respectively(11). Adjusted analyses were limited due to the insufficient number of observations or collinearity between the predictor variables.

The odds of cardiovascular mortality were uncertain for epoetin alfa when compared to darbepoetin alfa (2 studies, 487 participants): OR 2.15, 95% CI 0.31 to 14.91; IU = 0%) or a biosimilar ESA (Analysis 1.5.5 (2 studies, 657 participants): OR 0.53, 95% CI 0.20 to 1.35; IU = 0%). The odds of cardiovascular mortality were uncertain for epoetin beta when compared to a biosimilar ESA (1 study, 290 participants): OR 0.34, 95% CI 0.04 to 2.82).

The odds of cardiovascular mortality were uncertain for darbepoetin alfa when compared to methoxy polyethylene glycol-epoetin beta (3 studies, 938 participants): OR 0.69, 95% CI 0.32 to 1.48; IU = 0%).

**C) Progression to end-stage kidney disease**

This was difficult to measure in many reviews, as the study durations were often too short to measure this as a primary outcome(2, 5, 11).

**D) Worsening cardiovascular condition (i.e., worsening hypertension)**

**D.1) ESAs versus Placebo**

No significant differences were found for hypertension where darbepoetin was compared with placebo, CERA, epoetin alfa.(5) Similar findings were had for methoxy polyethylene glycol-epoetin beta, compared to placebo, epoetin alfa and darbepoetin.(7)

**D.2) ESAs versus each other**

Amato et al (11), comparing originator epoetin alfa with biosimilars found no significant difference in hypertension (5 studies, 1571 patients); RR 1.62 (0.98–2.66) or 17 more per 1000 (from
1 less to 47 more). A comparison of epoetin alfa versus darbepoetin alfa found similarly little difference (6 studies, 1628 patients); RR: 0.95 (0.7–1.29) or 9 less per 1000 (from 53 less to 51 more).

In Hahn et al for Epoetin alpha weekly versus every two weeks using same total dose of epoetin, there was no significant difference in hypertension: Risk Ratio (M-H, Random, 95% CI) 0.85 [0.55, 1.32]. Epoetin alpha every two weeks versus every four weeks using same total dose of epoetin, there was no significant difference in all-cause mortality (3 studies, 724 participants: Risk Ratio (M-H, Random, 95% CI) 1.02 [0.62, 1.69].

**E) Allo-immunisation**

**E.1 ESAs versus each other**

Anti-erythropoietin antibodies, which can cause pure red cell aplasia, were assessed In only five studies in Hahn et al(10). In a study of epoetin alfa against a biosimilar, the compared the biosimilar HX575 epoetin alpha with epoetin alpha; both medications were administered subcutaneously. The study was ceased when two patients receiving HX575 developed antibodies to epoetin and pure red cell aplasia and HX575 epoetin alpha was withdrawn for subcutaneous administration. The change in Hb from baseline at 13 weeks did not differ between groups (HX575 2.2 ± 0.9 g/dL; epoetin alpha 2.2 ± 1.0 g/dL) but the data could not be included in meta-analyses since no denominators were provided and information could not be obtained from the authors.

## iii. INTERNATIONAL GUIDELINE RECOMMENDATIONS

None of the international guidelines examined recommend one ESA over another or differentiate between the potential outcomes of one ESA versus another.

The KDIGO Guidelines (2012(12)) recommend that some patients will benefit from ESA in terms of quality of life improvement on the KDQ scale, mainly those starting with very low Hbs, and receiving high doses of EPO, targeting an Hb Level of 13.5-14.5g/dl. However, the recommendation is that this be balanced with consideration of the negative effects.

The National Guidelines Centre guidance (13) which has informed the NICE Guidance in the United Kingdom recommended “The GDG agreed that the evidence statements from the multisite RCT support the summary that there is no difference between darbepoetin and epoetin alfa for the outcomes measured, in a selected group of patients who were stable.” This review was not updated in the 2015 update, and so is dependent on reviews conducted in 2006.

The NICE Guideline update of 2021, on anaemia management in renal failure also did not update its searches or recommendations on ESAs. (14)

The Renal Association Guidelines update 2020 recommends that Anaemia be treated with ESAs – for CKD patients who are likely to benefit in terms of quality of life and physical function and to avoid blood transfusion; especially in patients considered suitable for transplantation. (1B) The choice of ESA is recommended that the decision on the choice of ESA is based on local availability of ESAs. (1B)(15)

The Anaemia working Group of European Renal Best Practice (ERBP)'s position statement on Anaemia management in patients with chronic kidney disease: 2009 update (16), also does not differentiate between choice of agent. However, the overall quality of this statement was questionable when interrogated in the AGREE II tool.

The Canadian Society of Nephrology also published Clinical Practice Guidelines for evidence-based use of erythropoietic-stimulating agents, but these have not been updated since 2008. Overall the guidance also scored low in the AGREE II assessment and was not referred to here.(16)

## 7. DOSING COMPARISONS

The systematic reviews offered little solid evidence in terms of dosing comparisons and overall dosing response, as ESA therapy tends to be initiated at recommended doses, and then adjusted according to response, based on haemoglobin levels, generally.

Table 1: The starting dose of these and other ESAs among patients receiving hemodialysis

| **Phase** | **Epoetin Alfa** | **Epoetin Beta** | **Darbepoetin Alfa** | **Methoxy polyethylene glycol-epoetin beta** |
|---|---|---|---|---|
| *Correction phase* | Preferably by IV route (but may be SC where IV not readily available)<br>Adult haemodialysis patients:<br>50IU/kg 3x/wk. adjust dose at 4 weekly intervals by 25IU/kg 3x/wk until Hb targets achieved | Can be administered SC or IV<br>SC: 20IU/kg 3x/wk. May be increased every 4 weeks by 20IU/kg 3x/wk<br>IV:40IU/Kg 3x/wk. Dose may be raised after 1 month to 80IU/kg 3x/wk with further increments of 20IU/Kg 3x/wk | SC use preferable for patients not in haemodialysis.<br>0.45mcg/kg SC/IV body weight as a single dose once weekly or 0.75mcg/kg every 2 weeks.<br>Increase dose every 4 weeks by 25% if response inadequate | SC/IV according to clinical preference<br>0.6mcg/kg once every 2 weeks. Dose can be increased by 25% if Hb increase less than 1g/dl in 4 weeks. Further increase of 25% until target obtained. |
| *Maintenance phase* | Individual dosing to maintain target of 10-12g/dl. Recommended weekly dose of 75-300IU/kg in divided doses. | Maintain Hb target of 10-12g/dl – half the correction phase dose. | Dialysis patients convert to every second week dosing, titrating to Hb targets | |
| *Switch from other agents* | | | Initial weekly dose by Divide existing EPO dose (IU/wk) by 200. | See Table 2 |

The starting doses of ESAs presented above are based upon recommendations within the South African product literature. The Kidney Disease Outcomes Quality Initiative (KDOQI) and kidney disease: Improving Global Outcomes (KDIGO) anemia guidelines do not specify a starting dose but state that the dose should be individualized.

**Table 2** Methoxy polyethylene glycol-epoetin beta **Starting Doses for Adult Patients Currently Receiving an ESA**

| **Previous Weekly Epoetin alfa Dose (units/week)** | **Previous Weekly Darbepoetin alfa Dose (mcg/week)** | **Methoxy polyethylene glycol-epoetin beta Dose Once** | |
|---|---|---|---|
| | | **Monthly (mcg/month)** | **Once Every Two Weeks (mcg/every two weeks)** |
| less than 8000 | less than 40 | 120 | 60 |
| 8000 to 16000 | 40 to 80 | 200 | 100 |
| more than 16000 | more than 80 | 360 | 180 |

## 8. DOSING COSTING COMPARISONS

Table 3 Provides a cost comparison per unit of each different ESA based on available prices in March 2022 and estimated per month costs based on starting doses. Epoetin alfa and Epoetin Beta are currently on National state tender, with state tender prices, so pricing for both the private sector and public sector where applicable have been provided.

**Table 3 Currently Available dosage forms, prices and prices per IU or ug of ESA**

| INN | Dosage form | Concentration | SEP* or Tender price** | Price per IU | Estimated monthly cost at starting dose |
|---|---|---|---|---|---|
| Epoetin Alfa | 0.6ml pfs | 6000 IU/0.6 ml | R452.78 SEP | R0.075 | R 3 150.00 |
| | 0.4ml pfs | 4000 IU/0.4 ml | R308.16 SEP | R0.077 | R 3 234.00 |
| | 0.5ml pfs | 2000 IU/0.5 ml | R159.79 SEP | R0.079 | R 3 318.00 |
| | 1 ml injection | 10 000 IU/ml – high doses general used in oncology | R1080.53 SEP | R0.108 | R 4 536.00 |
| Epoetin Beta | 0.3ml pfs | 6 000IU/ 0.3ml | R 509.26 SEP | 0.0849 | R 2851.86 |
| | 0.3ml pfs | 4 000IU/ 0.3ml | R 346.67 SEP | 0.0867 | R 2 912.06 |
| | 0.3ml pfs | 2 000IU/ 0.3ml | R 173.35 SEP | 0.0867 | R 2 912.06 |
| | 0.3ml pfs | 2000IU/0.3ml | R50.32 Tender | 0.025 | R 840.00 |
| | 0.3ml pfs | 10 000IU/0.3ml | R957.12 SEP | 0.0957 | R 4 019.88 |
| Darbepoetin Alfa | 0.4ml pfs | 10mcg/0.4ml | R195.57 SEP | 19.557 | R 2 464.18 |
| | 0.4ml pfs | 20mcg/0.4ml | R391.14 SEP | 19.557 | R 2 464.18 |
| | 0.4ml pfs | 30mcg/0.4ml | R586.71 SEP | 19.557 | R 2 464.18 |
| | 0.4ml pfs | 60mcg/0.4ml | R1173.44 SEP | 19.557 | R 2 464.18 |
| | p0.4ml pfs | 150mcg/0.4ml | R2933.54 SEP | 19.557 | R 2 464.18 |
| | 0.4ml pfs | 300mcg/0.4ml | 5867.07 SEP | 19.557 | R 2 464.18 |
| | 0.4ml pfs | 100mcg/0.4ml | 1051.75 SEP | 10.51 | R 2 464.18 |
| Methoxy polyethylene glycol epoetin beta | 0.3ml pfs | 30mcg/0.3ml | 726.31 SEP | 24.210 | R 2 033.64 |
| | 0.3ml pfs | 50mcg/0.3ml | 1255.07 SEP | 25.101 | R 2 108.48 |
| | 0.3ml pfs | 75mcg/0.3ml | 1882.61 SEP | 25.101 | R 2 108.48 |
| | 0.3ml pfs | 100mcg/0.3ml | 1902.53 SEP | 19.025 | R 1598.10 |
| | 0.3ml pfs | 120mcg/0.3ml | 3012.18 SEP | 25.101 | R 2 108.48 |
| | 0.3ml pfs | 150mcg/0.3ml | 3765.22 SEP | 25.101 | R 2 108.48 |
| | 0.3ml pfs | 200mcg/0.3ml | 3805.05 SEP | 19.025 | R 1598.10 |
| | 0.3ml pfs | 250mcg/0.3ml | 3805.05 SEP | 15.22 | R 1 278.48 |
| | 0.3ml pfs | 360mcg/0.3ml | 5752.42 SEP | 15.98 | R 1 278.48 |

*Pfs=prefilled syringe; ml = milliliter; IU = international units*

* SEP database, 31 December 2021

** Contract circular HP06-2021SVP/01

## 9. CONCLUSION

In this class review of existing erythropoiesis-stimulating agents (ESAs), including Epoetin alfa and Epoetin beta; methoxy polyethylene glycol epoetin beta; Darbepoetin alfa, we looked at systematic reviews of efficacy and safety of these agents (including against placebo and biosimilar agents) and interrogated existing international guidelines on the use of ESAs for anaemia in renal failure.

Epoetin alfa and epoetin beta; methoxy polyethylene glycol epoetin beta and darbepoetin alfa have all demonstrated efficacy versus placebo, as indicated by, haemoglobin responses or prevention of the need for transfusion.
Versus placebo or no treatment, haemoglobin increased by Mean difference D 1.90 g/dL, 95% CI 1.47 to 2.34: I2 =30%). Reduction in transfusions needed placebo was relatively consistent, however estimates vary, for epoetins where relative risk was lower than placebo by about 30% (3 studies, 111 participants): RR 0.32, 95% CI 0.12 to 0.83; I2 = 0%), to darbepoetin alfa versus versus alfa reduced need for one or more blood transfusions (RR 0.60, 95% CI 0.53 to 0.69). There were no notable differences in outcomes reported for quality of life, haemoglobin level improvements or prevention of the need for transfusion, between the agents examined, including when agents were compared at different dosage frequencies.

There were also no remarkable differences in adverse events such as all-cause mortality, cardiovascular related mortality, hypertension or alloimmunization. One systematic review drew from concerns of a biosimilar trial which was terminated early when two patients developed antibodies to their biosimilar epoetin.

International Guidelines also do not discriminate between the different ESAs on the basis of efficacy nor safety.

**10.LIMITATIONS**

It is important to reiterate that although this analysis examined both chronic renal failure patients on dialysis as well as not on dialysis, the current indication in the standard treatment guidelines is for patient on renal dialysis. Another PICO has been developed to examine the efficacy of ESAs in patients not yet on dialysis (broadening of STG indication). This analysis serves to inform the therapeutic interchange database for the purpose of tendering for the various agents. . It was not intended to adjudicate the efficacy of ESAs versus placebos or to compare one ESA agent specifically versus another.

This review was a review of the many systematic reviews available on the topic of ESAs in chronic renal failure, distinguishing more based on outcomes in the renal failure population than on the specifics of each patient subgroup e.g. dialysis versus non-dialysis; pre-existing conditions such as Type 2 diabetes , or iron status prior to ESA initiation. The studies included in the different systematic reviews had different primary outcomes, as well as examining trials where target Hb levels may have differed and dose escalations may also have been managed differently.

**APPENDIX 1: SEARCH STRATEGIES IN PUBMED AND COCHRANE**

| **Pubmed** |
| --- |
| ((((erythropoietin OR epoetin alpha OR epoetin beta OR darbepoetin alpha OR EPO OR methoxy polyethylene glycol epoetin beta OR "Epoetin Alfa" OR "Erythropoietin" OR "epoetin beta") OR "continuous erythropoietin receptor activator") AND (end stage renal disease OR chronic renal failure OR "Renal Insufficiency, Chronic" OR "Renal Insufficiency, Chronic")))<br><br>Limited to Systematic Reviews and Meta-analyses |
| **Cochrane Library** |
| ((renal insufficiency, chronic) OR (chronic renal disease) OR (kidney Failure)) AND ((erythropoietin) OR (epoetin) OR (darbopoetin) OR (methoxy polyethylene glycol-epoetin)) |

## APPENDIX 2: SUMMARY OF SYSTEMATIC REVIEWS AN META-ANALYSIS INCLUDED IN THE ANALYSIS

| Citation | Details of study | Population (n) | Comparators | Outcomes | Main Findings |
|---|---|---|---|---|---|
| Alsalimy, N., Awaisu, A. Methoxy polyethylene glycol-epoetin beta versus darbepoetin alfa for anemia in non-dialysis-dependent CKD: a systematic review. Int J Clin Pharm 36, 1115–1125 (2014). (8)https://doi.org/10.1007/s11096-014-0023-x | Systematic review of original studies examining Efficacy and tolerability of MPG-EPO compared with other erythropoiesis stimulating agents (in particular darbepoetin alfa) for the treatment of anemia in non-dialysis-dependent CKD patients. | The review ultimately included Four trials involving 1,155 patients were included in the review. Patients were all pre-dialysis. | Methoxy polyethylene glycol-epoetin beta versus darbepoetin alfa | • Changes in Hb Level from baseline<br>• Proportion of patients requiring blood transfusions<br>• Time to haemoglobin response<br>• Incidence of serious adverse effects | The changes in hemoglobin level from the baseline reported by the reviewed studies demonstrate that MPG-EPO was clinically non-inferior to darbepoetin alfa. In addition, the studies documented that MPG-EPO-treated patients experienced a lower rate of hemoglobin level above the target range of 12–13 g/dL than darbepoetin-treated patients.<br>The proportion of patients requiring RBC transfusion was higher among patients who received darbepoetin alfa than those who received MPG-EPO. However, the time to hemoglobin response was longer with MPG-EPO than with darbepoetin.<br>The incidences of serious adverse events were similar between the two therapeutic agents.<br>However, the authors concluded that the review was not conclusive due to limited number of studies. |
| Amato L, Addis A, Saulle R, Trotta F, Mitrova Z, Davoli M.<br>Comparative efficacy and safety in ESA biosimilars vs. originators in adults with chronic kidney disease: a systematic review and meta-analysis. J Nephrol. 2018 Jun;31(3):321-332. doi: 10.1007/s40620-017-0419-5. Epub 2017 Jun 23. PMID: 28646375.(9) | Systematic literature search of CENTRAL, PubMed, and Embase through November 11, 2015.<br>RCTs that evaluated the comparative effectiveness of different ESAs originators and/or biosimilar.<br>30 eligible studies including 7843 patients with CKD, and 21/30 studies included patients using hemodialysis or peritoneal dialysis. | The considered participants were adults aged 18 years or older with anemia due to CKD (on dialysis or not on dialysis) | | | Compared with ESA biosimilars, epoetin α did not statistically differ for any of the ten measured outcomes.<br>The quality of evidence varied from low to very low. In the comparison between epoetin α vs. darbepoetin α, no differences were observed for all outcomes, but blood transfusions showed favorable results for darbepoetin α: RR 2.18 (1.31-3.62).<br>The quality of evidence varied from low to very low. No differences were observed between epoetin β and methoxy polyethylene glycol-epoetin β, and between darbepoetin α and methoxy polyethylene glycol-epoetin β, the quality of evidence varied from moderate to very low. |
| Cody JD, Hodson EM. | Systematic review of randomised controlled trials | Patients with the anaemia of CKD who | ALL EPO interventions, regardless of dose and mode of delivery | 1. Measures of progression of kidney failure: | There was an improvement in haemoglobin (MD 1.90 gm/L, 95% CI -2.34 |

| Citation | Details of study | Population (n) | Comparators | Outcomes | Main Findings |
|---|---|---|---|---|---|
| Recombinant human erythropoietin versus placebo or no treatment for the anaemia of chronic kidney disease in people not requiring dialysis. Cochrane Database of Systematic Reviews 2016, Issue 1. Art. No.: CD003266.(2) | (RCTs) or quasi-RCTs comparing the use of rHuEPO with no treatment or placebo in predialysis patients. Nineteen studies (enrolling 993 participants) were included. | have not yet commenced dialysis were included. The definitions of anaemia and CKD used by each individual study were accepted. There were no age exclusions | were compared to placebo or no treatment. | time from start of rHuEPO to start of dialysis. numbers starting RRT in each group; glomerular filtration rate (GFR) at the end of the study; change in GFR; serum creatinine at the end of the study and change in creatinine in each group. 2. Measures of correction of anaemia: haemoglobin/haematocrit values; numbers of blood transfusions. 3. Quality of life measures, including changes in exercise capacity. 4. Measures of hypertension: systolic blood pressure; diastolic blood pressure; numbers with an increase or introduction of antihypertensive treatment. 5. Other adverse events: numbers discontinued due to adverse events; access problems for patients commenced on haemodialysis; seizures. 6. Mortality. | to -1.47) and haematocrit (MD 9.85%, 95% CI 8.35 to 11.34) with treatment and a decrease in the number of patients requiring blood transfusions (RR 0.32, 95% CI 0.12 to 0.83). The data from studies reporting quality of life or exercise capacity demonstrated an improvement in the treatment group. Most of the measures of progression of kidney disease showed no statistically significant difference. No significant increase in adverse events was identified. |
| Collister D, Komenda P, Hiebert B, Gunasekara R, Xu Y, Eng F, Lerner B, Macdonald K, Rigatto C, Tangri N. The Effect of Erythropoietin-Stimulating Agents on Health-Related Quality of Life in Anemia of Chronic Kidney Disease: A Systematic Review and Meta-analysis. Ann Intern Med. 2016 Apr | Systematic review of randomized, controlled trials that evaluated the treatment of anemia with ESAs, including erythropoietin and darbepoetin, targeted higher versus lower hemoglobin levels, and used validated HRQOL metrics. 17 Eligible studies were included. | | | Outcome measures were scores on the Short Form-36 Health Survey (SF-36), Kidney Dialysis Questionnaire (KDQ), and other tools. | Of 17 eligible studies, 13 reported SF-36 outcomes and 4 reported KDQ outcomes. Study populations consisted of patients not undergoing dialysis (n = 12), those undergoing dialysis (n = 4), or a mixed sample (n = 1). Only 4 studies had low risk of bias. Pooled analyses showed that higher hemoglobin targets resulted in no statistically or clinically significant differences in SF-36 or KDQ domains. Differences in HRQOL were further attenuated in studies at low risk of bias and in subgroups of dialysis recipients. |

| Citation | Details of study | Population (n) | Comparators | Outcomes | Main Findings |
|---|---|---|---|---|---|
| 5;164(7):472-8. doi: 10.7326/M15-1839. Epub 2016 Feb 16. PMID: 26881842(3) | | | | | |
| Coronado Daza J, Martí-Carvajal AJ, Ariza García A, Rodelo Ceballos J, Yomayusa González N, Páez-Canro C, Loza Munárriz C, Urrútia G. Early versus delayed erythropoietin for the anaemia of end-stage kidney disease. Cochrane Database of Systematic Reviews 2015,(17) | Systematic review of randomised controlled trials (RCTs) and quasi-RCTs evaluating at the clinical benefits and harms of early versus delayed EPO for anaemia in patients with ESKD undergoing haemodialysis or peritoneal dialysis. . | Anaemic in patients with ESKD undergoing haemodialysis or peritoneal dialysis. | Studies comparing EPO with another EPO, placebo or no treatment were eligible for inclusion. | **Primary outcomes**<br>1. All-cause mortality<br>2. Cardiovascular mortality<br>3. Quality of life<br>**Secondary outcomes**<br>1. Adverse events: hypertension<br>2. Myocardial infarction (fatal or non-fatal)<br>3. Stroke (ischaemic or haemorrhagic, either fatal or non-fatal)<br>4. Thrombotic events (deep venous thrombosis, peripheral arterial thrombotic events, and dialysis vascular access thrombosis)<br>5. Blood transfusions requirements<br>6. Haemoglobin level reached at end of study. | No Conclusions could be made as no trials matched the inclusion criteria |
| Hahn D, Esezobor CI, Elserafy N, Webster AC, Hodson EM. Short-acting erythropoiesis-stimulating agents for anaemia in predialysis patients. Cochrane Database of Systematic Reviews 2017(6) | All RCTs and quasi-RCTs (RCTs in which allocation to treatment was obtained by alternation, use of alternate medical records, date of birth or other predictable methods) looking at epoetins (shortacting ESAs) for treatment of anaemia in patients with CKD not on dialysis. | Patients of any age (adults and children) with anaemia due to CKD (stages 2 to 5) of any severity, who were not receiving dialysis, were included. The definitions of CKD and anaemia used in individual studies were used. | Short-acting ESAs including epoetins alpha, beta, delt, epoetin theta and biosimilars of epoetin alpha, epoetin zeta<br>• Short-acting ESAs including epoetins with different routes of administration<br>• Short-acting ESAs including epoetins used at different frequencies of administration<br>• Short-acting ESAs including epoetins used at different doses<br>• Head-to-head comparisons of different short-acting ESAs. | **Primary outcomes**<br>1. Death<br>• All-cause mortality<br>• Mortality due to cardiac disease or cerebrovascular events<br>2. Measures of correction of anaemia<br>• Values of Hb/HCT or change in Hb/HCT at the end of the study<br>3. Quality of life.<br>**Secondary outcomes**<br>1. Hypertension and blood pressure outcomes<br>2. Cardiovascular morbidity<br>3. Cerebrovascular morbidity<br>4. Adverse effects<br>5. Kidney function measures (GFR, serum creatinine (SCr), doubling of SCr) as reported by the authors of primary studies<br>6. Need for iron supplementation. | See detailed description in text |

| Citation | Details of study | Population (n) | Comparators | Outcomes | Main Findings |
|---|---|---|---|---|---|
| Koulouridis I, Alfayez M, Trikalinos TA, Balk EM, Jaber BL. Dose of erythropoiesis-stimulating agents and adverse outcomes in CKD: a metaregression analysis. Am J Kidney Dis. 2013 Jan;61(1):44-56. doi: 10.1053/j.ajkd.2012.07.014. Epub 2012 Aug 22. PMID: 22921639; PMCID: PMC3525813.(11) | Review of published meta-analyses and selected randomized controlled trials assessing the efficacy of ESAs for treatment of anemia in adults with CKD, with minimum 3-month duration. | Adults with Anaemia from Chronic kidney disease. | Epoetin alfa, Epoetin Beta, darbepoetin | All-cause mortality<br>Cardiovascular mortality, cardiovascular events, kidney disease progression or transfusion requirement. | All-cause mortality was associated with higher (per epoetin-alfa–equivalent 10,000-U/wk increment) first-3-month mean ESA dose (incidence rate ratio [IRR], 1.42; 95% CI, 1.10–1.83) and higher total-study-period mean ESA dose (IRR, 1.09; 95% CI, 1.02–1.18).<br>First-3-month ESA dose remained significant after adjusting for first-3-month mean hemoglobin (IRR, 1.48; 95% CI, 1.02- 2.14), as did total-study-period mean ESA dose adjusting for target hemoglobin (IRR, 2 1.41; 95% CI, 1.08–1.82).<br>Parameter estimates between ESA dose and cardiovascular mortality were similar in magnitude and direction but not statistically significant. Higher total-study-period mean ESA dose was also associated with increased rate of hypertension, stroke, and thrombotic events including dialysis vascular access related thrombotic events. |
| Palmer_SC, Saglimbene_V, Mavridis_D, Salanti_G, Craig_JC, Tonelli_M, Wiebe_N, Strippoli_GFM. Erythropoiesis-stimulating agents for anaemia in adults with chronic kidney disease: a network meta-analysis. *Cochrane Database of Systematic Reviews* 2014, Issue 12. Art. No.: CD010590. DOI: 10.1002/14651858.CD010590.pub2.(1) | Systematic Review of Randomised controlled trials (RCTs) that included a comparison of an ESA (epoetin alfa, epoetin beta, darbepoetin alfa, methoxy polyethylene glycol-epoetin beta, or biosimilar ESA) with another ESA, placebo or no treatment in adults with CKD and that reported prespecified patient-relevant outcomes were considered for inclusion.<br><br>Identified 56 eligible studies involving 15,596 adults with CKD. | Studies in adults aged 18 years or older with anaemia due to CKD were included. CKD was characterised by clinically relevant proteinuria, haematuria, and/or structural kidney disease with or without estimated glomerular filtration rate (eGFR) < 60 mL/ min/1.73 mU, recipients of a kidney transplant, and people with Stage 5 CKD treated with dialysis (KDIGO 2013). | ESAs - epoetin alfa, epoetin beta, darbepoetin beta, methoxy polyethylene glycol-epoetin beta, biosimilar administered via any route (IV or SC), compared with each other, placebo or no treatment. Dose adaptation of ESAs and non-randomised iron supplementation depending on haematological response were allowed. We included studies in which iron was administered as a randomised intervention in all arms of the study. | Primary outcomes<br>**Response to treatment**<br>• Preventing blood transfusion<br>Safety<br>• All-cause mortality.<br>**Secondary outcomes**<br>Response to treatment<br>• Fatigue (as defined by study authors)<br>• Dyspnoea (as defined by study authors)<br>• Cardiovascular mortality<br>• Fatal or nonfatal MI<br>• Fatal or nonfatal stroke<br>• Vascular access thrombosis<br>• Major adverse cardiovascular event (as adjudicated by investigators)<br>• End-stage kidney disease (ESKD). | In network analyses, there was moderate to low confidence that epoetin alfa (OR 0.18, 95% CI 0.05 to 0.59), epoetin beta (OR 0.09, 95% CI 0.02 to 0.38), darbepoetin alfa (OR 0.17, 95% CI 0.05 to 0.57), and methoxy polyethylene glycolepoetin beta (OR 0.15, 95% CI 0.03 to 0.70) prevented blood transfusions compared to placebo.<br>The comparative effects of ESAs compared with another ESA, placebo or no treatment on all-cause mortality were imprecise.<br>All proprietary ESAs increased the odds of hypertension compared to placebo (epoetin alfa OR 2.31, 95% CI 1.27 to 4.23; epoetin beta OR 2.57, 95% CI 1.23 to 5.39; darbepoetin alfa OR 1.83, 95% CI 1.05 to 3.21; methoxy polyethylene glycol-epoetin beta OR 1.96, 95% CI 0.98 |

| Citation | Details of study | Population (n) | Comparators | Outcomes | Main Findings |
|---|---|---|---|---|---|
| | | | | | to 3.92).<br>The comparative effects of all ESAs on cardiovascular mortality, myocardial infarction (MI), stroke, and vascular access thrombosis were uncertain and network analyses for major cardiovascular events, end-stage kidney disease (ESKD), fatigue and breathlessness were not possible. |
| Palmer SC, Saglimbene V, Craig JC, Navaneethan SD, Strippoli GFM. Darbepoetin for the anaemia of chronic kidney disease. Cochrane Database of Systematic Reviews. 2014(3). | Systematic review of RCTs and quasi-RCTs of<br>darbepoetin alpha alone or in combination with other nonrandomized co-interventions (e.g., iron supplementation, or red cell transfusion) in individuals with anaemia and CKD (ESA-naïve patients and conversion from other ESAs) were included. The first period of randomised cross-over studies was also considered.<br>Studies were considered without language restriction. Studies were of at least three months in duration. | Individuals with stage 3, 4, and 5 CKD (including patients on dialysis) as defined by the NKF-KDOQI guidelines.<br>* Stage 3: glomerular filtration rate (GFR) 30 to 59 mL/min/1.73 mQ<br>* Stage 4: GFR 16 to 29 mL/min/1.73 mQ<br>* Stage 5: GFR < 15 mL/min/1.73 mQ<br>* Stage 5D: GFR < 15 mL/min/1.73 mQ (treated with dialysis)<br>• Kidney transplant recipients<br>• Adults and children | Studies of darbepoetin alfa by any route (SC or IV) or dose,<br>compared with epoetin alfa or beta, methoxy polyethylene glycolepoetin beta, placebo, or no treatment were included. | The following parameters were analysed for each planned treatment comparison.<br>* Number of individuals achieving the recommended Hb levels during the study period<br>• Progression of CKD in patients not yet requiring renal replacement therapy (RRT: haemodialysis, peritoneal dialysis or kidney transplantation).<br>• Clinical outcomes including cardiovascular events, Hospital admissions, Cardiovascular mortality, All-cause mortality, Vascular access thrombosis, Cancer: onset of new documented cancer, or as defined by the investigators<br>• Quality of life | See individual summaries in text |
| Saglimbene VM, Palmer SC, Ruospo M, Natale P, Craig JC, Strippoli GF. Continuous erythropoiesis receptor activator (CERA) for the anaemia of chronic kidney disease. Cochrane Database Syst Rev. 2017;8(8):Cd009904.(7) | All RCTs and quasi-RCTs (RCTs looking at CERA alone or in combination with other non-randomised co-interventions (such as iron supplementation or red cell transfusion) in were included. Studies of at least three months' follow-up duration were included. | People with CKD (any stage) and anaemia | CERA versus placebo or no treatment<br>• CERA versus darbepoetin alfa<br>• CERA versus epoetin alfa or beta<br>• CERA versus CERA with diLering strategies for administration<br>(For example: higher versus lower doses; IV versus SC administration; longer versus shorter dosing intervals; higher versus lower target haemoglobin levels). | **Primary outcomes**<br>• Clinical outcomes<br>• Quality of life<br>• Adverse events<br>**Secondary outcomes**<br>• Achieving and maintaining haemoglobin levels/iron status | There was low certainty evidence that CERA had little or no effects on mortality (RR 1.07, 95% CI 0.73 to 1.57; RR 1.11, 95% CI 0.75 to 1.65), major adverse cardiovascular events (RR 5.09, 95% CI 0.25 to 105.23; RR 5.56, 95% CI 0.99 to 31.30), hypertension (RR 1.01, 95% CI 0.75 to 1.37; RR 1.00, 95% CI 0.79 to 1.28), need for blood transfusion (RR 1.02, 95% CI 0.72 to 1.46; RR 0.94, 95% CI 0.55 to 1.61), or additional iron therapy (RR 1.03, 95% CI 0.91 to 1.15; RR 0.99, 95% CI 0.95 to 1.03) compared to epoetin alfa/beta or darbepoetin alfa respectively. |

| Citation | Details of study | Population (n) | Comparators | Outcomes | Main Findings |
|---|---|---|---|---|---|
| | | | | | There was insufficient evidence to compare the effect of CERA to placebo on clinical outcomes. Only one low quality study reported that CERA compared to placebo might lead to little or no difference in the risk of major cardiovascular events (RR 2.97, 95% CI 0.31 to 28.18)<br>and hypertension ((RR 0.73, 95% CI 0.35 to 1.52). There was low certainty evidence that different doses (higher versus lower) or frequency (twice versus once monthly) of CERA administration had little or no different effect on all-cause mortality (RR 3.95, 95% CI 0.17 to 91.61; RR 0.97, 95% CI 0.56 to 1.66), hypertension (RR 0.45, 95% CI 0.08 to 2.52; RR 0.85, 95% CI 0.60 to 1.21), and blood cell transfusions (RR 4.16, 95% CI 0.89 to 19.53; RR 0.91, 95% CI 0.51 to 1.62).<br>No studies reported comparative treatment effects of different ESAs on health-related quality of life. |

## APPENDIX 3: SUMMARY OF INTERNATIONAL GUIDANCE ON THE USE OF ESAS IN CHRONIC RENAL DISEASE

| Guidelines | Source of information for recommendations | AGREE II Assessment | Recommendation for ESA Choice | Recommendations in relation to ESAs |
|---|---|---|---|---|
| KIDIGO Clinical practice Guideline for Anaemia in chronic kidney disease. (12) | Systematic review of specifically identified topics, using POCO methodology with the application of the GRADE system of evidence and evaluation of overall study quality.<br>The COGS Checklist was used to evaluate the final reporting of the Guideline | Overall score of 6 – high quality systematic reviews, evidence grading, and declarations of interest. Largely physicians on the working group and little attention to patient preferences. | 3.11.1: We recommend choosing an ESA based on the balance of pharmacodynamics, safety information, clinical outcome data, costs, and availability. (1D)<br>3.11.2: We suggest using only ESAs that have been approved by an independent regulatory agency. Specifically, for 'copy' versions of ESAs, true biosimilar products should be used. (2D) | At present, there is no evidence that any given ESA brand is superior to another in terms of patient outcomes, with the historical exception of the temporary increase in the incidence of antibody-mediated pure red cell aplasia (PRCA) about 10–20 years ago, which was associated with SC administration of an epoetin-alfa formulation available in Europe, but not in the United States. It is the considered opinion of the Work Group that the likelihood of differences in clinical outcomes among ESA brands is low, although there is no robust evidence supporting this assumption. |
| National Clinical Guideline Centre, United Kingdom. Final version, June 2015<br>Anaemia Management in Chronic Kidney Disease<br>Partial update 2015. (13) | Followed the NICE methodology – systematic reviews for selected clinical issues – some recommendations were not updated as a result and still reference the previous updates in 2006 and 2009. | Overall score of 6 – high quality systematic revies addressing specific questions. Lower score on editorial independence and Applicability | The GDG agreed that the evidence statements from the multisite RCT support the summary that there is no difference between darbepoetin and epoetin alfa for the outcomes measured, in a selected group of patients who were stable<br>Evidence statements on efficacy suggest that both darbepoetin and epoetin beta effectively maintain target haemoglobin levels. ESAs are made available to NHS trusts through a system of tendering for local supply contracts. Costs therefore vary between locations and over time. The recommendation 10 below outlines the considerations in agreeing on a first choice ESA rather than specifying a particular 11 agent for all patients. This is intended to allow flexibility for local units over the lifetime of the 12 guidelines while providing useful advice in selecting the best treatment for the patient. | The recommendations were still based on the original reviews from 2006 (not repeated in this update of the guideline) – Update evidence reviews focused on optimizing iron doses in renal patients and some other questions which address the clinical management of the disease, rather than the clinical comparative efficacy of the ESAs. |
| The Renal Association: Clinical Practice Guideline Anaemia of Chronic Kidney Disease<br>Updated: February 2020(15) | Systematic reviews of evidence for specific issues as well as reference to existing guidelines (NICE, KDIGO, KDOQI, ERBP) | Overall score of 5. Valid methodology but lacking in consideration of patient preferences, and some declaration of interests issues. Includes auditing measures | Guideline 3.1 - Treatment of Anaemia - Erythropoiesis Stimulating Agents<br>We recommend that treatment with Erythropoiesis Stimulating Agents (ESAs) should be offered to patients with anaemia of CKD who are likely to benefit in terms of quality of life and physical function and to avoid blood transfusion; especially in patients considered suitable for transplantation. (1B)<br>Guideline 3.2 - Treatment of Anaemia - Choice of ESA<br>We recommend that the decision on the choice of ESA is based on local availability of ESAs. (1B) | No differentiation between agents – choice based on local availability. |
| Anaemia management in patients with chronic | Not clear – reads like a narrative review | Overall score of 2 because of low quality | Use new EPOS as other rHuEPOs<br>CERA Starting dose: 0.6 µg/kg | There is no preference given to any specific ESA – dosing is per recommended use and IV versus SC not differentiated |

| Guidelines | Source of information for recommendations | AGREE II Assessment | Recommendation for ESA Choice | Recommendations in relation to ESAs |
|---|---|---|---|---|
| kidney disease: a position statement by the Anaemia Working Group of European Renal Best Practice (ERBP) – 2009 update(18) | | of evidence reporting and translation of evidence into recommendation framework | Frequency: once every 2 weeks for correction; once every 4 weeks for maintenance Administration route: i.v. or s.c. Biosimilars Use as originator compounds, strict post marketing surveillance, only IV administration biosimilars and Epoetin zeta<br>– – Use as epoetin alpha; strict post-marketing surveillance<br>CKD patients with cancer– – Use caution; do not aim for Hb >12 g/dl | |
| Canadian Society of Nephrology - Clinical Practice Guidelines for evidence-based use of erythropoietic-stimulating agents 2008(16) | Not clear - narrative | | | |

## APPENDIX 4: EVIDENCE TO DECISION FRAMEWORK

| | JUDGEMENT | EVIDENCE & ADDITIONAL CONSIDERATIONS |
|---|---|---|
| QUALITY OF EVIDENCE OF BENEFIT | **What is the certainty/quality of evidence?**<br>High: [ ] Moderate: [X] Low: [ ] Very low: [ ]<br>*High quality:* confident in the evidence<br>*Moderate quality:* mostly confident, but further research may change the effect<br>*Low quality:* some confidence, further research likely to change the effect<br>*Very low quality:* findings indicate uncertain effect | All ESAs have demonstrated moderate certainty evidence of benefit in increasing Hb levels, and reducing the need for blood transfusions versus placebo, however there is little evidence of differences between the different ESAs. Impacts on quality of life are uncertain, even versus placebo.<br><br>Versus placebo or no treatment, haemoglobin increased, mean difference 1.90 g/dL, 95% CI 1.47 to 2.34: I2 =30%. Reduction in transfusions needed placebo was relatively consistent, however estimates vary, for recombinant erythropoietins where relative risk was lower than placebo by about 70% (3 studies, 111 participants): RR 0.32, 95% CI 0.12 to 0.83; I2 = 0%), to darbepoetin alfa versus versus placebo- 40% reduction in need for one or more blood transfusions (RR 0.60, 95% CI 0.53 to 0.69). |
| EVIDENCE OF BENEFIT | **What is the size of the effect for beneficial outcomes?**<br>Large: [ ] Moderate: [ ] Small: [ ] None: [X] | Very little difference was noted between the different ESAs, when compared to placebo.<br><br>Studies have indicated at least an increase of 1g/dl improvement versus placebo. No notable differences in Hb improvements between the difference active treatments. Blood transfusions were reduced by up to 70% versus placebo in the largest meta-anaysis in this review. |
| QUALITY OF EVIDENCE OF HARM | **What is the certainty/quality of evidence?**<br>High: [ ] Moderate: [ ] Low: [X] Very low: [ ]<br>*High quality:* confident in the evidence<br>*Moderate quality:* mostly confident, but further research may change the effect<br>*Low quality:* some confidence, further research likely to change the effect<br>*Very low quality:* findings indicate uncertain effect | The evidence is relatively weak. Grade Assessments were performed in most of the Systematic reviews, the confidence in the evidence evidence was low to very low,<br><br>Evidence for negative cardiovascular outcomes of one ESA versus the others is very weak, with little demonstrable differences between agents and different dosing regimens of the same agents. No significant differences reported for hypertension development between agents. Increase in all-cause mortality has been reported versus placebo, however this seems to be related more to higher initial doses of ESAs, than any particular ESA |
| EVIDENCE OF HARMS | **What is the size of the effect for harmful outcomes?**<br>Large: [ ] Moderate: [ ] Small: [ ] None: [X] | The risk of cardiovascular events and all-cause mortality among the various formulations of ESAs (compared to placebo) including the ones dosed less frequently, appears to be comparable, although the confidence in the information is very low. In comparison to each other, ESAs appear to have no significant risks above others, although confidence intervals were wide. |
| BENEFITS & HARMS | **Do the desirable effects outweigh the undesirable harms?**<br>Favour's intervention: [ ] Favour's control: [ ] Intervention = Control *or* Uncertain: [X] | ESA agents have similar effects when compared to placebo |
| THERAPEUTIC INTERCHANGE | Therapeutic alternatives available:<br>Yes: [x] No: [ ] | Epoetin alfa and Epoetin beta; methoxy polyethylene glycol epoetin beta and Darbepoetin alfa<br><br>Specific exclusion from the group: None |
| FEASABILITY | **Is implementation of this recommendation feasible?**<br>Yes: [x] No: [ ] Uncertain: [ ] | Epoetin is already being provided to dialysis patients as part of the Standard Treatment Guidelines – issues have been experienced with availability of the products on tender, hence the request for a class review. |
| RESOURCE USE | **How large are the resource requirements?**<br>More intensive: [ ] Less intensive: [ ] Uncertain: [X]<br>**Note:** This judgement is for the current indication of anaemia of CKD in dialysed patients only | **Price of medicines:**<br>**Medicine** / **SEP (ZAR)** / **Contract price**<br>Epoetin alfa, 6000IU injection: R452.78: N/A<br>Epoetin alfa, 4000IU injection: R308.16: N/A<br>Epoetin alfa, 2000IU injection: R159.79: NA<br>Epoetin beta, 6000IU injection: R509.26: NA<br>Epoetin beta, 4000IU injection: R346.67: NA<br>Epoetin beta, 2000IU injection: R173.35: R50.32 |

| | JUDGEMENT | EVIDENCE & ADDITIONAL CONSIDERATIONS |
|---|---|---|

| | | | |
|---|---|---|---|
| Darbepoetin alfa 10mcg prefilled syringe | R195.57 | NA |
| Darbepoetin alfa 20mcg prefilled syringe | R391.14 | NA |
| Darbepoetin alfa 30mcg prefilled syringe | R586.71 | NA |
| Darbepoetin alfa 60mcg prefilled syringe | R1173.44 | NA |
| Darbepoetin alfa 150mcg prefilled syringe | R2933.54 | NA |
| Darbepoetin alfa 300mcg prefilled syringe | R5867.07 | NA |
| Methoxy polyethylene glycol epoetin beta, 50mcg prefilled syringe | R1255.07 | NA |
| Methoxy polyethylene glycol epoetin beta, 75mcg prefilled syringe | R1882.61 | NA |
| Methoxy polyethylene glycol epoetin beta, 100mcg prefilled syringe | R1902.53 | NA |
| Methoxy polyethylene glycol epoetin beta, 120mcg prefilled syringe | R3012.18 | NA |
| Methoxy polyethylene glycol epoetin beta, 150mcg prefilled syringe | R3765.22 | NA |
| Methoxy polyethylene glycol epoetin beta, 200mcg prefilled syringe | R3805.05 | NA |
| Methoxy polyethylene glycol epoetin beta, 250mcg prefilled syringe | R3805.05 | NA |
| Methoxy polyethylene glycol epoetin beta, 360mcg prefilled syringe | R5752.42 | NA |

*SEP database, 24 December 2021

Rough Estimates at recommended initiation doses (70kg patient, at starting doses
**NOTE – two products are already on national tender and available at prices substantially less than SEP**

| Medicine | Price (ZAR) |
|---|---|
| Epoetin alfa - 3500IU 3x a week (10 500) | R3 234 per month SEP |
| Epoetin beta, 1400IU 3x a week (SC) (4200); 2800IU 3x a week (IV) (8400) | R2 912.06 per month SEP |
| | R1 056.72 per month tender (only 2000IU of epo beta available) |
| Methoxy polyethylene glycol epoetin beta, 42 mcg every second week | R2 108 per month SEP |
| Darbepoetin alfa 0.45mcg/ kg weekly (31.5) | R 2 464.18 per month SEP |

**VALUES, PREFERENCES, ACCEPTABILITY**

**Is there important uncertainty or variability about how much people value the options?**

| Minor | Major | Uncertain |
|---|---|---|
| X | | |

**Is the option acceptable to key stakeholders?**

| Yes | No | Uncertain |
|---|---|---|
| X | | |

Already available on tender and in use in units – so acceptable.

Subcutaneous and intravenous administration were examined in the trials, with few differences between these routes of administration.

**EQUITY**

**Would there be an impact on health inequity?**

| Yes | No | Uncertain |
|---|---|---|
| | X | |

Unlikely to have an impact on equity, if available at secondary level.

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