SUMMARY OF 2017 KDIGO CKD-MBD GUIDELINE RECOMMENDATIONS

The Kidney Disease: Improving Global Outcomes (KDIGO) 2017 Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease-Mineral and Bone Disorder (CKD-MBD) represents a selective update of the prior CKD-MBD Guideline published in 2009. Topic areas encompassing updated recommendations include: diagnosis of bone abnormalities in CKD-MBD; treatment of CKD-MBD by targeting phosphate lowering and calcium maintenance; treatment of abnormalities in PTH in CKD-MBD; treatment of bone abnormalities by antiresorptives and other osteoporosis therapies; and evaluation and treatment of kidney transplant bone disease.

NOTE: The 2009 CKD-MBD Guideline Chapters 1 and 2 provide the Introduction and Methodological Approach, respectively; therefore, guideline recommendations begin from Chapter 3.1. **Updated Recommendations are Denoted in Boxes.**

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CHAPTER 3.1: DIAGNOSIS OF CKD-MBD: BIOCHEMICAL ABNORMALITIES

3.1.1: We recommend monitoring serum levels of calcium, phosphate, PTH, and alkaline phosphatase activity beginning in CKD G3a *(1C)*. In children, we suggest such monitoring beginning in CKD G2 *(2D)*.

3.1.2: In patients with CKD G3a-G5D, it is reasonable to base the frequency of monitoring serum calcium, phosphate, and PTH on the presence and magnitude of abnormalities, and the rate of progression of CKD *(Not Graded)*.

Reasonable monitoring intervals would be:

- In CKD G3a-G3b: for serum calcium and phosphate, every 6-12 months; and for PTH, based on baseline level and CKD progression.
- In CKD G4: for serum calcium and phosphate, every 3-6 months; and for PTH, every 6-12 months.
- In CKD G5, including G5D: for serum calcium and phosphate, every 1-3 months; and for PTH, every 3-6 months.
- In CKD G4-G5D: for alkaline phosphatase activity, every 12 months, or more frequently in the presence of elevated PTH (see Chapter 3.2).

In CKD patients receiving treatments for CKD-MBD, or in whom biochemical abnormalities are identified, it is reasonable to increase the frequency of measurements to monitor for trends and treatment efficacy and side-effects *(Not Graded)*.

3.1.3: In patients with CKD G3a-G5D, we suggest that 25(OH)D (calcidiol) levels might be measured, and repeated testing determined by baseline values and therapeutic interventions (2C). We suggest that vitamin D deficiency and insufficiency be corrected using treatment strategies recommended for the general population *(2C)*.

3.1.4: In patients with CKD G3a-G5D, we recommend that therapeutic decisions be based on trends rather than on a single laboratory value, taking into account all available CKD-MBD assessments *(1C)*.

3.1.5: In patients with CKD G3a-G5D, we suggest that individual values of serum calcium and phosphate, evaluated together, be used to guide clinical practice rather than the mathematical construct of calcium-phosphate product (Ca × P) *(2D)*.

3.1.6: In reports of laboratory tests for patients with CKD G3a-G5D, we recommend that clinical laboratories inform clinicians of the actual assay method in use and report any change in methods, sample source (plasma or serum), and handling specifications to facilitate the appropriate interpretation of biochemistry data *(1B)*.

CHAPTER 3.2: DIAGNOSIS OF CKD-MBD: BONE

3.2.1: In patients with CKD G3a-G5D with evidence of CKD-MBD and/or risk factors for osteoporosis, we suggest BMD testing to assess fracture risk if results will impact treatment decisions *(2B)*.

3.2.2: In patients with CKD G3a-G5D, it is reasonable to perform a bone biopsy if knowledge of the type of renal osteodystrophy will impact treatment decisions *(Not Graded)*.

3.2.3: In patients with CKD G3a-G5D, we suggest that measurements of serum PTH or bone-specific alkaline phosphatase can be used to evaluate bone disease because markedly high or low values predict underlying bone turnover *(2B)*.

3.2.4: In patients with CKD G3a-G5D, we suggest not to routinely measure bone-derived turnover markers of collagen synthesis (such as procollagen type I C-terminal propeptide) and breakdown (such as type I collagen cross-linked telopeptide, cross-laps, pyridinoline, or deoxypyridinoline) *(2C)*.

3.2.5: We recommend that infants with CKD G2-G5D have their length measured at least quarterly, while children with CKD G2-G5D should be assessed for linear growth at least annually *(1B)*.

CHAPTER 3.3: DIAGNOSIS OF CKD-MBD: VASCULAR CALCIFICATION

3.3.1: In patients with CKD G3a-G5D, we suggest that a lateral abdominal radiograph can be used to detect the presence or absence of vascular calcification, and an echocardiogram can be used to detect the presence or absence of valvular calcification, as reasonable alternatives to computed tomography-based imaging *(2C)*.

3.3.2: We suggest that patients with CKD G3a-G5D with known vascular/valvular calcification be considered at highest cardiovascular risk *(2A)*. It is reasonable to use this information to guide the management of CKD-MBD *(Not Graded)*.

CHAPTER 4.1: TREATMENT OF CKD-MBD TARGETED AT LOWERING HIGH SERUM PHOSPHATE AND MAINTAINING SERUM CALCIUM

4.1.1: In patients with CKD G3a-G5D, treatments of CKD-MBD should be based on serial assessments of phosphate, calcium and PTH levels, considered together *(Not Graded)*.

4.1.2: In patients with CKD G3a-G5D, we suggest lowering elevated phosphate levels towards the normal range *(2C)*.

4.1.3: In adult patients with CKD G3a-G5D, we suggest avoiding hypercalcemia *(2C)*. In children with CKD G3a-G5D, we suggest maintaining serum calcium in the age-appropriate normal range *(2C)*.

4.1.4: In patients with CKD G5D, we suggest using a dialysate calcium concentration between 1.25 and 1.50 mmol/l (2.5 and 3.0 mEq/l) *(2C)*.

4.1.5: In patients with CKD G3a-G5D, decisions about phosphate-lowering treatment should be based on progressively or persistently elevated serum phosphate *(Not Graded)*.

4.1.6: In adult patients with CKD G3a-G5D receiving phosphate-lowering treatment, we suggest restricting the dose of calcium-based phosphate binders *(2B)*. In children with CKD G3a-G5D, it is reasonable to base the choice of phosphate-lowering treatment on serum calcium levels *(Not Graded)*.

4.1.7: In patients with CKD G3a-G5D, we recommend avoiding the long-term use of aluminum-containing phosphate binders and, in patients with CKD G5D, avoiding dialysate aluminum contamination to prevent aluminum intoxication *(1C)*.

4.1.8: In patients with CKD G3a-G5D, we suggest limiting dietary phosphate intake in the treatment of hyperphosphatemia alone or in combination with other treatments *(2D)*. It is reasonable to consider phosphate source (e.g., animal, vegetable, additives) in making dietary recommendations *(Not Graded)*.

4.1.9: In patients with CKD G5D, we suggest increasing dialytic phosphate removal in the treatment of persistent hyperphosphatemia *(2C)*.

CHAPTER 4.2: TREATMENT OF ABNORMAL PTH LEVELS IN CKD-MBD

4.2.1: In patients with CKD G3a-G5 not on dialysis, the optimal PTH level is not known. However, we suggest that patients with levels of intact PTH progressively rising or persistently above the upper normal limit for the assay be evaluated for modifiable factors, including hyperphosphatemia, hypocalcemia, high phosphate intake, and vitamin D deficiency *(2C)*.

4.2.2: In adult patients with CKD G3a-G5 not on dialysis, we suggest calcitriol and vitamin D analogs not be routinely used *(2C)*. It is reasonable to reserve the use of calcitriol and vitamin D analogs for patients with CKD G4-G5 with severe and progressive hyperparathyroidism *(Not Graded)*.

In children, calcitriol and vitamin D analogs may be considered to maintain serum calcium levels in the age-appropriate normal range *(Not Graded)*.

4.2.3: In patients with CKD G5D, we suggest maintaining intact PTH levels in the range of approximately two to nine times the upper normal limit for the assay *(2C)*.

We suggest that marked changes in PTH levels in either direction within this range prompt an initiation or change in therapy to avoid progression to levels outside of this range *(2C)*.

4.2.4: In patients with CKD G5D requiring PTH-lowering therapy, we suggest calcimimetics, calcitriol, or vitamin D analogs, or a combination of calcimimetics with calcitriol or vitamin D analogs *(2B)*.

4.2.5: In patients with CKD G3a-G5D with severe hyperparathyroidism who fail to respond to medical or pharmacological therapy, we suggest parathyroidectomy *(2B)*.

CHAPTER 4.3: TREATMENT OF BONE WITH BISPHOSPHONATES, OTHER OSTEOPOROSIS MEDICATIONS, AND GROWTH HORMONE

4.3.1: In patients with CKD G1-G2 with osteoporosis and/or high risk of fracture, as identified by World Health Organization criteria, we recommend management as for the general population *(1A)*.

4.3.2: In patients with CKD G3a-G3b with PTH in the normal range and osteoporosis and/or high risk of fracture, as identified by World Health Organization criteria, we suggest treatment as for the general population *(2B)*.

4.3.3: In patients with CKD G3a-G5D with biochemical abnormalities of CKD-MBD and low BMD and/or fragility fractures, we suggest that treatment choices take into account the magnitude and reversibility of the biochemical abnormalities and the progression of CKD, with consideration of a bone biopsy *(2D)*.

4.3.4: In children and adolescents with CKD G2-G5D and related height deficits, we recommend treatment with recombinant human growth hormone when additional growth is desired, after first addressing malnutrition and biochemical abnormalities of CKD-MBD *(1A)*.

CHAPTER 5: EVALUATION AND TREATMENT OF KIDNEY TRANSPLANT BONE DISEASE

5.1: In patients in the immediate post-kidney-transplant period, we recommend measuring serum calcium and phosphate at least weekly, until stable *(1B)*.

5.2: In patients after the immediate post-kidney-transplant period, it is reasonable to base the frequency of monitoring serum calcium, phosphate, and PTH on the presence and magnitude of abnormalities, and the rate of progression of CKD *(Not Graded)*.

Reasonable monitoring intervals would be:

- In CKD G1T-G3bT, for serum calcium and phosphate, every 6-12 months; and for PTH, once, with subsequent intervals depending on baseline level and CKD progression.
- In CKD G4T, for serum calcium and phosphate, every 3-6 months; and for PTH, every 6-12 months.
- In CKD G5T, for serum calcium and phosphate, every 1-3 months; and for PTH, every 3-6 months.
- In CKD G3aT-G5T, measurement of alkaline phosphatases annually, or more frequently in the presence of elevated PTH (see Chapter 3.2).

In CKD patients receiving treatments for CKD-MBD, or in whom biochemical abnormalities are identified, it is reasonable to increase the frequency of measurements to monitor for efficacy and side-effects *(Not Graded)*.

It is reasonable to manage these abnormalities as for patients with CKD G3a-G5 *(Not Graded)* (see Chapters 4.1 and 4.2).

5.3: In patients with CKD G1T-G5T, we suggest that 25(OH)D (calcidiol) levels might be measured, and repeated testing determined by baseline values and interventions *(2C)*.

5.4: In patients with CKD G1T-G5T, we suggest that vitamin D deficiency and insufficiency be corrected using treatment strategies recommended for the general population *(2C)*.

5.5: In patients with CKD G1T-G5T with risk factors for osteoporosis, we suggest that BMD testing be used to assess fracture risk if results will alter therapy *(2C)*.

5.6: In patients in the first 12 months after kidney transplant with an estimated glomerular filtration rate greater than approximately 30 ml/min per 1.73 m^2 and low BMD, we suggest that treatment with vitamin D, calcitriol/alfacalcidol, and/or antiresorptive agents be considered *(2D)*.

- We suggest that treatment choices be influenced by the presence of CKD-MBD, as indicated by abnormal levels of calcium, phosphate, PTH, alkaline phosphatases, and 25(OH)D *(2C)*.
- It is reasonable to consider a bone biopsy to guide treatment *(Not Graded)*.

There are insufficient data to guide treatment after the first 12 months.

5.7: In patients with CKD G4T-G5T with known low BMD, we suggest management as for patients with CKD G4-G5 not on dialysis, as detailed in Chapters 4.1 and 4.2 *(2C)*.