# Micronutrients of Concern: During CKD and After Transplant

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## Goals and Objectives

By the end of this presentation, the audience will:

- Review micronutrients of concern in pediatric CKD
- Understand the complications of the common micronutrient disturbances before and after transplant.
- Identify which micronutrients (including V/M/TE) that are impacted in pediatric patients after renal transplantation.
- Develop recommendations for pediatric renal patients as it pertains to correcting vitamin and mineral abnormalities pre and post transplant.

## Covered Topics (1-6)

| Topics To Be Discussed | Topics NOT being covered |
|---|---|
| Fat-Soluble Vitamins (A,D,K) | The effects of dialysis on V/M. Will focus on stages of CKD and after Transplant! |
| Water Soluble Vitamins (thiamine B1, pyridoxine B6, cobalamin B12, folate, C) | |
| Minerals (Phos, Mg, K+) | Carnitine, Iron |
| Certain trace elements (Se, Cu, Zn) | Not ALL trace elements, metals (Al, Fl, Cl, Su) |

## Case Patient AB

A 24 month old female (AB) is admitted under the Pediatric Nephrology service with a BUN of 32 and Cr of 2.3 . AB's weight has declined by several percentiles coupled with a plateau in linear growth. BMI Z-score on admission was -3.4. The team placed a nutrition consult for failure to thrive. Upon talking with mom, you estimate that AB has likely been consuming <<25% of her nutrition needs over the past 2-3 weeks given on and off diarrhea and poor appetite.

In this case, what micronutrients would you be concerned about??



B1 (2, 7-11), Zinc (12-15), K+, Mg (16-17), Phos (16) (RFS)

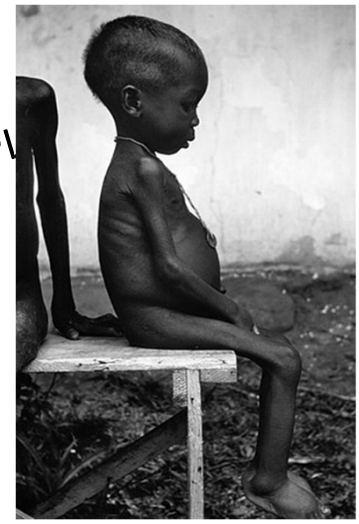
# Thiamine (B1) in CKD - Low

**Reason:** Underlying malnutrition- starved patients, ↓regulation of transporters?

**Research:** ↓GFR = ↓B vitamin intake
(n 202) 60% pts had << intakes
Need supplementation, especially in RRT



**Recommendation:** Renal MVI, nutrition supplementation



Picture: https://en.wikipedia.org/wiki/Kwashiorkor

# Zinc in CKD – Low or Normal

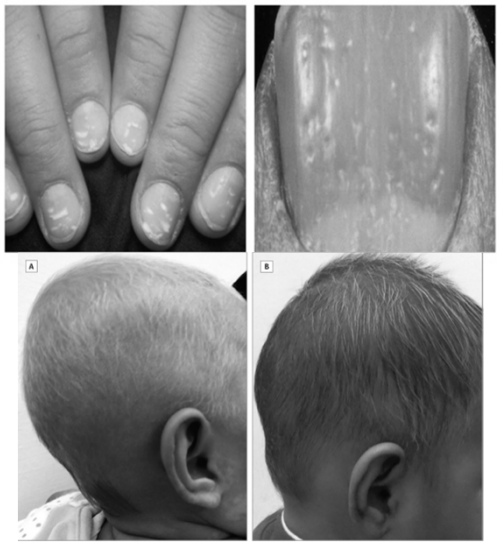
**Reasons**: associated with poor growth, diarrhea, +losses in dialysis

**Research:** (ped n 200)
No difference in CKD v controls
CKD >> HD/PD
(n 45) 43% deficient



**Recommendations:**

Dialysis- check TE 1-2x/yr, supplement if deficiency is identified



Picture: http://kinghealthylife.com/index.php/2017/06/22/eat-foods-fight-zinc-deficiency/

## K+, Mg, Phos in CKD – High or Normal

**Reason:** poor excretion

Δ in Mg seen in late CKD (dialysis)

**Research:**

Well described

**Recommendations:**

Diet restriction

Formula manipulation

Decant formula

Phos binders




Picture: https://www.pharmapacks.com/products.php?product=Similac-PM-60%7B47%7D40-Low%252dIron-Infant-Formula-Powder-14.10-oz

## Case Patient AB

As the dietitian, you realize AB would benefit from tube feeding. Given the likelihood of dialysis and long term nutrition support needed, AB goes to the OR for a G-tube. In the coming days after surgery, the team is concerned that the G-tube site is leaking without any significant signs of healing.

In this case, what micronutrient(s) would you be concerned about??



Vitamin C (2-18-22), Vitamin K (23-25)
Zinc

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# Vitamin C in CKD- Low

**Reason:**

- seen in late CKD stages, lost in dialysis especially
- Poor intakes

**Research:** (n 58)

- as GFR ↓, plasma Vit C ↓
- Scurvy rarely reported

**Recommendations:**

- +Renal multivitamin
- **DO NOT over supplement** -> +oxalate -> kidney stones



Picture: http://pediatrics.aappublications.org/content/108/3/e55

# Vitamin K in CKD – Normal (at risk)

**Reason:**

- At risk with antibiotic use
- ↓intakes
- Uremia

**Research: (n 172)**

- >50% w/ low intakes
- Only 6% had insufficiency

**Recommendations:**

- Be aware of Vit K w/ hx of diarrhea and presence of poor healing




https://www.stylecraze.com/articles/top-10-vitamin-k-rich-foods/

## Case Patient AB

The team is thinking about starting dialysis on AB; however, in the meantime, the team asks you to develop a formula recipe that provides 120cal/kg, 3g protein/kg, 2mEq K+/kg in 70mL/kg volume. You decide the best and easiest solution is to provide full strength Suplena.



Over time, mom is concerned AB has become less willing to walk and cries when you try to get her to bear weight. Upon checking a BMP, you see her calcium levels are elevated at 11.5mg/dL.

## In this case, what micronutrient(s) would you be concerned about??

# Vitamin A[26-28], Vitamin D[28-32]

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## Vitamin A in CKD - high

**Reason:**

- poor excretion of retinol and RBP
- For every 10mL/min/1.73m2 decrease in GFR there is a 13% increase in retinol -> hypercalcemia

**Research:**

- Ped study (n 105) - 77% ↑ retinol levels

**Recommendations:**

- Renal multivitamin (no Vit A)
- Look at the A content of formula!
  - FS Suplena = 560mcg A (>>RDA 300mcg)

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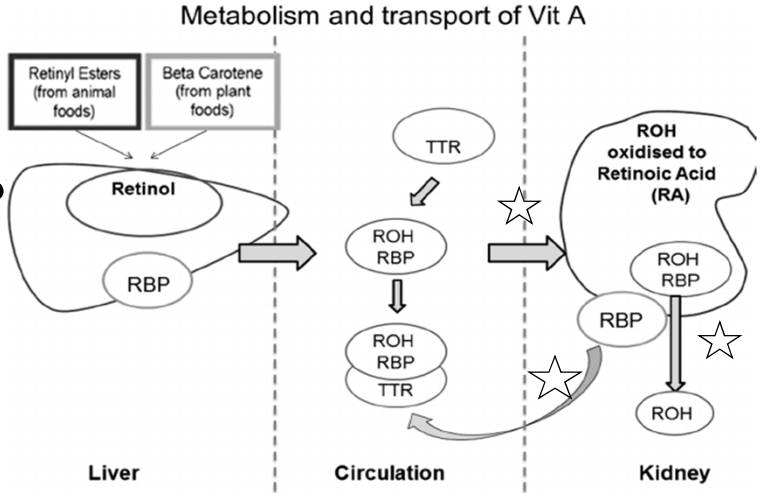


# Vitamin D in CKD – Low or Normal

**Reason:**

- ↓ activation of Vitamin D in the kidney
  - ↑ FGF 23 = ↓ activation of 25 -> 1, 25
- ↓ dietary intakes

**Research:**

- 40-77% in CKD population
- Ped study (n 167) – 23% deficient CKD 3-4, 51% in CKD 5+

**Recommendations:**

- KDOQI Guidelines



# KDOQI Guidelines for serum levels

**Table 15. Recommended Supplementation for Vitamin D Deficiency/Insufficiency in Patients with CKD Stages 3-4**

| Serum 25(OH)D (ng/mL) | Definition | Ergocalciferol Dose (Vitamin $D_2$) | Duration (months) | Comment |
|---|---|---|---|---|
| <5 | Severe vitamin D deficiency | 8,000 IU/day orally x 4 weeks or, (50,000 IU per week X 4 weeks); then 4,000 IU/day or, (50,000 IU 2X per month for 2 months) X 2 months | 3 months | Measure 25(OH)D levels after 3 months |
| 5-15 | Mild vitamin D deficiency | 4,000 IU/day orally x 12 weeks or, (50,000 IU every other week, for 12 weeks) | 3 months | Measure 25(OH)D levels after 3 months |
| 16-30 | Vitamin D insufficiency | 2,000 IU daily or, (50,000 IU every 4 weeks) | 3 months | Measure 25(OH)D levels after 3 months |

## Case Patient AB

AB returns for a follow-up visit and mom is complaining her daughter is feeling lethargic and is sleeping longer than her usual 10 hours at night and is needing more frequent naps. The team draws a CBC with concerns for anemia.



## In this case, what micronutrient(s) would you be concerned about??

Vitamin B6 (2,11, 33-34)

B12 (2,11,33,36-37), Folate (2,11,33, 39-41)

Copper (12,15,42), Vitamin K



## B6, B12, Folate in CKD – low or normal

**Reason:**

- ↓GFR = ↓B vitamin intake
- inflammation

**Research:** n 202

B6: 40-45% ↓intakes

B12: 45% ↓intakes

Folate: 70-75% ↓intakes

**Recommendations:**

Renal multivitamin to meet RDA's

Helpful in ↓homocysteine levels!

## Copper in CKD – low or normal

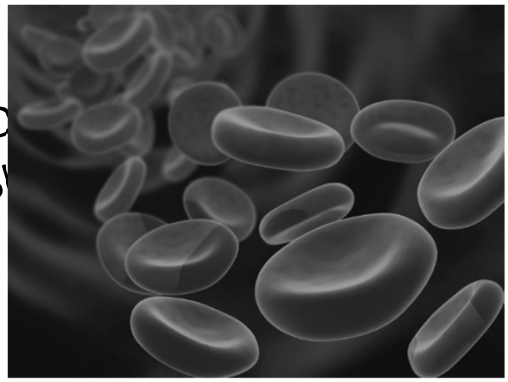
**Reason:** +losses in dialysis

**Research:**

- Ped study: no difference in CKD v. controls
  - HD patients >> losses

**Recommendations:**

- Check level if concerned for deficiency, supplement as needed





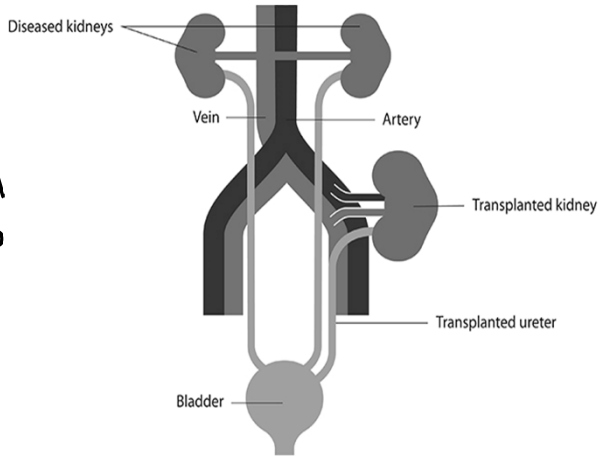
## Case Patient AB

AB has now been on dialysis for several weeks and a living donor has been identified. The team is working to arrange her living donor kidney transplant. Knowing that AB has had complications with micronutrients, mom wants to talk to you about what to expect when she gets her functioning graft.

## Nutrition Implications After TRX (43-46)

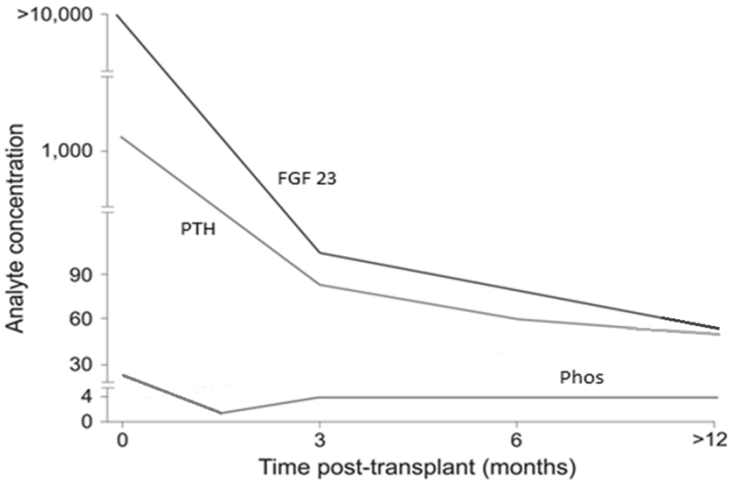
- Lingering CKD manifestations
- Improvement in appetite
  - with steroids
- Symptoms of uremia are resolved
- Improved absorption without N/V/D previously seen in CKD.





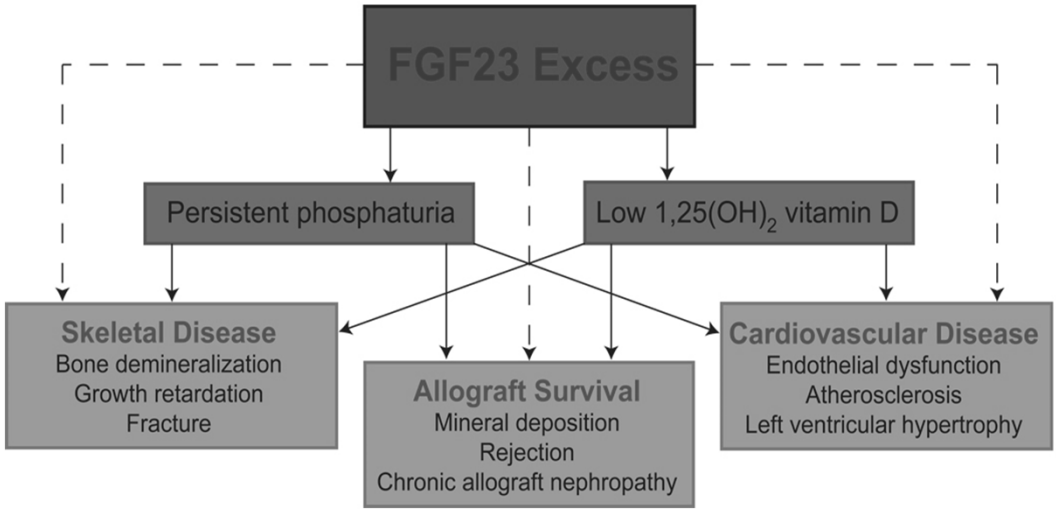

## How does a new kidney affect micronutrients?

## Serum changes throughout transplant- Phos (47-51)




- ↑FGF 23
- ↑PTH

(47-49)



# Phosphorus After Transplant- Low (50, 52-56)

**Reason:**

Prolonged FGF 23, PTH

**Research:**

Ped study: 85% < 0.8mMol/L

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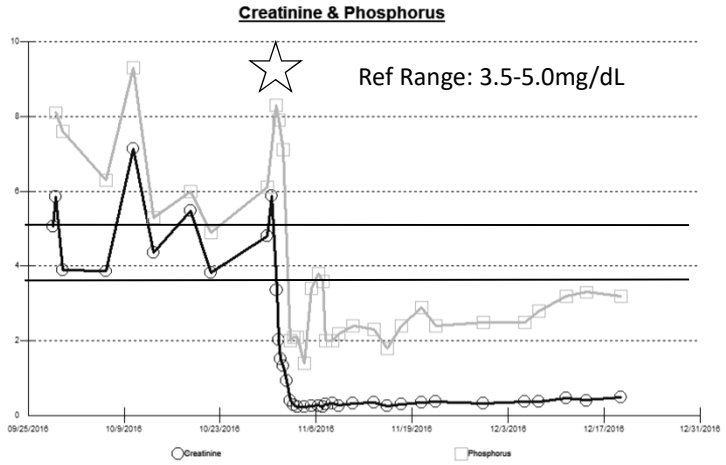
**Recommendations:**

+ intake of high phos foods

+ Phos supplement

Med changes

Frequent monitoring



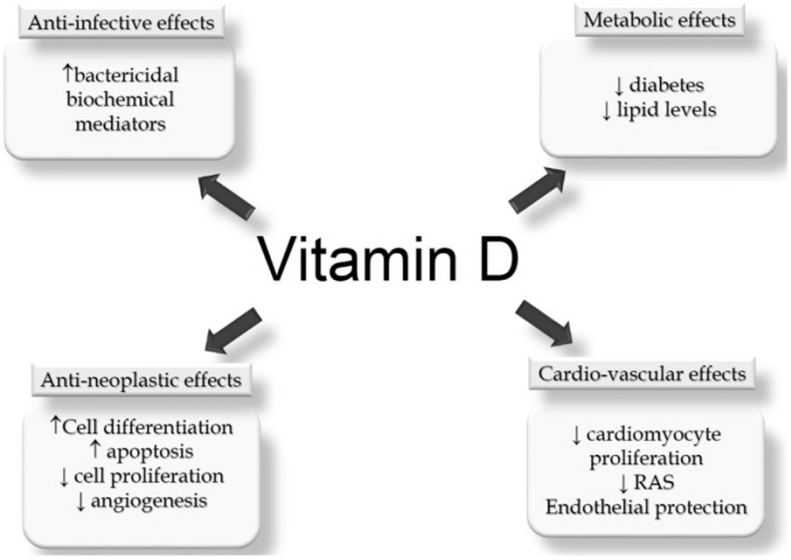

# KDOQI: Phos monitoring (31)

**Table 30. Recommended Frequency of Measurement of Calcium, Phosphorus, PTH and Total $CO_2$ After Transplant**

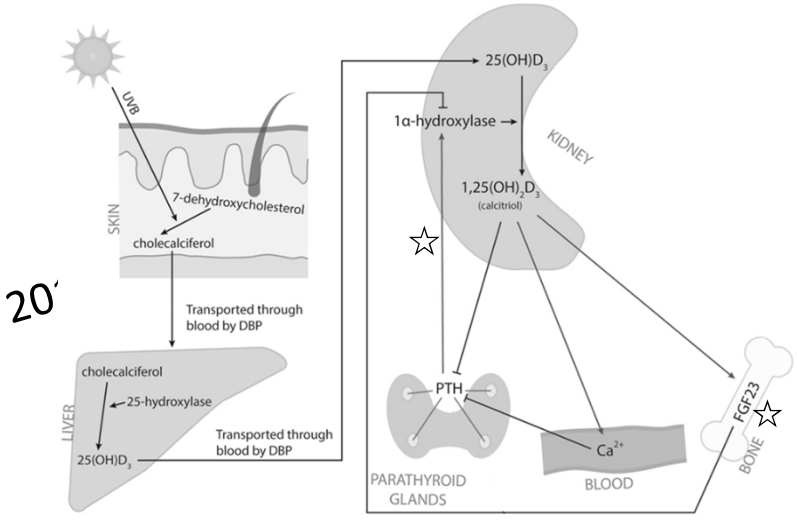
| Parameter | Week 1 | First 2 Months | 2-6 Months | >6 Months |
|---|---|---|---|---|
| Calcium | Daily | Weekly | Monthly | |
| Phosphorus | Daily | Weekly | Monthly | As per guidelines for stage of CKD |
| PTH | Optional | At 1 month, then optional | If normal initially, optional | |
| Total $CO_2$ | Daily | Weekly | Monthly | |

Adapted with permission.[121]

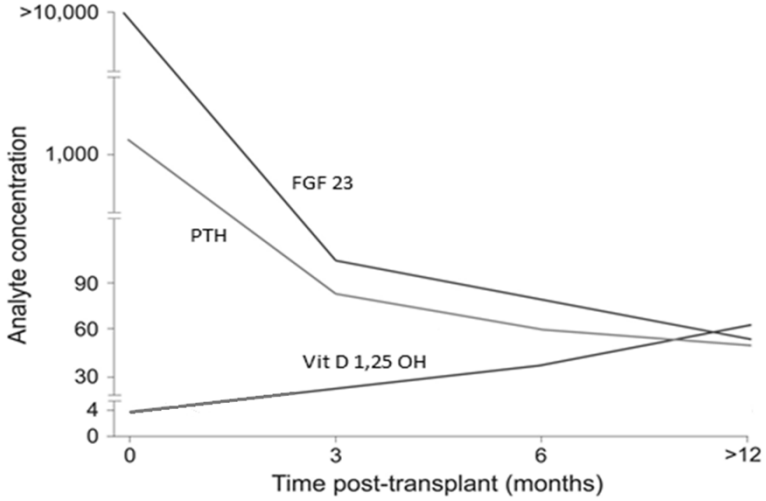
# Vitamin D- Going Beyond Bones




# Vitamin D Pathway in CKD (57)



## Serum changes throughout transplant- Vit D




- ↑FGF 23
- ↑PTH

## Vitamin D After Transplant- Low (58-61)

**Reason:**

↑FGF 23 – delayed activation

↑PTH – uses substrate (25OH VD)

**Research:**

Ped study (n 167)- 22% deficient

(n 29)- 76% deficient

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**Recommendations:**

Continue to monitor levels of vitamin D after transplant!

May need to supplement until FGF23, PTH levels normalize

## Vitamin D: related to graft survival? (60-62)

- Vitamin D suggested to play protective role!
- US Cohort (n 350+)
  - Low Vit D = 2x risk of acute rejection
- Adult study (n 600+)
  - Low Vit D = Low GFR at 1 year biopsy
- Pediatric study (n 37)
  - Showed NO correlation b/w Vit D status and graft fxn



## Case Patient AB

AB is now 6 months out of transplant and mom is elated about her development since receiving her kidney- she is more active, eating solid foods by mouth, completely weaned off of her nutrition supplementation and her medications are decreasing with each follow-up visit!

At her next clinic visit, mom wants to chat with you about nutritional concerns that will impact AB in the long run.

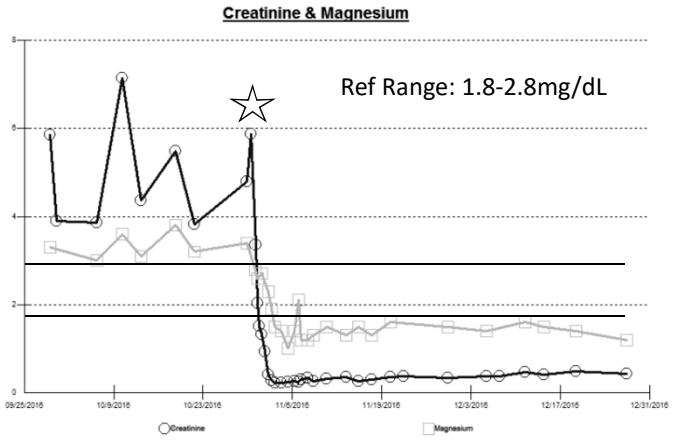
# Nutritional impacts of Trx Meds (63-67)

**Potassium - HIGH**

- Reason: calcineurin inhibitors
- Research:
  - K+: 44-73% in adult data
  - Mg: 41% def in ped study (n 91)
    - Tacro > cyclosporine
- Recommendations:
  - K+: mild restriction
  - Mg: + supplement (watch for stooling patterns!)



**Magnesium - LOW**




| Micronutrient | During CKD | After Transplant | Recommendations |
|---|---|---|---|
| Thiamine (B1) | ↓ | – | Renal MVI, None |
| Pyridoxine (B6) | ↓ | ↓/– | Renal MVI, None |
| Cobalamin (B12) | ↓ | – | Renal MVI, None |
| Folate | ↓ | – | Renal MVI, None |
| Vitamin C | ↓ | – | Avoid >> RDA, None |
| Vitamin A | ↑ | – | Avoid supplementation, None |
| Vitamin D | ↓ | ↓ | Monitor and supplement |
| Vitamin K | – | – | None |
| Potassium | ↑ | ↑/ – | Restrict, (as needed) |
| Magnesium | ↑/ – | ↓/ – | Monitor and supplement |
| Phosphorus | ↑ | ↓ | Monitor and supplement |
| Zinc | ↓*dialysis | – | None |
| Copper | ↓*dialysis | – | None |
| Selenium | ↓*dialysis | – | None |

# Take-aways

## Practical Use

- Micronutrient monitoring does not end at transplant!
  - Phos, Mg, K+
  - Continue Vitamin D supplementation after transplant!
  - Be cognizant of clinical signs/symptoms of deficiencies/toxicities
- More research is needed – especially in pediatrics!

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# Questions??



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