Live. Learn. Hope.

Renal Osteodystrophy

By: Clinical Education

4/2021

NORTHWEST Kidney Centers

Learning Objectives

At the end of the presentation, the nurse will be able to:

1. Understand the role of the kidneys in preventing renal bone disease
2. Explain the relationships between Ca, Phos, & PTH
3. Comprehend the difficulties of CKD patients in managing/preventing secondary hyperparathyroidism
4. Understand & apply the NKC protocol for paricalcitol

Kidney Functions – A Review

The kidneys are bean shaped, multifunctional organs.

Key function besides filtration is hormone production:

- ✓ erythropoietin = red blood cell production
- ✓ renin = blood pressure regulation
- ✓ ***calcitriol*** **=** *the active form of vitamin D = helps maintain calcium balance in the body for bone health*

Calcitriol Absent, Yes. But why bother?

Calcitriol absence makes bones vulnerable to:

- ✓ Electrolyte burglary – thieves with accomplices lurking
- ✓ A brewing storm
- ✓ A vicious cycle starts

The Burglary Role Players:

Victim = **Calcium**

The Thief = **Phosphorus**

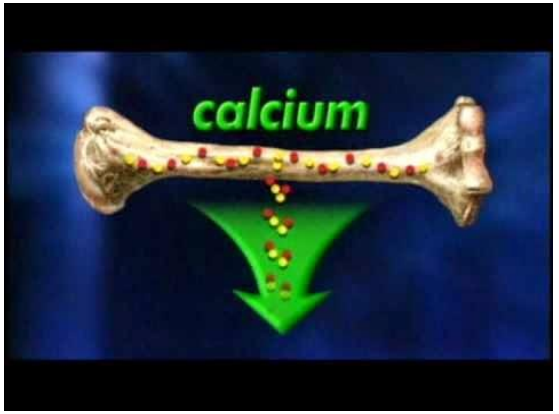
The Accomplices = **Parathyroid Glands**

The Victim:

Calcium = Responsible for the production and maintenance of bone cells.

- Activates enzymes for metabolic functions.
- Helps in blood coagulation, transmission of nerve impulses, contraction of skeletal, cardiac, & muscle fibers.

Target serum level = **8.5-10.5mg/dL**



The Thief:

Phosphorus = Essential in ATP/energy formation but in elevated serum levels will steal serum calcium preventing calcium absorption thus denying the bone of much needed building blocks leading to bone loss AKA renal osteodystrophy.

Phos  Ca!

Target serum level = 3.5-5.5mg/dL

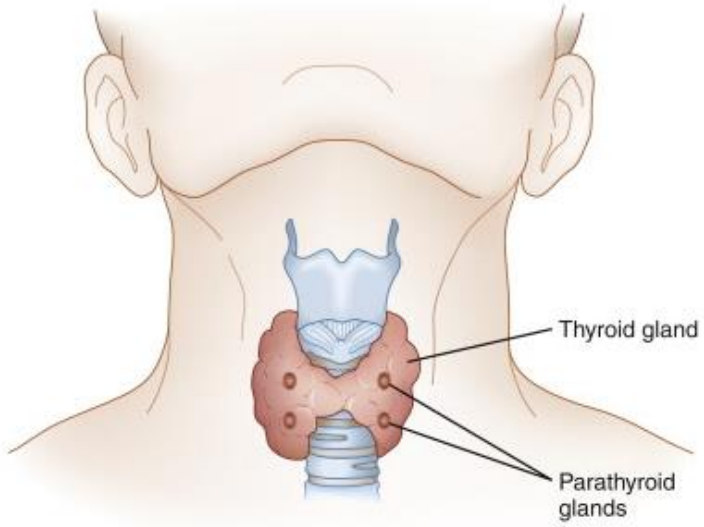
The Accomplices:

Parathyroid Glands = produce a hormone (PTH) which helps the body keep the right balance of calcium.

Hyper: over production
= high Ca levels

Hypo: under production
= low Ca levels

Target serum level = 200-400 pg/mL

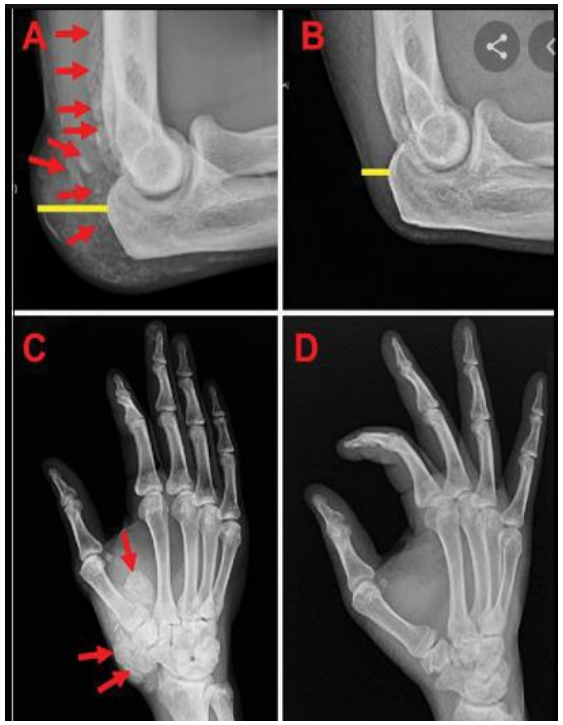


The Perfect Crime:

When serum calcium drops, PTH sends signals to the bones to release their stored calcium.

If serum phosphorus is elevated (due to poor diet control or binder non-compliance), phosphorus steals the serum calcium.

If this continues, the parathyroid glands may not be able to stop hormone production and the vicious cycle ensues.



Crime Scene Investigators

The Nurse –

Nursing Process

- ✓Review of labs results
- ✓Interview patient
- ✓Further assessments
- ✓Follow the protocol
- ✓Collaborate with other investigators - RDs
- ✓Evaluate outcomes

The Registered Dietician

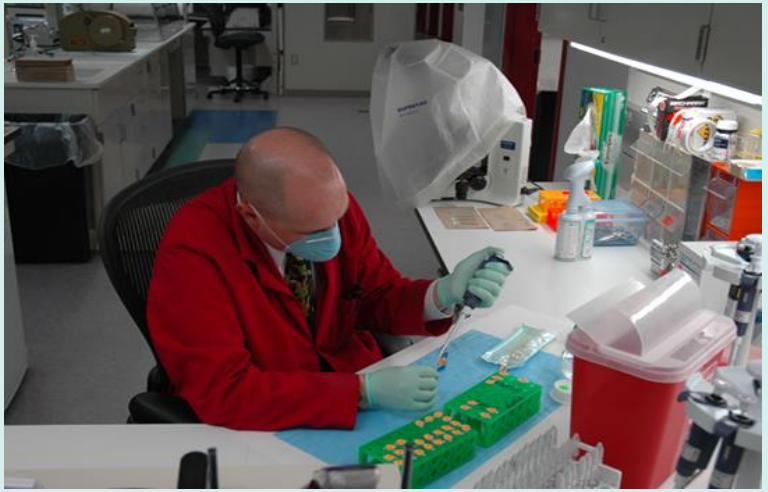
- ✓Review lab results
- ✓Interview patient
- ✓Where's the beef?
- ✓Where's the binder?
- ✓What & how much binder?

Evidence #1

High Serum **Phos**
> 5.5 mg/dL

Low Serum **Ca**
< 8.5 mg/dL

High **iPTH**
> 400 pg/mL



Evidence #2

- High Phosphorus Foods:

✓ Prepared food (Phosphorous is often used as a preservative)
✓ Fast food
✓ Dairy Products
✓ Dark colas
✓ Dark & organ meats
✓ Whole grains

Evidence #3

Where's the phosphorus binder?

- ✓Compliance?
- ✓What type?
- ✓How many per meal?

Physical Evidence:

- ✓Pruritus
- ✓Calciphylaxis (x-ray)

In the Eyes of the Court

Relationship between CKD & Renal Osteodystrophy

Who's involved in the crime? Phosphorus? iPTH?

What about the victim (Calcium)?

How will the jury see the effects?

CKD & Renal Osteodystrophy

- Remember CKD patients, especially HD, suffers from a constant state of Metabolic Acidosis which results in depletion of minerals.
- Alterations in mineral & bone metabolism start in early stages of CKD.
- Calcium is a buffer for acidosis leading to lower Calcium level.
- Calcium also further decreases due to the impaired ability of the kidney to synthesize Vit D3 resulting in lesser absorption of Calcium in the gut.

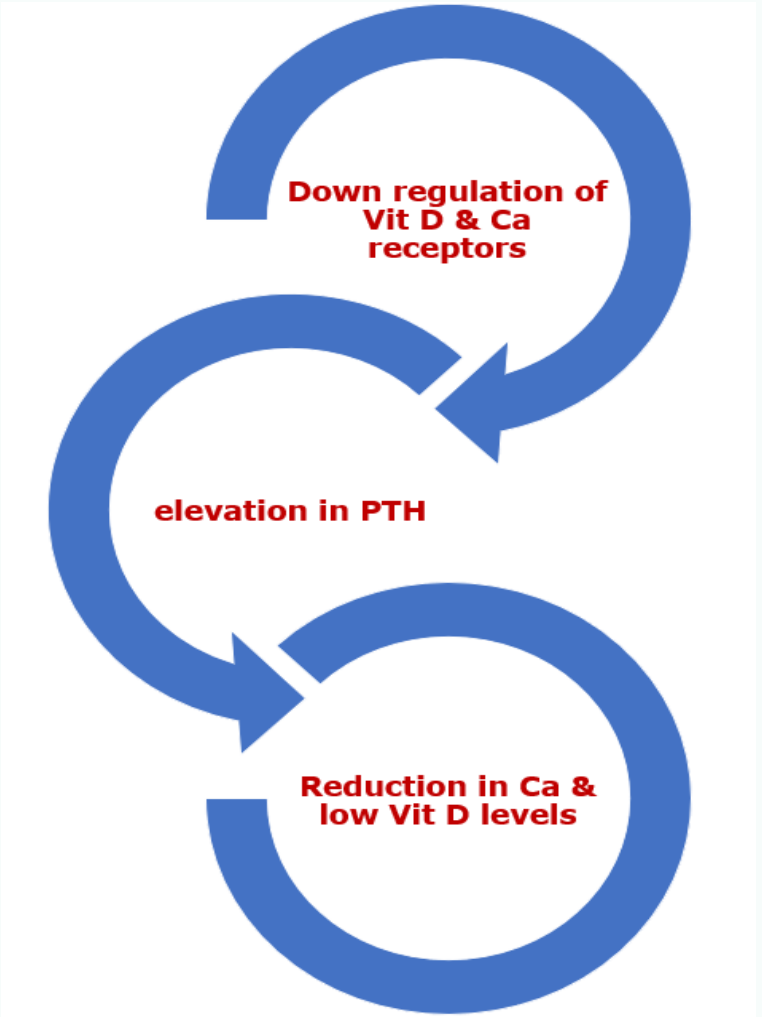
CKD & Renal Osteodystrophy

- Phos levels increases which also disrupts Vit D3 production.
- High levels of phos are seen in later stages of CKD.
- Difficult to balance compliance – diet restrictions & phos binders with meals.
- Excess phosphates bind to calcium in the soft tissues and deposit in tissues resulting in soft tissue & vascular calcifications.

Secondary Hyperparathyroidism

Pathogenesis in CKD due to the "down regulation" of parathyroid receptors on the parathyroid gland – then a destructive chain reaction!

Don't forget the phosphorus!



Secondary Hyperparathyroidism

The “down regulation” on the parathyroid receptors results in:

- hyperplasia of parathyroid glands
- Bone & minerals defects
- Soft tissue calcification
- Vascular calcification
- Cardiovascular disease
- Increase mortality

Cross Examination Time!

Before We Hand the Verdict…

Cross Examination # 1

What is the hormone that the kidneys produce to help maintain our bone structure?

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Answer:

Calcitriol which is the active form of vitamin D = helps maintain calcium balance in the body for bone health

Cross Examination # 2

What is the relationship between Calcium, Phosphorus, and PTH?

Cross Examination # 2

What is the relationship between Calcium, Phosphorus, and PTH?

Answer:

Calcium & phosphorus have a “love/hate” relationship – phosphorus “loves” calcium which makes the serum calcium level drop (hate) then body compensates and stimulates release of PTH.

PTH looks for calcium in bones & teeth to release to the blood to keep muscles & heart functioning.

Cross Examination # 3

What are the conditions that will make serum calcium level drops for CKD patients?

Cross Examination # 3

What are the conditions that will make serum calcium level drops for CKD patients?

Answers:

First, CKD patients, esp. HD, are in a constant state of metabolic acidosis. Calcium act as a buffer thus the body uses more serum calcium.

Second, it is difficult for CKD patients to keep up with diet restrictions (high phos) and also to take phos binders with every meals.

Third, it is also difficult to remove phos during dialysis

Cross Examination # 4

What are the effects of secondary hyperparathyroidism?

Cross Examination # 4

What are the effects of secondary hyperparathyroidism?

Answers:

- Hyperplasia of parathyroid glands
- Bone & minerals defects
- Soft tissue calcification
- Vascular calcification
- Cardiovascular disease
- Increase mortality

The Verdict

Follow the:

Chronic Maintenance In-Center Standing Orders – Paricalcitol

Paricalcitol (ICD10 - N25.81)

Targets: iPTH 200 – 400 pg/ml

Calcium ≤ 10.2

The Sentencing #1

- **Lab Draws**:
  a. Draw monthly calcium (in NKC Profile) unless otherwise indicated by tables below.

  b. Draw iPTH quarterly (Jan.-Apr.-July-Oct.) unless otherwise indicated by tables below.

  c. Draw labs with the routine monthly lab draws unless otherwise indicated by tables below.

  d. If calcium > 10.5 notify physician for guidance on management. If paricalcitol on hold for elevated calcium continue to check calcium with monthly labs or per the Held Dose Algorithm (Table 4).

The Sentencing #2

Use of Drugs

Drug of Choice:
Zemplar = 5mcg/mL
(Paricalcitol)
3x/wk IV

Alternative Drug:
Hectorol = 2mcg/mL
(Doxecalciferol)

The Sentencing #2 - continued

a. Paricalcitol dosing is based on tiers that correspond to specific doses in mcg as indicated in Table 1:

Table 1: Tier Dosing

Tier	Dose, mcg	Tier	Dose, mcg
0	0	6	6
1	1	7	8
2	2	8	10
3	3	9	12
4	4	10	14
5	5	>10	Call physician

b. Give paricalcitol doses IV, 3x/week with dialysis. If patient dialyzes >3x/week, ensure doses are spaced evenly 3x/week throughout the week. If patient runs only 1 or 2 times per week administer the dose with each dialysis i.e. qweek or 2x/week respectively

First Time Offenders:

Paricalcitol Naïve/Incident (New)Patients

have not received any paricalcitol or other Vit D analogs (e.g., calcitriol, Hectorol)within the past year

The key verdicts are:

1. **iPTH 200** pg/mL **or higher** **<AND>**

2. **Calcium < 9.5** mg/dL

First Time Offenders:

Paricalcitol Naïve/Incident (New)Patients

- ✓Do not start paricalcitol until Ca <9.5
- ✓Once Ca is <9.5, follow Table 2 dosing

Table 2: Incident Patient (paricalcitol naive) Algorithm

Calcium (mg/dl)	**iPTH** (pg/ml)	**Tier**	**Dose** (mcg)	**Next iPTH draw**
< 9.5	< 200	0	0	Quarterly
	200 - 400	2	2	Quarterly
	401 - 500	4	4	One month
	501 - 600	5	5	One month
	> 600	7	8	One month
≥ 9.5	Do not start			Quarterly

- ✓Once paricalcitol started & result if next iPTH draw known, follow Table 3 = Prevalent Patient Algorithm

Repeat Offenders

Prevalent Patient Algorithm – patient already received paricalcitol – follow carefully!

Table 3: Prevalent Patient Algorithm (for patients already on paricalcitol)

Calcium (mg/dl)	**iPTH** (pg/ml)	**PPC** (Percent iPTH Change)	**Tier Adjustment**	**Next iPTH draw**	**Next Ca draw**
≤ 10.1	< 200	NA	Hold dose	One month	Monthly labs
	200 - 400	-80 or more	Decrease 2 tiers	One month	Monthly labs
		-80 ↔ -21	Decrease 1 tier	Quarterly	Monthly labs
		-20 ↔ 20	Maintain current tier	Quarterly	Monthly labs
		21 ↔ 80	Increase 1 tier	Quarterly	Monthly labs
		> 80	Increase 2 tiers	One month	Monthly labs
	401 - 500	-80 or more	Maintain current tier	One month	Monthly labs
		-80 ↔ -21	Maintain current tier	Quarterly	Monthly labs
		-20 ↔ 20	Increase 1 tier	Quarterly	Monthly labs
		21 ↔ 80	Increase 1 tier	Quarterly	Monthly labs
		> 80	Increase 2 tiers	One month	Monthly labs
	501 - 600	-80 or more	Maintain current tier	One month	Monthly labs
		-80 ↔ -21	Increase 1 tier	Quarterly	Monthly labs
		-20 ↔ 20	Increase 1 tier	Quarterly	Monthly labs
		21 ↔ 80	Increase 1 tier	Quarterly	Monthly labs
		> 80	Increase 2 tiers	One month	Monthly labs
	> 600	-80 or more	Increase 1 tier	One month	Monthly labs
		-80 ↔ -21	Increase 1 tier	Quarterly	Monthly labs
		-20 ↔ 20	Increase 1 tier	Quarterly	Monthly labs
		21 ↔ 80	Increase 2 tiers	One month	Monthly labs
		> 80	Increase 3 tiers	One month	Two weeks
> 10.1	Hold Dose			Quarterly	Two weeks

Repeat Offenders - continued

Key items to remember for the "Prevalent" dosing:

1. Watch the Calcium – it has to be equal to or less than 10.1 mg/dL to continue dosing
2. iPTH needs to be 200 pg/mL or higher to continue dosing
3. Calcium levels are drawn every month
4. iPTH are drawn either monthly or quarterly – based on results
5. **HOLD** paricalcitol **IF** Calcium **>10.1** mg/dL **OR** iPTH **< 200** pg/mL

Repeat Offenders - continued

Also remember for "Prevalent" dosing:

- If dosing Tier drops to "**0**" – follow the "Held Dose Algorithm"

- If a dose above tier 10 (14mcg) is reached for 3 consecutive month **AND** the iPTH remains > 600, change to quarterly iPTH draws **AND** notify MD of "relative vitamin D resistance."

Sentencing Held

When to **HOLD** paricalcitol for "Prevalent" patients:

✓Calcium **>** 10.1 mg/dL <**OR**>

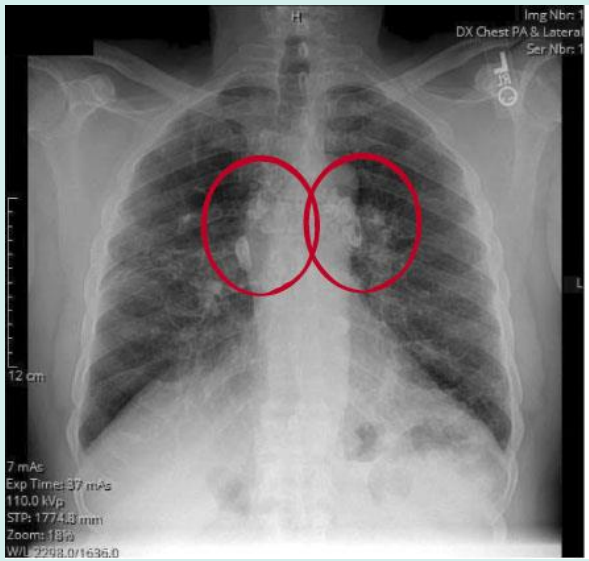
✓iPTH **<** 200 pg/mL

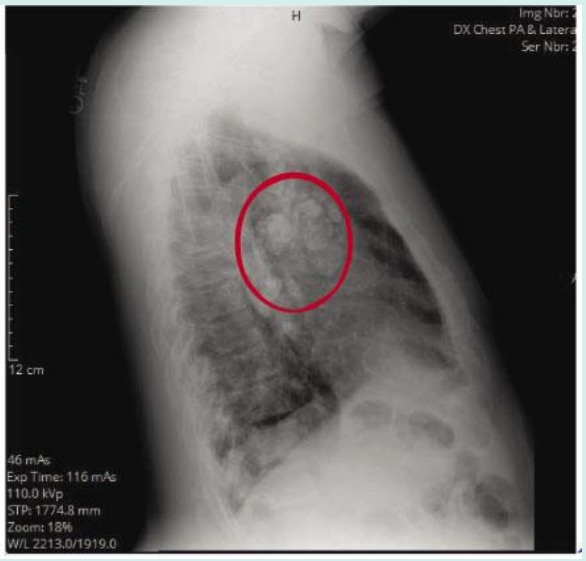
Then follow the lab draw schedule.

Table 4: Held Dose Algorithm (for prevalent patients)

Calcium (mg/dl)	**iPTH** (pg/ml)	**PPC**	**Tier Adjustment**	**Next iPTH draw**	**Next Ca draw**
≤ 10.1	< 200	NA	Continue to hold dose	One month, if 3 consecutive draws are <200, switch to quarterly	Monthly labs
	≥ 200	≤ 80	Reduce dose by 1 tier lower than the dose at the time of hold, if the dose tier was 1 at the time of hold resume dose at tier 1	One month	Two weeks
		> 80	Resume same dose as at the time of hold	One month	Two weeks
> 10.1	NA	NA	Continue to hold dose	Quarterly	Two weeks, if 3 consecutive draws ≥ 10.2, contact physician

Primary Nurse Bootcamp





Nursing Bootcamp Training #1

Investigate and solve the following cases for first offenders (Incident patients/paricalcitol naïve):

A. Pt A's calcium is <9.5, PTH is <200.

B. Pt B's calcium is 9.3, PTH is 420.

Nursing Bootcamp Training #1

Investigate and solve the following cases for first offenders (Incident patients/paricalcitol naïve):

Table 2: Incident Patient (paricalcitol naive) Algorithm

Calcium (mg/dl)	**iPTH** (pg/ml)	**Tier**	**Dose** (mcg)	**Next iPTH draw**
< 9.5	< 200	0	0	Quarterly
	200 - 400	2	2	Quarterly
	401 - 500	4	4	One month
	501 - 600	5	5	One month
	> 600	7	8	One month
≥ 9.5	Do not start			Quarterly

A. Pt A's calcium is <9.5, PTH is <200.

Answer: Do not start paricalcitol

B. Pt B's calcium is 9.3, PTH is 420.

Answer: Start at 4mcg IV 3x/wk

Nursing Bootcamp Training #2

Investigate and solve the following cases for repeat offenders (already received paricalcitol):

A. Pt C's calcium is 10.0. PTH 500. Last PTH was 400.

B. Pt D's calcium is 10.2. PTH 400.

Nursing Bootcamp Training #2

Investigate and solve the following cases for repeat offenders (already received paricalcitol):

Table 3: Prevalent Patient Algorithm (for patients already on paricalcitol)

Calcium (mg/dl)	**iPTH** (pg/ml)	**PPC** (Percent iPTH Change)	**Tier Adjustment**	**Next iPTH draw**	**Next Ca draw**
≤ 10.1	< 200	NA	Hold dose	One month	Monthly labs
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		-20 ↔ 20	Increase 1 tier	Quarterly	Monthly labs
		21 ↔ 80	Increase 1 tier	Quarterly	Monthly labs
		> 80	Increase 2 tiers	One month	Monthly labs
> 10.1	Hold Dose			Quarterly	Two weeks

A. Pt C's calcium is 10.0. PTH 500. Last PTH was 400.

Answer: Increase dose by 1 Tier

B. Pt D's calcium is 10.2. PTH 400.

Answer: Hold paricalcitol

What Tools Do Nurses Have?

How can you quickly review & act on Ca, Phos, & iPTH results?

Go to "Ascend LabCheck" > Click on "Reports" > "Custom"

You can create your own custom report(s) or select from the list. Here's a sample:

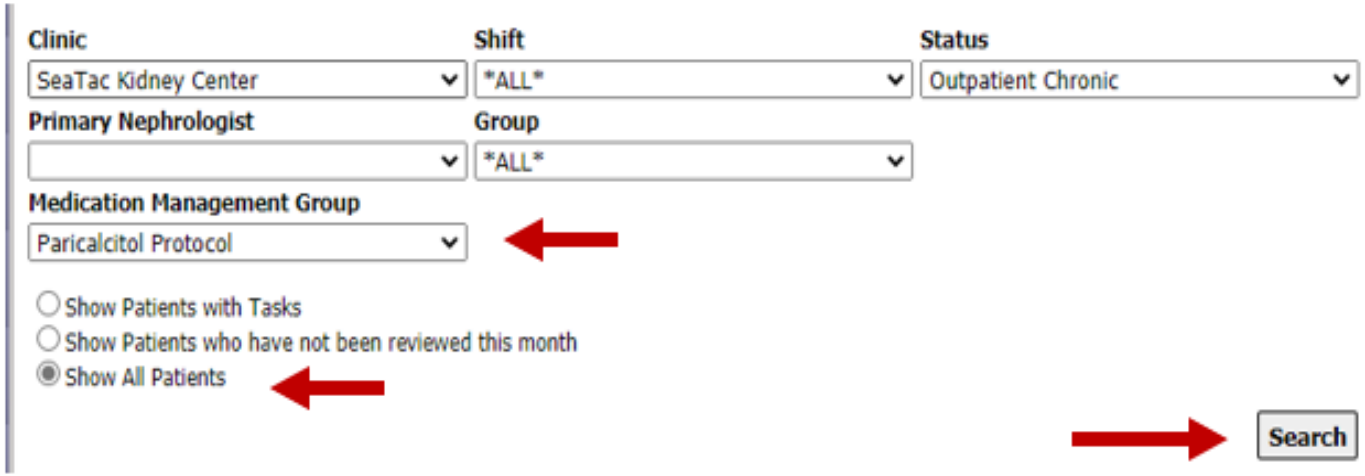
Renal Osteo

01/01/2021 to 02/01/2021

Patient Name	MRN	Nephrologist	CA	PTHIN	>=5.5 PHOS	
			9.6	331		
			10.2	<7		
			8.7	150		
			10.8	54	5.8	
			6.9	117	6.9	
			9.0	277		
			7.7	484	8.7	

What Tools Do Nurses Have?

In Clarity, go to "Patient" > "Medications Management" > "Medication Management" > select "Paricalcitol Protocol" select "Show All Patients" then click "Search"



What Tools Do We Have?

Medication Management Protocol

Patient

<< Prev Patient | Next Patient >>

Patient: A

Primary Nephrolog

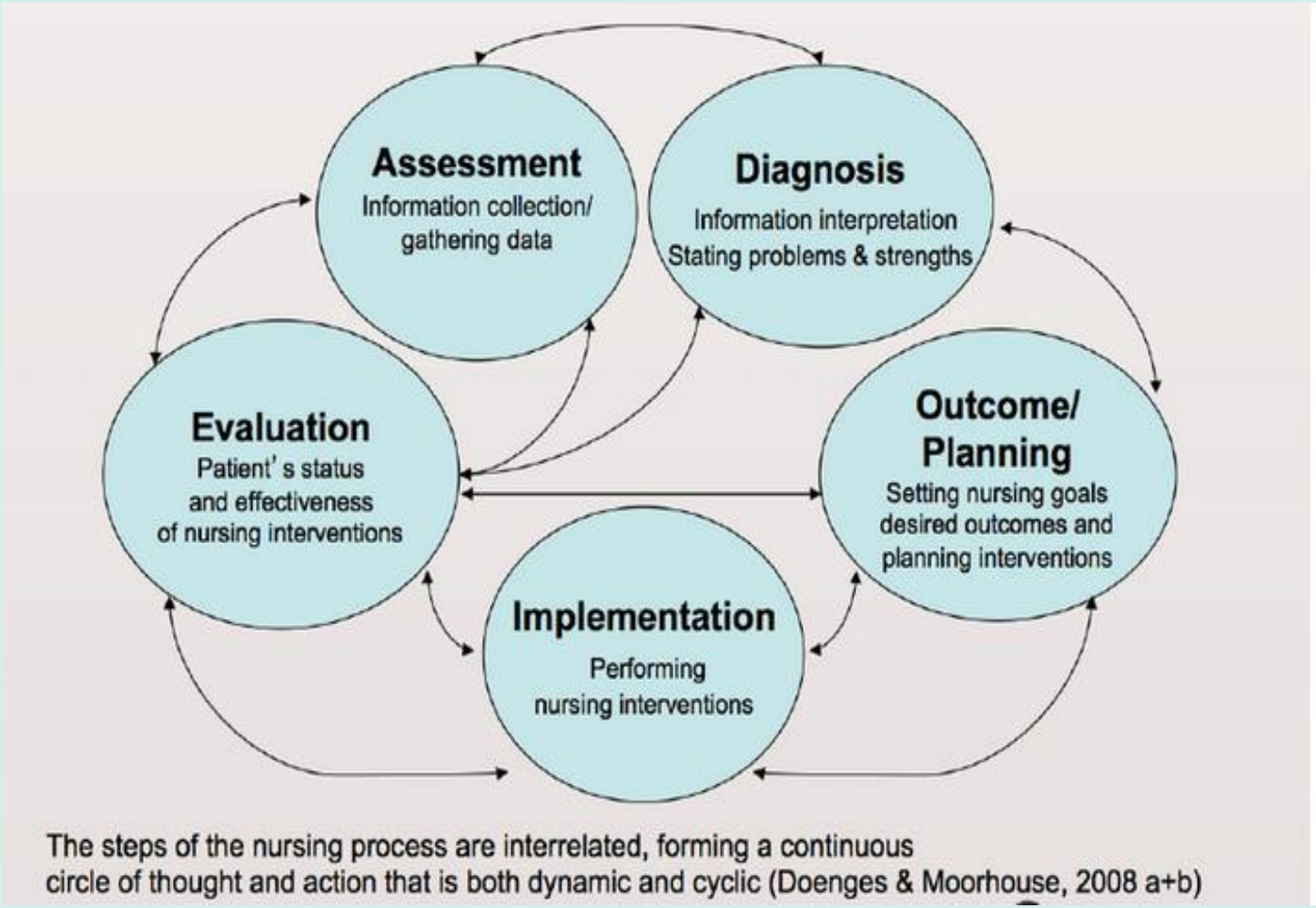
SeaTac Kidney Cen

Medical Record#: 5

Patient Allergies: Ferrlecit -

Item	Value		
Ca+2	**02/03/2021** 9.4	**01/06/2021** 9.2	**12/16/2020** 7.2
PTH - Intact	**02/10/2021** 490.0	**01/18/2021** 1003.0	**01/06/2021** 968.0
Calcimimetics	**Sensipar** 60 mg orally (60 mg tablet) once a day **02/06/2021**		
Vitamin D Analogs	**paricalcitol** 6 mcg intravenously (5 mcg/mL solution) each Mon Wed Fri **02/06/2021** 5 mcg intravenously (5 mcg/mL solution) each Mon Wed Fri **01/13/2021 - 02/05/2021** *On Hold* 10.4 **12/10/2020 - 01/12/2021** 5 mcg intravenously (5 mcg/mL solution) each Mon Wed Fri **10/10/2020 - 12/09/2020**		

Remember The Nursing Process!



The steps of the nursing process are interrelated, forming a continuous circle of thought and action that is both dynamic and cyclic (Doenges & Moorhouse, 2008 a+b)

*Remember, it is more than just about numbers!

In Closing

Using the "Nursing Process" when reviewing lab results – look at the overall picture. It is not just about the results (numbers)!

Always start with complete assessment:

- Collect additional data
- Look at trends
- Assess the pt., ask questions
- Review comorbid conditions
- Look for s/s associated with abnormal results

Collaborate with the members of the IDT – especially with the patients. The patients are the main driver for these results – especially the phos.

References

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Questions?