Live. Learn. Hope.

Dialysis Lab Interpretation Part 1: Chemistries

Clinical Education

4/2021

NORTHWEST Kidney Centers

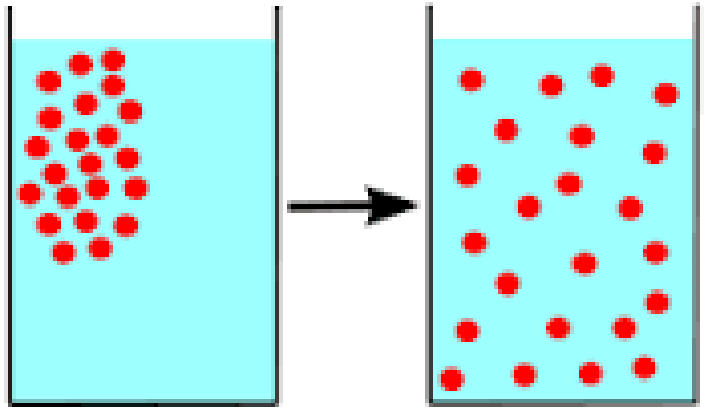
Learning Objectives

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

1. Explain the roles of electrolytes & acceptable levels
2. Understand the composition of dialysate
3. Review the rationale for choosing varying dialysate composition of the following:
    a. Sodium
    b. Potassium
    c. Bicarbonate
    d. Calcium
4. Identify associated signs & symptoms with hyper & hypo levels & the nursing implications
5. Identify the tools available

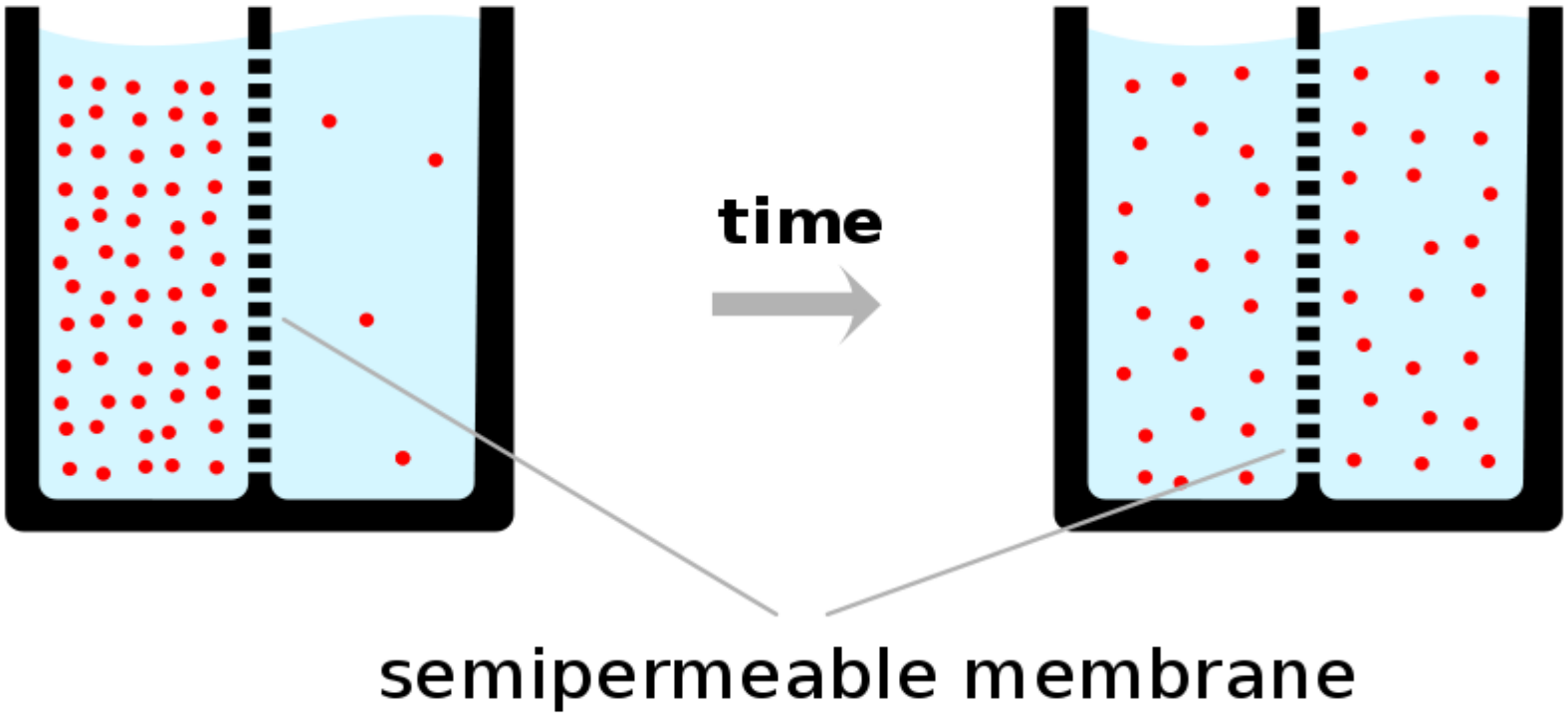
Dialysis Review

- Dialysis - Mechanical treatment for kidney failure
- Works by **diffusion**.
  - Movement of solutes from area of high to low concentration. “Tea bag” effect!



Diffusion During Dialysis

- Diffusion of solutes across a semi-permeable membrane.



Dialysate

- Solution separated from blood by a semi-membrane.
- Used to remove or add substances to blood through the process of diffusion.
- Made by mixing two concentrate components, which may be provided as liquid or powder (dry) concentrates.
  - **Acid**
  - **Base**

Dialysate Components

- **BASE component**:
  - Sodium bicarbonate

- **ACID component (electrolytes)**:
  - Sodium chloride
  - Potassium
  - Calcium
  - Magnesium
  - Acetate (or citrate)
  - Glucose

- These two components are mixed simultaneously with purified water (R/O)to make the dialysate.
  - Proper mixing ensured by dialysate proportioning pumps

Dialysate Composition

- Little data supporting the optimal dialysate composition.
  - Often, the concentrations of key components are chosen intuitively (opinion based)

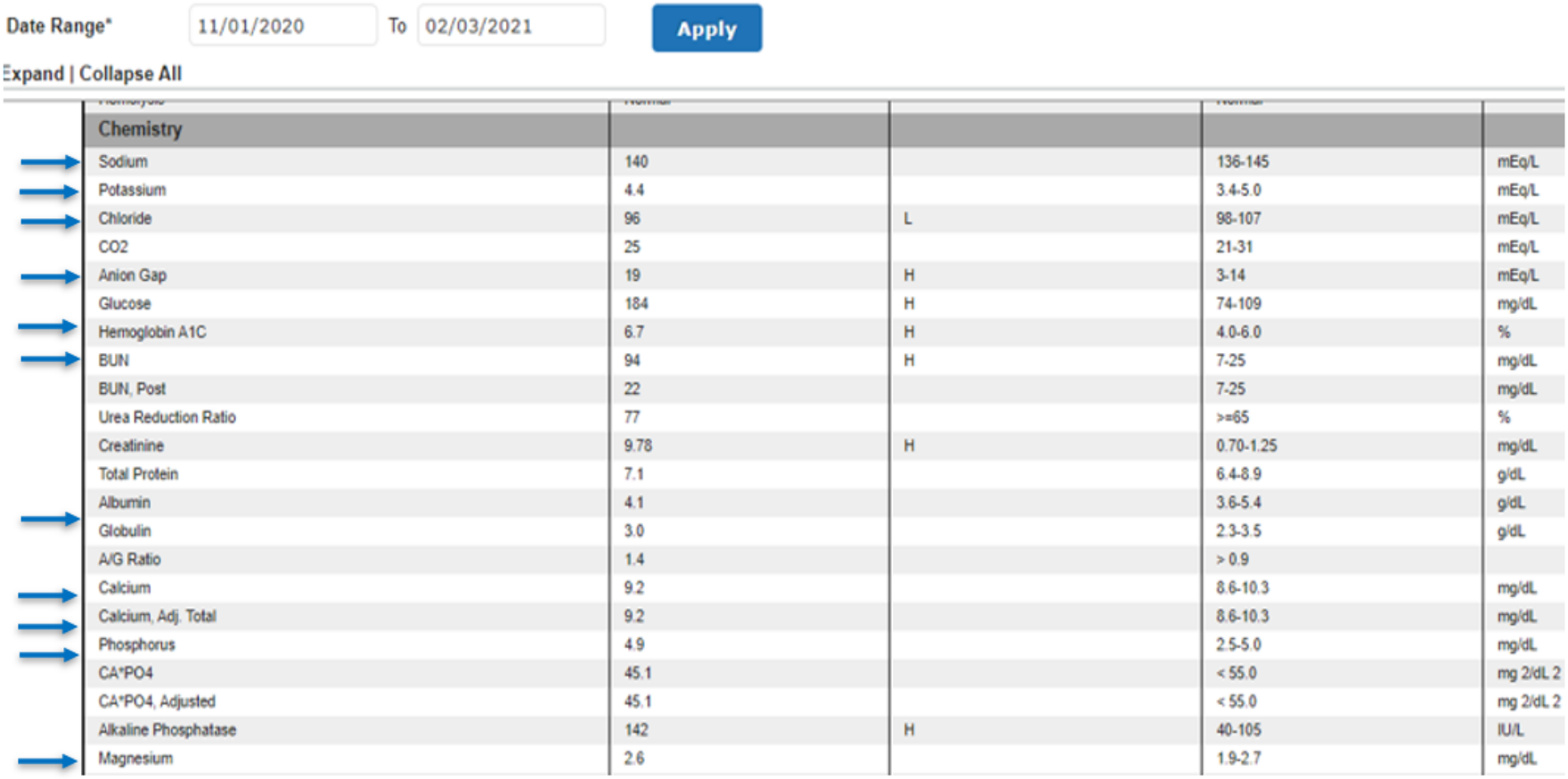
- **Goal** = normalize serum chemistries.
  - Should they be normalized at the end of the treatment?
  - Or by the beginning of the next dialysis session?
    - Current practice, although this may be harmful because it may lead to "over correction."

Major Dialysate Components

- Potassium (K)
- Calcium (Ca)
- Sodium (Na)
- Bicarbonate (HCO3)

Where are Lab Results Posted?

- **First option** (best) – **Ascend Labs** - Select "**Chemistry**"



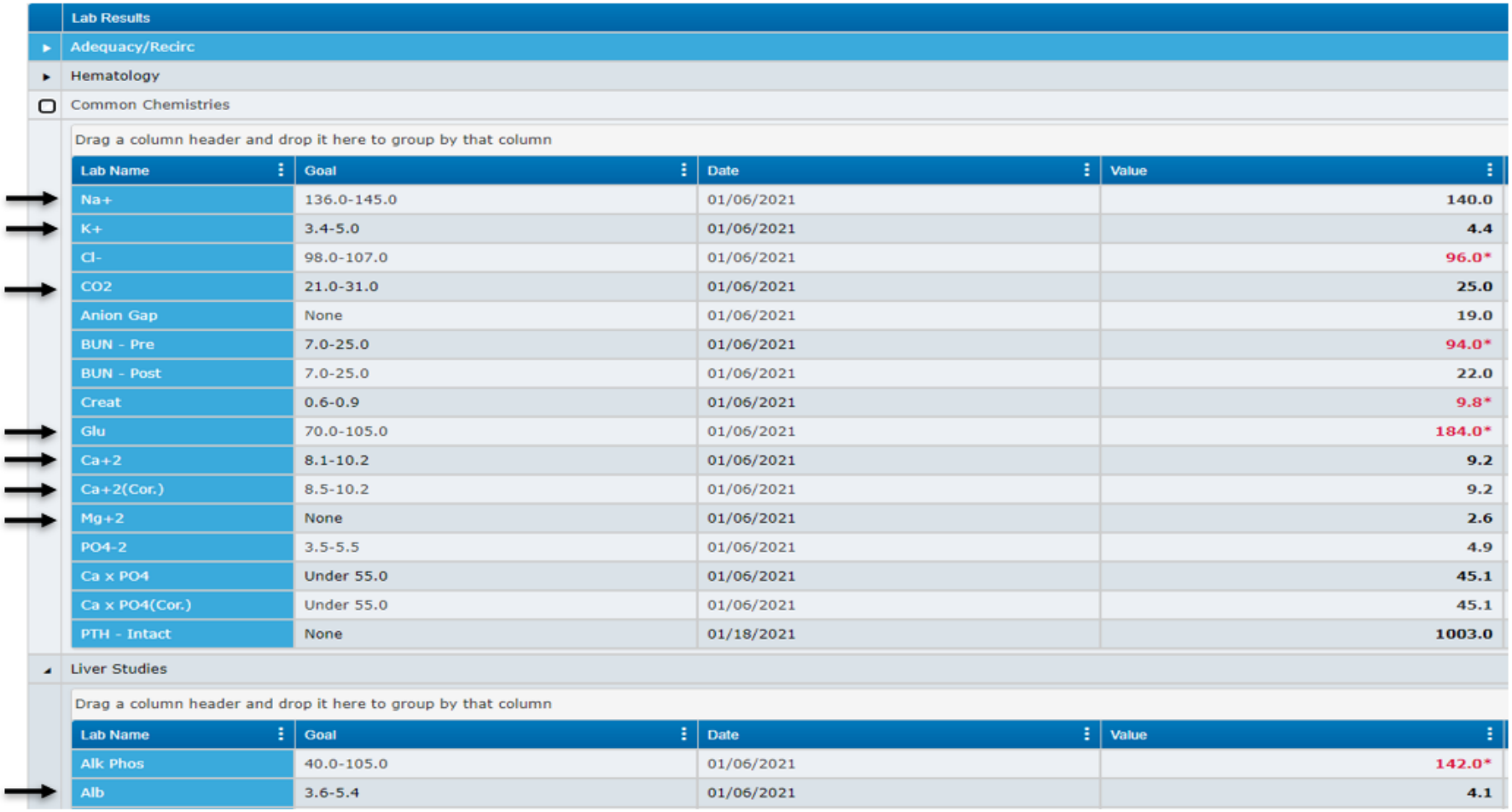
Date Range* 11/01/2020 To 02/03/2021 Apply

Expand | Collapse All

	Chemistry				
→	Sodium	140		136-145	mEq/L
→	Potassium	4.4		3.4-5.0	mEq/L
→	Chloride	96	L	98-107	mEq/L
	CO2	25		21-31	mEq/L
→	Anion Gap	19	H	3-14	mEq/L
	Glucose	184	H	74-109	mg/dL
→	Hemoglobin A1C	6.7	H	4.0-6.0	%
→	BUN	94	H	7-25	mg/dL
	BUN, Post	22		7-25	mg/dL
	Urea Reduction Ratio	77		>=65	%
	Creatinine	9.78	H	0.70-1.25	mg/dL
	Total Protein	7.1		6.4-8.9	g/dL
	Albumin	4.1		3.6-5.4	g/dL
→	Globulin	3.0		2.3-3.5	g/dL
	A/G Ratio	1.4		> 0.9	
→	Calcium	9.2		8.6-10.3	mg/dL
→	Calcium, Adj. Total	9.2		8.6-10.3	mg/dL
→	Phosphorus	4.9		2.5-5.0	mg/dL
	CA*PO4	45.1		< 55.0	mg 2/dL 2
	CA*PO4, Adjusted	45.1		< 55.0	mg 2/dL 2
	Alkaline Phosphatase	142	H	40-105	IU/L
→	Magnesium	2.6		1.9-2.7	mg/dL

Where are Lab Results Posted?

- **Second option – Clarity > Patient Chart View>Lab Results**



Lab Results

▸ Adequacy/Recirc

▸ Hematology

▢ Common Chemistries

Drag a column header and drop it here to group by that column

Lab Name	Goal	Date	Value
Na+	136.0-145.0	01/06/2021	140.0
K+	3.4-5.0	01/06/2021	4.4
Cl-	98.0-107.0	01/06/2021	96.0*
CO2	21.0-31.0	01/06/2021	25.0
Anion Gap	None	01/06/2021	19.0
BUN - Pre	7.0-25.0	01/06/2021	94.0*
BUN - Post	7.0-25.0	01/06/2021	22.0
Creat	0.6-0.9	01/06/2021	9.8*
Glu	70.0-105.0	01/06/2021	184.0*
Ca+2	8.1-10.2	01/06/2021	9.2
Ca+2(Cor.)	8.5-10.2	01/06/2021	9.2
Mg+2	None	01/06/2021	2.6
PO4-2	3.5-5.5	01/06/2021	4.9
Ca x PO4	Under 55.0	01/06/2021	45.1
Ca x PO4(Cor.)	Under 55.0	01/06/2021	45.1
PTH - Intact	None	01/18/2021	1003.0

◂ Liver Studies

Drag a column header and drop it here to group by that column

Lab Name	Goal	Date	Value
Alk Phos	40.0-105.0	01/06/2021	142.0*
Alb	3.6-5.4	01/06/2021	4.1

How Do Chemistries Results Fit In?

Nursing implications – what actions you, as the nurse, need to take

- *Nursing Assessment*
  - Patient manifestations of signs & symptoms
- *Nursing Interventions*
  - Consult with MD, suggest changes in treatment parameters – bath changes
  - Follow Standing Orders
  - Evaluate effectiveness of interventions
- *Need for other members of IDT interventions*
  - RD consult
  - Other caregivers such as SNF, AFH, family members

Potassium (K)

- Is a major intracellular electrolyte in our body
- Important in electrical impulses for the nerves & the heart
- Helps in maintaining normal water, acid, & base balance, and osmotic equilibrium

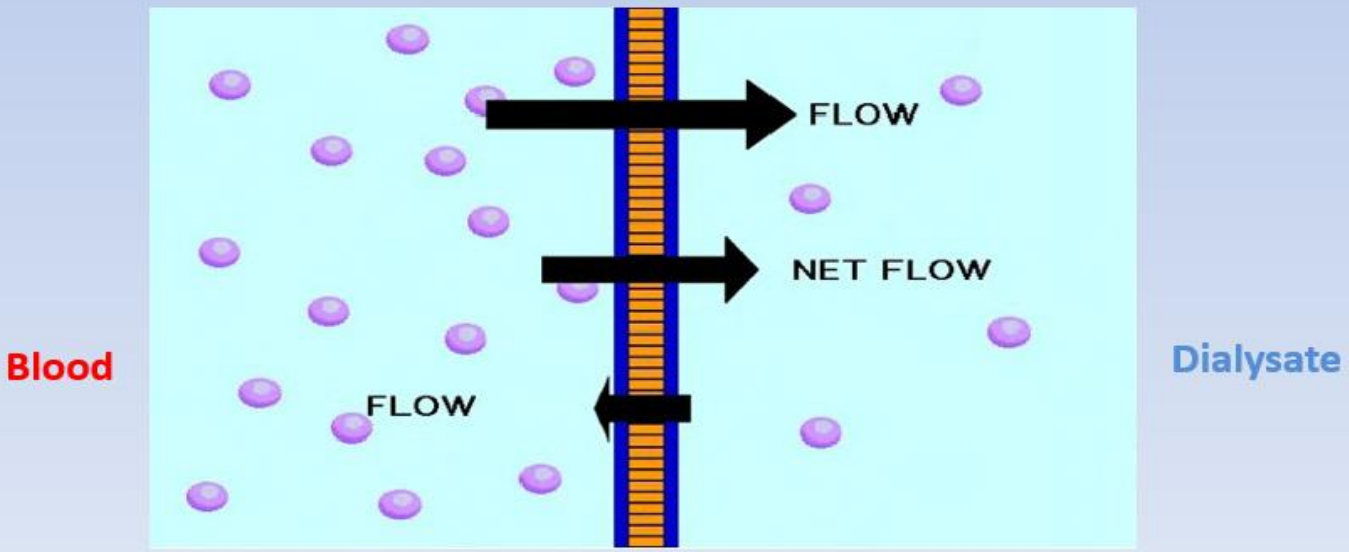
- Normal serum potassium level: 3.5-5.0 mEq/L
- Acceptable levels for CKD patients: 3.5-5.5 mEq/L

- Standard NKC dialysate K baths: **2K or 3K**

Something Else to Consider

Potassium Gradient

- Key determinant of amount of K that will be removed, especially in the first hour
- The lower the dialysate K, the more K will be removed



Potassium Kinetics

Something to think about when evaluating K bath

During dialysis – remember diffusion!

- **First hour**: K decreases by 1 mmol/L
  - Faster K shift from blood to dialysate if bath is lower
- **Next 2 hours**: K declines another 1 mmol/L

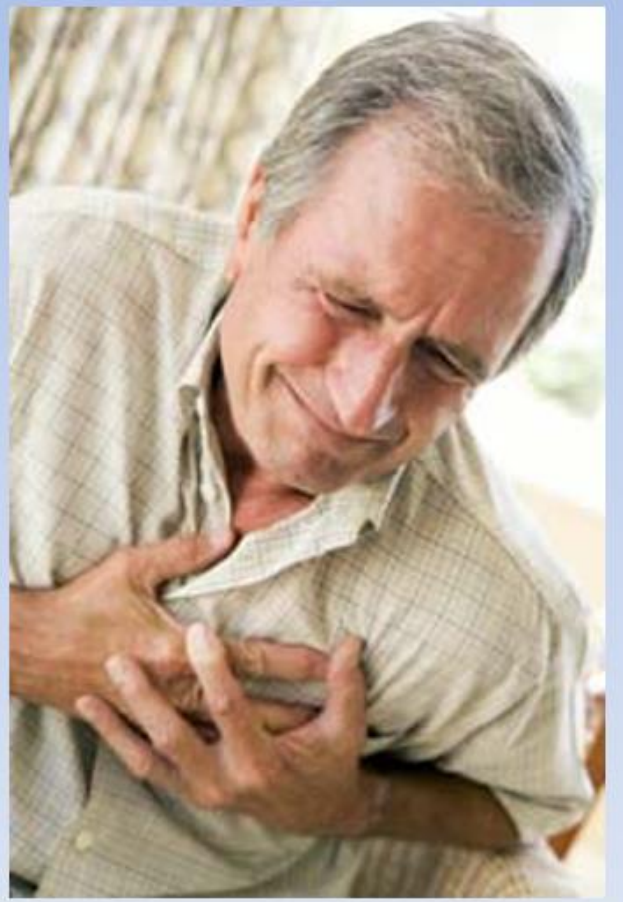
**Rapid K shift is very dangerous!

After dialysis

- K rebounds post dialysis
- Takes several hours (6-12) before the potassium concentrations between extracellular and intracellular compartments are the same.

Why Reconsider Rate of K Diffusion ?

- High potassium gradient may increase the risk of arrhythmia and sudden cardiac death.
- **30 times higher** in risk in the dialysis population than the general population.



Long Weekend Between HD Runs

Highest risk of Sudden Cardiac Death is around the first hemodialysis session of the week

- **Monday**, for Monday, Wednesday, Friday schedule
- **Tuesday**, for Tuesday, Thursday, Saturday schedule

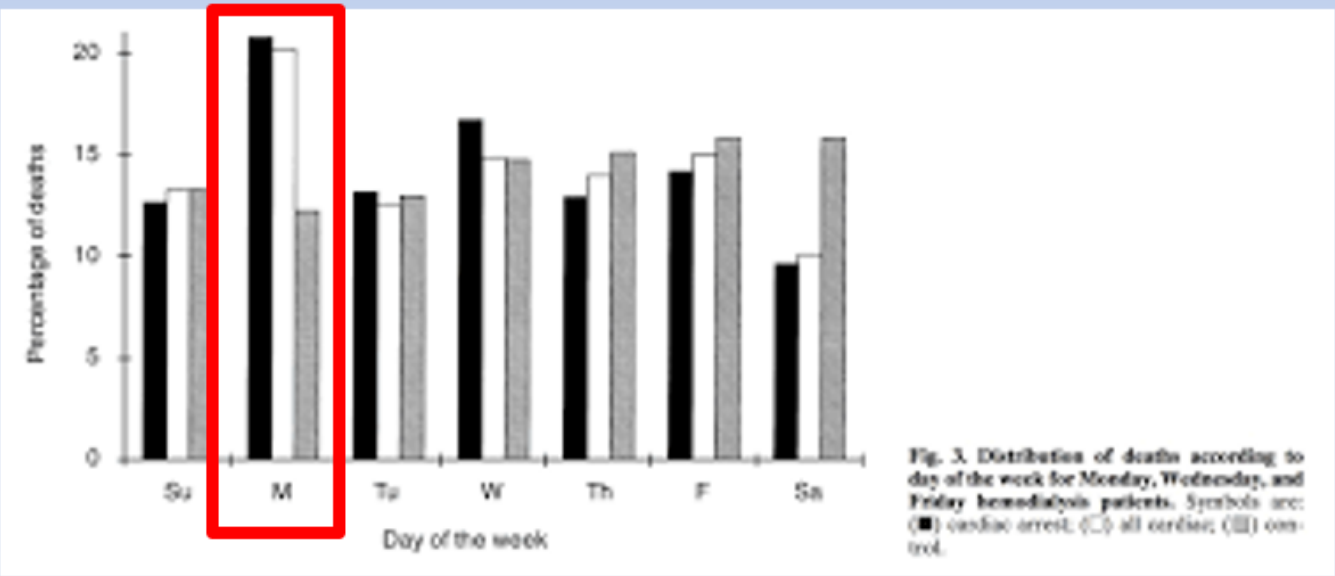


Fig. 3. Distribution of deaths according to day of the week for Monday, Wednesday, and Friday hemodialysis patients. Symbols are: (■) cardiac arrest, (□) all cardiac, (▨) control.

Bleyer AJ et al. KI 1999; 55: 1553-1559

Why the Higher Risk?

- Probably due to electrolyte abnormalities, particularly potassium.
  - Before dialysis: hyperkalemia
  - After dialysis: hypokalemia
- Potassium gradient between blood and inside cells may irritate cell membranes.
- Rate of potassium removal.

Hyperkalemia

- Hyperkalemia is the most common & often most dangerous problem r/t acute & chronic kidney disease
- **Serum K level >5.5 mEq/L**
- Signs & symptoms:
  - Muscle weakness
  - Nausea & vomiting
  - Diarrhea
  - Numbness & tingling especially around the lips & tongue
  - Irregular HR & abnormal EKG
  - Chest pain

- Extreme level can lead to sudden cardiac death (SCD)

Hyperkalemia

Common causes:

- Kidney failure
- Diet – excess intake > 3000 mEq/L / day
- Under-dialyzed due access problems or due to recirculation, noncompliance with treatments & diet restrictions
- Long intervals without dialysis treatment
- Blood transfusion or bleeding - related to lysis of RBC which can cause intracellular release of K

Hyperkalemia

Sources of High Potassium:

Fruits: bananas, oranges, prunes, raisins, apricots, etc.

Vegetables: Artichoke, beans, green leafy veg., etc.

Beverages: milk, OJ, V8, fruit juices, instant breakfast, etc.

Nursing Implications – High K

- Conduct complete assessment of patient including diet intake
- Assess if patient had recent blood transfusion or bleeding
- Assess for metabolic acidosis due to under-dialyzed (skipped runs)
- Evaluate recent & trends of serum K levels
- Evaluate appropriateness of current K bath

Nursing Implications – High K

- Call MD to:
  - Consider possible one-time K bath change
  - Check K level
  - Possibly transfer patient to hospital (based on S&S)

- Evaluate other contributing comorbid conditions (related to hormones such as Addison's disease), medications (K supplements) or recent blood transfusion

- Refer to RD for diet consult

Hypokalemia

- **Serum K level < 3.5 mEq/L**

- Signs & symptoms – may be very vague
  - Weakness
  - Muscle cramps
  - Constipation
  - Irregular HR / abnormal EKG

Hypokalemia

- **Common causes**:
  - Diarrhea
  - Vomiting
  - Excessive sweating
  - Excessive alcohol intake
  - Use of diuretics (common for AKI & new patients)
  - Low intake & low K bath
  - Other comorbid conditions such as diabetic ketoacidosis

Nursing Implications – Low K

- Conduct complete assessment of patient including diet intake
- Assess if patient has been vomiting or having diarrhea – reasons on how pt. might be losing K
- Evaluate recent & trends of serum K level
- Evaluate appropriateness of current K bath

Nursing Implications – Low K

- Call MD to:
  - Consider possible K bath change
  - Recheck K level
  - Possibly transfer patient to hospital (based on S&S)

- Evaluate other contributing factors, comorbid conditions (GI problems), or medications (diuretics)

- Refer to RD for diet consult

Calcium (Ca)

- Most abundant mineral in the body – found in hard tissues, bone, & teeth
- Builds & maintains bones & teeth
- Activates enzymes for metabolic functions
- Helps in blood coagulation, transmission of nerve impulses, contraction of skeletal, cardiac, & muscle fibers

- Serum Ca range: 8.5-10.5mg/dl

- Standard NKC dialysate Ca bath: **2.5 mEq/L**

Hypercalcemia

- Serum Ca **> 10.5 mg/dl**
- Signs & symptoms – mostly vague
  - Constipation
  - Muscle & bone weakness &/or pain
  - Neurological – confusion, lethargy, fatigue

- Possible causes:
  - Hyperparathyroidism
  - Ca supplements or high Ca bath

- Nursing implications will be discussed in Renal Osteodystrophy module

Hypocalcemia

- Serum Ca **< 8.5 mg/dl**

- Signs & symptoms – also vague
  - Arrythmias
  - Neurological – confusion, memory loss
  - Muscle spasms, stiffness, &/or cramps
  - Numbness & tingling on hands, feet, & face
  - Brittle nails & bones
  - Hypotension

Hypocalcemia

- Possible causes:
  - Kidney failure
  - High phosphorus
  - S/p Parathyroidectomy
  - Low diet intake
  - Low dialysate Ca bath
  - Medications such as phenytoin, phenobarbital, & rifampin
  - Advanced stage cancer

- Nursing implications will be discussed in Renal Osteodystrophy module

Dialysate Ca Concentrations

- **2.5** mEq/L (low calcium dialysate)
  - Similar to normal serum ionized calcium level
- **3.0** mEq/L (high calcium dialysate)
  - Common in the 1970s in response to widespread hypocalcemia and hyperparathyroidism among dialysis patients.

Phosphorus (PO4)

- Second most abundant mineral in the body (next to Ca)
- Found in bones & teeth
- Functions to build & maintain bones & teeth, activates Vit D, used for nerve & muscle activities

- **Goal 2.5-5.0 mg/dL**

- Common sources: dairy products, dark meat, & dark sodas

- Levels controlled by compliance with diet, phosphorus binders, and adequate dialysis

Phosphorus

Hyperphosphatemia – signs & symptoms

- Itchy skin
- Bone & joint pain
- Weak bones

Hypophosphatemia – signs & symptoms (vague)

- Joint stiffness
- Weakness

Nursing implications will be discussed in Renal Osteodystrophy module

Sodium (Na)

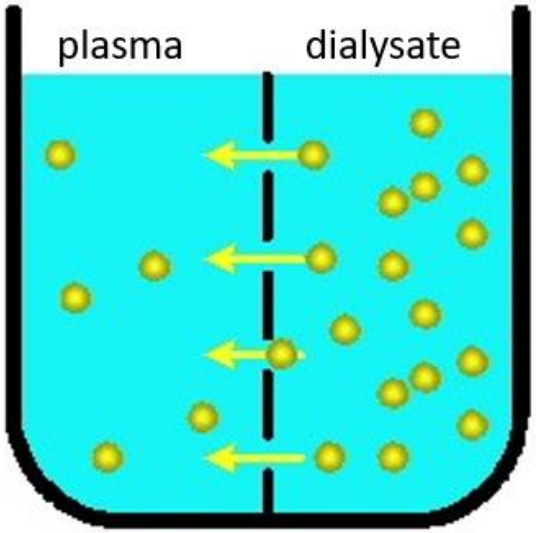
- Major cation of the extracellular fluid
- Regulates extracellular fluid volume
- Helps conduct nerve impulses
- Controls muscle contraction
- Good indicator of fluid status – FOL or dehydration – results are not necessarily reflective of sodium diet intake

- Serum Na level = 135-145 mEq/L

- Standard NKC Na dialysate bath = **135 mEq/L**

Sodium

- Mean predialysis serum sodium concentration for dialysis patients in the US is 138 mmol/L.
- Dialysate Na < 138 will remove sodium from the patient.
- Dialysate Na > 138 will result in sodium infusion into the patient.



Diffusion

(Solvent moves by concentration gradient)

Low Dialysate Sodium

- Removes more sodium from the patient during dialysis.

- Leaves a patient less thirsty and therefore less likely to drink fluid in between dialysis treatments.

<u>Downside</u>

- More likely associated with intradialytic hypotension & possibly cramping & headache.

Higher Dialysate Sodium

Benefit

- Better for hemodynamic stability during the dialysis treatment (less hypotension).

Downside

- Positive sodium balance.
- More sodium in the patient stimulates thirst and promotes volume expansion.

Hypernatremia

- Serum Na **>145 mEq/L**

- Signs & symptoms
  - Excessive thirst
  - Hypertension
  - Lethargy
  - Confusion

- Possible causes:
  - Dehydration
  - Diarrhea, Vomiting
  - Fever, sweating
  - Bleeding

Hyponatremia

- Serum Na **<135 mEq/L**

- Signs & symptoms
  - Nausea with vomiting
  - Headache
  - Cramps
  - Confusion

- Possible causes:
  - Fluid overload
  - Diuretics
  - Hormone imbalances

Sodium – Hyper & Hypo

- Nursing implications:
  - Assess patient – evaluate possible cause(s)
  - Evaluate serum Na levels – always look at trends
  - Consider advantages & disadvantages of higher or lower Na dialysate bath
  - Notify MD if symptoms persist or worsen
  - If trend continues, refer to RD for further evaluation

Carbon Dioxide & Bicarbonate

- The relationship between carbon dioxide (CO2) & bicarbonate (HCO3) has to do with the metabolic acidosis condition of patients with kidney failure.

- An abnormally high acid level in the body is detected with a test that measures a form of carbon dioxide (CO_2) that's dissolved in the blood called *serum bicarbonate*. *(NKF, 2019)*

Carbon Dioxide & Bicarbonate

- Bicarbonate is referred to as a *base*, which the body needs to help keep a normal acid-base (pH) balance. This balance prevents your body from becoming too acidic. *(NKF, 2019)*

- We use Sodium Bicarbonate in HD to treat the metabolic acidosis of our patients

Metabolic Acidosis

- Signs & symptoms – mostly vague
  - Tachycardia
  - Headaches / confusion
  - Weakness or c/o feeling very tired
  - Vomiting or GI upsets
  - Loss of appetite

- Long term complications
  - Bone loss / weak bones
  - Muscle loss
  - Endocrine disorders

Carbon Dioxide & Bicarbonate

- CO2 goal level: **>22**
- NKC standard bicarb bath = 33meq/L

- Nursing Implications:
  - Assess patient for signs & symptoms of metabolic acidosis
  - Evaluate current result vs trend
  - If trend is lower than goal, consult with MD to increase dialysate bicarb level

Albumin

- It is the protein that body uses to transport electrolytes, hormones, & fatty acids
- Protein is important in cell repairs & inflammatory response
- It is the main contributor to oncotic pressure that helps fluid to stay in or move to the vascular space = easier fluid removal during dialysis

Goal: >4.0 gm/dL

- Low levels contribute to higher morbidity & mortality rate on ESRD patients

Albumin

- Hypoalbuminemia <3.6g/dL

- Nursing Implications
  - Evaluate contributing factors especially changes in health & living status, dental problems, recent hospitalization
  - Evaluate recent vs trend results
  - Refer to RD

**_Remember_ – dialysis triggers inflammatory responses resulting in the body using more protein for cell repair resulting in lower albumin level

What Tools Do We Have?

How can you quickly review & act on chemistry 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:

Auburn Kidney Center — **monthly lab review**

1501 West Valley Highway N, Auburn, WA 98001

02/01/2021 to 02/18/2021

Collected	Patient Name	Schedule	Shift	K	CA	PHOS	CO2	ALB	AL	GLU	HA1C
02/02/2021		STTh	Shift 3	5.2	9.9	4.7	21	3.9			
02/02/2021		STTh	Shift 3	3.8	9.8	5.6	27	4.0		433	
02/02/2021		STTh	Shift 3	3.8	9.7	8.0	28	3.9			
02/02/2021		STTh	Shift 2	3.9	9.5	2.9	25	4.0		161	
02/02/2021		STTh	Shift 1	4.7	9.9	4.5	27	3.6		108	
02/02/2021		STTh	Shift 2	4.8	10.4	8.4	25	4.3		104	
02/02/2021		STTh	Shift 1	4.4	9.3	6.8	27	3.8		95	
02/02/2021		STTh	Shift 1	4.3	9.5	8.2	23	4.0		157	
02/02/2021		STTh	Shift 2	5.0	9.0	3.9	25	4.1		108	

What Tools Do We Have?

Also run the "Clinic" report from Clarity titled "Hemodialysis Bath Information"

- It shows current K & Ca results & bath orders
- Do you need to make any adjustments based on the lab result & current bath orders

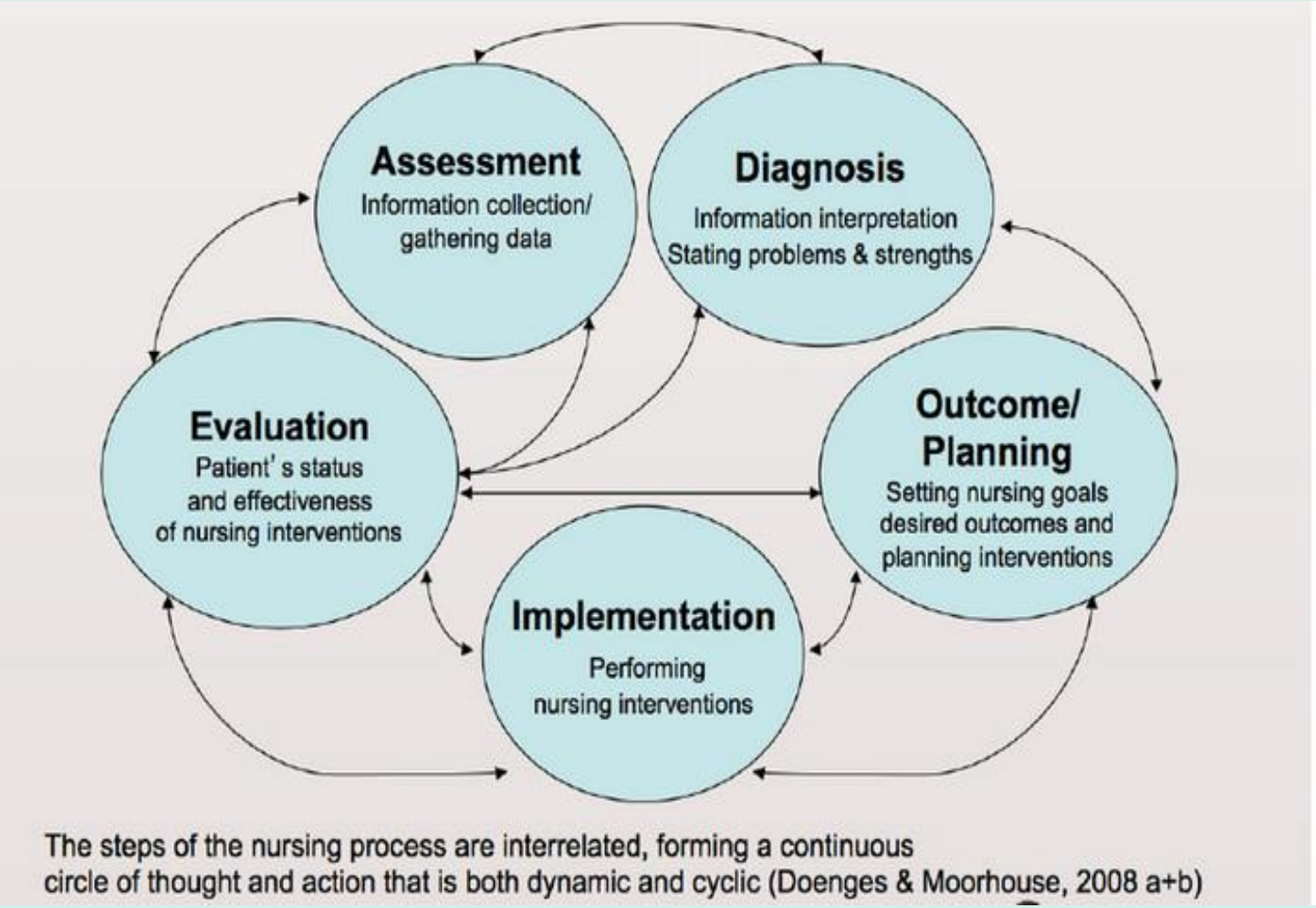
Hemodialysis Bath Information

Northwest Kidney Centers - Auburn Kidney Center

Report Date: 02/18/2021 09:12

Patient Name	Prescription Type	Bath Orders	Current K+		Current Ca+2(cor.)	
	* Outpatient Hemodialysis	K 2.0 Ca 2.50 HCO3 40.0	02/02/21	5.5	02/02/21	10.3
	* Outpatient Hemodialysis	K 3.0 Ca 2.50 HCO3 33.0	02/03/21	4.1	02/03/21	9.9
	* Outpatient Hemodialysis	K 1.0 Ca 2.50 HCO3 33.0	02/10/21	6.4	02/03/21	11.0
	* Outpatient Hemodialysis	K 3.0 Ca 2.50 HCO3 33.0	02/02/21	5.1	02/02/21	9.4
	* Outpatient Hemodialysis	K 2.0 Ca 2.50 HCO3 35.0	02/03/21	5.4	02/03/21	9.4
	* Outpatient Hemodialysis	K 3.0 Ca 2.50 HCO3 33.0	02/02/21	4.6	02/02/21	9.2
	* Outpatient Hemodialysis	K 2.0 Ca 2.50 HCO3 33.0	02/02/21	4.7	02/02/21	9.3
	* Outpatient Hemodialysis	K 2.0 Ca 2.50 HCO3 35.0	02/03/21	6.0	02/03/21	9.6
	* Outpatient Hemodialysis	K 3.0 Ca 2.50 HCO3 33.0	02/02/21	4.1	02/02/21	9.6
	* Outpatient Hemodialysis	K 2.0 Ca 2.50 HCO3 33.0	02/04/21	4.2	02/04/21	9.5
	* Outpatient Hemodialysis	K 2.0 Ca 2.50 HCO3 31.0	02/05/21	4.3	02/05/21	8.6
	* Outpatient Hemodialysis	K 2.0 Ca 2.50 HCO3 30.0	02/03/21	5.5	02/03/21	8.5
	* Outpatient Hemodialysis	K 3.0 Ca 2.50 HCO3 35.0	02/02/21	5.7	02/02/21	9.3

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)

Summary

- Main contributing factor for abnormal chemistry results on our patients is their kidney failure
- The goal of dialysis is to “normalize” some of those levels by way of diffusion and using appropriate levels of acid & base
- The rate of diffusion is affected by the concentration gradient and by other factors

Summary

- When evaluating results, it is important to look at the whole picture: patient condition, adequacy of dialysis, access, trends, contributing factors, and comorbid conditions

- Work with members of the IDT, especially the RDs, when trying to resolve abnormal results

References

- *Ascend Lab Check*. (2021). Retrieved from Lab Results: https://labcheck5.com/app/Patient/Results/Index/406844
- Brockenbrough, A. (2019). Dialysate. Kent. Retrieved January 2021
- *Clarity*. (2021). Retrieved from Patient Chart View Lab Results: https://id.visonex.net/IdMg/
- *Core Curriculum for Dialysis Technician.* (2012). Madison: Medical Education Institute.
- Counts, C. (2015). *Core Curriculum for Nephrology Nursing* (Sixth ed.). Pitman, NJ: ANNA.
- *K-NET (1).* (2018, December). Retrieved from Chronic Maintenance In-Center Hemodialysis Standing Orders: https://knet.nwkidney.org/docs/1399914623044.pdf?t=637480214579092318
- *NKF (1)*. (2019, September 4). Retrieved from Facts About Metabolic Acidosis and Chronic Kidney Disease: https://www.kidney.org/atoz/content/facts-about-metabolic-acidosis-and-chronic-kidney-disease
- Wilkens, K., Nygren, N. G., Shanaman, B., Smith, V., & Anstley, A. (2019). *The Art of Good Eating.* Seattle: Northwest Kidney Centers.
- Wolfgram, D. (n.d.). *Albumin: Important Facts You Should Know*. Retrieved from Wisconsin Dialysis Web site: https://www.wisconsindialysis.org/kidney-health/healthy-eating-on-dialysis/albumin-important-facts-you-should-know/

Questions