Hemodialysis 101

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Objectives

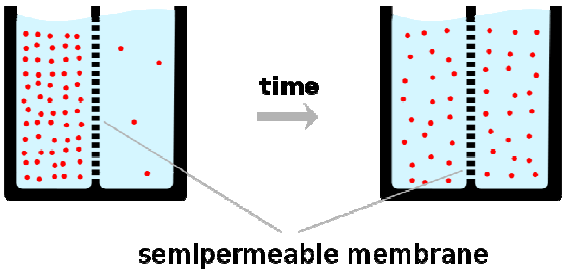
- Review general principles of hemodialysis including fluid management in ESRD
- Differentiate types of dialysis vascular accesses
- Discuss complications associated with ESRD & dialysis therapy
- Review dialysis adequacy markers and troubleshooting techniques to achieve adequacy

I don't care what day it is.
Four hours is four hours.

PRINCIPLES OF HEMODIALYSIS

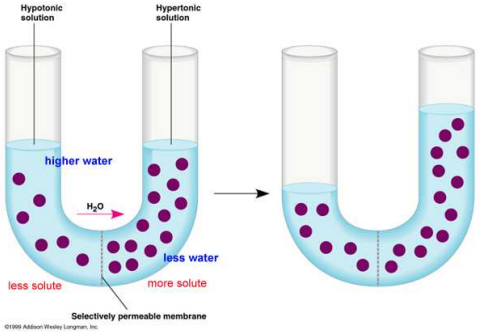
Diffusion

- Movement of molecules from an area of ***high*** concentration to an area of ***low*** concentration across a semipermeable membrane
- Occurs when there is a ***concentration*** gradient



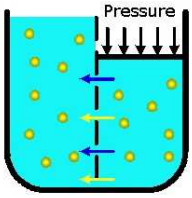
Osmosis

- Movement of water across a semipermeable membrane from an area of ***low solute*** concentration to an area of ***high solute*** concentration in order to reach equilibrium



Ultrafiltration

- Process by which plasma water is removed during hemodialysis because of a **pressure** gradient (osmotic & hydraulic)

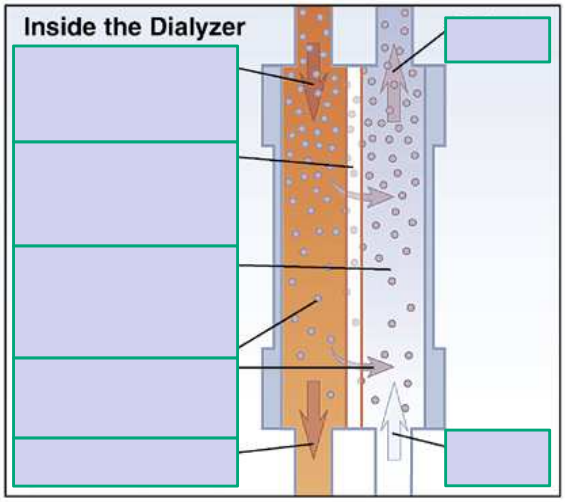


Ultrafiltration
(Solution moves by pressure gradient)

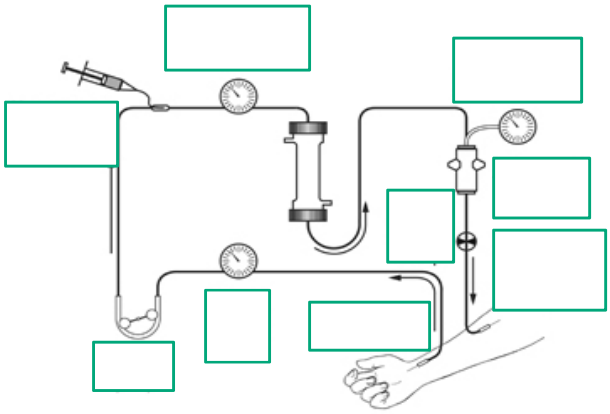
Convection

- Movement of solutes across a semipermeable membrane together with fluid, in response to a transmembrane pressure (TMP)
- Also known as "solute drag"
- Enhances removal of small and mid-sized molecules

Inside the Dialyzer



Hemodialysis Flow Schematic



Dialytic Solute Clearance

Blood		Dialysate
Na = 140 mEq/L	→	Na= 140 mEq/L
K = 4.5 mEq/L	→	K= 2 mEq/L
Cl =100 mEq/L	→	Cl= 100 mEq/L
CO2 = 24 mEq/L	←	HCO3=35 mEq/L
BUN = 30 mg/dL	→	Urea=0 mg/dL
Cr = 5 mg/dL	→	Cr=0 mg/dL
Glucose = 100 mg/dL	→	Dextrose= 200 mg/dL
Calcium=1.2 mmole/L	→	Calcium=2.5 mEq/L
Phosphorus=4 mg/dL	→	Phosphorus = 0 mg/dL
Magnesium=2 mg/dL	→	Magnesium=1.2 mg/dL
Vit B12 = 500 pg/mL	←	Vit B12= 0
Albumin = 4 g/dL	→	Albumin =0

Intermittent Hemodialysis

- KRT used to treat AKI and ESRD
- Patients typically dialyze 3 days a week for 3-5 hours at a time

Evidence Based Medicine: *Minimum Dialysis Time & Frequency*

Dialysis Outcomes and Practice Patterns Study (DOPPS)

22,000 HD patients

Session length **greater than four hours**, compared with shorter times

- Associated with a lower risk of all-cause and cardiovascular mortality
- Lower risk of sudden death
- Lower pre- and postdialysis systolic blood pressure
- Greater intradialytic weight loss
- Higher hemoglobin and serum albumin
- Lower serum phosphorus and white blood cell counts

Tentori F, Zhang J, Li Y, et al. Longer dialysis session length is associated with better intermediate outcomes and survival among patients on in-center three times per week hemodialysis: results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). Nephrol Dial Transplant 2012; 27:4180

Factors that Influence Dialysis

- Molecular weight
- Dialysate temperature
- Membrane permeability
- Membrane surface area
- Membrane resistance (clotting, line kinks, etc)
- Flow geometry
- Ultrafiltration
- Time
- Patient tolerance

Heparin

- Given to prevent clotting of the extracorporeal circuit
- Standard dose 100 u/kg
- Antidote is protamine sulfate
- Half life is approximately 2 hours
- "Tight Heparin" is the minimum amount of drug required to keep the system from clotting (Low dose = Approximate 50 u/kg)

On-Line Urea Clearance Monitoring

- Fresenius machines on-line clearance monitoring (OLCM) module estimates the delivered urea clearance by measuring the change in dialysate conductivity during a brief change in the sodium level
- The mean K_{ECN} is calculated as the average of six OLCM measurements during the treatment; reflection of heparinization
- The subscript indicates that the Effective clearance is determined from the Conductivity of Na (sodium)
- The "traffic light" on top of the HD machine is officially known as the AMP light, where AMP stands for "Adequacy Monitoring Program

Infection Control and Machine Maintenance

- The outer surface of the dialysis machine is cleaned after every patient
- At the end of the day, a strong acid (vinegar) is used to break down residual bicarb on the inner fluid pathways of the machine which (if left in place) could corrode machine parts
- The inner fluid pathways are then disinfected using heat or a strong chemical (bleach)

Hepatitis B Virus

- All dialysis patients must have documented evidence of hepatitis B status
- Two labs are drawn:
  - Hepatitis B Surface Antigen
    - Reactive: Patient *has* Hep B
    - Nonreactive: Patient does *not* have Hep B
  - Hepatitis B Surface Antibody
    - Positive (greater than 12 mIntUnit/mL): Immune to HBV (Occurs as a result of receiving Hep B vaccine series)
    - Negative: Susceptible to HBV
- RNs caring for patients with HBV must do so in isolation
- RN may care for other patients without HBV but those patients *must* have antibodies to the virus

Test	Result	Interpretation

Dialyzer Reuse/Reprocessing

- Pros
  - Avoid first use syndrome (ETO sensitivity)
  - Cost savings
- Cons
  - Potential infusion of germicide
    - Burning, taste of gasoline, SOB, CP, N/V, hypotension, hemolysis, crenation (shriveling of RBCs) AKA "black blood"
  - Potential for sepsis if dialyzer wasn't thoroughly disinfected
  - Potential for dialyzer mixup

Dialyzer Reuse/Reprocessing

- Completely voluntary
- Hep B clients may not participate

Comparison of Dialysis Modalities

Dialysis Modality	Length of Tx	Frequency	Indications	Contraindications	Complications

FLUID MANAGEMENT IN DIALYSIS

Fluid Removal via Hemodialysis

- Fluid is removed from the patient during hemodialysis by ultrafiltration
  - Fluid removal through application of hydraulic pressure
- Patients are weighed at the beginning and end of each dialysis treatment and fluid removal goals determined by the nephrologist and dialysis nurse

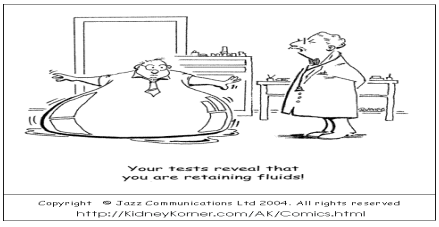
Fluid Removal via Hemodialysis

- Each dialysis patient has a goal weight (called a "dry weight") that he/she should weigh by the end of each dialysis treatment
- Fluid removal goal is determined based on how positive he/she is from his/her dry weight
- Each 1 liter of fluid = approx. 1 kg of fluid
- If a patient with a dry weight of 70kg weighs 74kg before dialysis, an ultrafiltration goal of 4L is selected
- Patients are weighed after each dialysis treatment to determine effectiveness of fluid removal
- Most effective measure of fluid removal is weight

Dry Weight Management: *Volume Overload in ESRD*

- **Precipitating factors:**
  - ↑ Serum sodium
  - ↑ Extracellular fluid
- **Mechanism of Action:**
  - Inability to excrete sodium effectively
  - Increase in overactivity of the RAAS resulting in increase aldosterone production
- **Assessment:**
  - Weight gain
  - ↑ BP
  - ↑ Heart rate
  - SOB/↑ RR
  - JVD
  - Peripheral edema

- **Treatment:**
  - Restriction of salt intake
  - Diuretics: Loops on non-dialysis days
  - Extra HD sessions or longer daily session to increase UF
  - SEQ dialysis X 1 hour to increase UF rate



Ultrafiltration & Mortality

- Ultrafiltration rates greater than 13mL/kg/hr are associated with **increased all-cause and cardiovascular mortality**
- Ultrafiltration rates greater than 10- 13mL/kg/hr are associated with CHF
- Max Ultrafiltration
  - **10-13 mL/kg/hr + prime**
  - **UF rate /hour is the critical determinant NOT the total volume**
  - Example:
    - EDW 80kg
    - Calculation: 80kg X 13mL/kg/hr = 1040mL/hr (Max UF Hourly Rate)
    - Rx Time @ 4 hrs = 1040 X 4 = 4160 mL/4 hours
    - Rinse = 500mL
    - Total Goal Set: 4160 + 500 = 4660mL

Jefferies HJ, Virk B, Schiller B, Moran J, McIntyre CW. Frequent hemodialysis schedules are associated with reduced levels of dialysisinduced cardiac injury (myocardial stunning). Clin J Am Soc Nephrol. 2011;6:1326-1332.

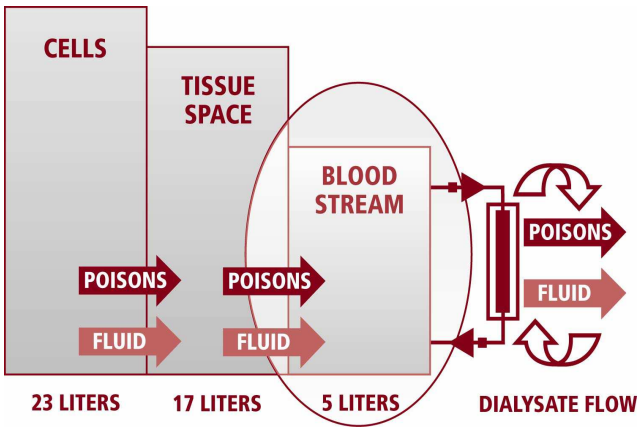
Flythe JE, Kimmel SE, Brunelli SM. Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. Kid Int. 2011: 79: 250-257

Plasma Refill Rate

- Ultrafiltration Rate (UFR)= Rate of fluid removed from the intravascular space
- Plasma Refill Rate (PRR)= Rate of fluid entering the intravascular space

UFR<PRR

Plasma Refill and How Ultrafiltration Works



Water Treatment for Hemodialysis

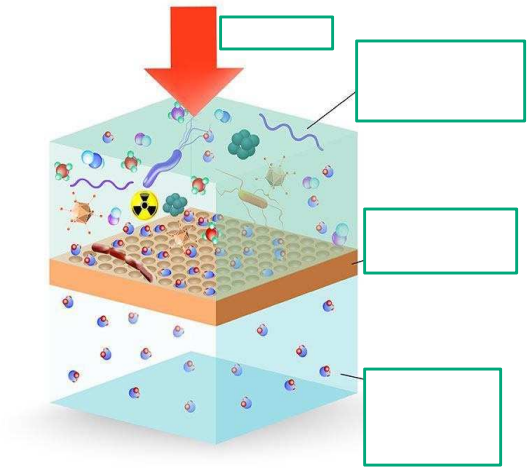
Functions of Water Treatment Devices

- **Multimedia tank**
  - Filters sediment from incoming water source (city water)
- **Carbon tank #1** (**worker**)
  - Clears water of chloramines and chlorine
- **Carbon tank #2** (**polisher**)
  - Backup in case first tank fails
- **Water softener**
  - Exchanges sodium ions for Mg+ and Ca2+ to preserve life of RO
- **Reverse osmosis unit**
  - Filters water of ions, bacteria yielding pure water
- **RO unit**
  - Should reject 90% of water (only **10%** goes to dialysis machines for use)

Functions of Water Treatment Devices

- **Deionizer (DI)**
  - Backup system for failing RO or used as polisher for RO
  - Removes ions but does not filter bacteria because bacteria does not contain an ionic charge
- **Endotoxin filters**
  - Filters water of endotoxins
  - Water must go through an endotoxin filter to remove bacteria

REVERSE OSMOSIS



What Happens if the Water Treatment System Fails?

- Multimedia filter
  - No patient effect – Will wear out the life of the RO quickly
- Carbon tank #1 (**worker**)
  - No patient effect so long as polisher is still functional
- Carbon tank #2 (**polisher**)
  - Bleed through of chloramines and chlorine causes hemolysis, leading to eventual death
- Water softener
  - In theory, nothing
  - However, on the exam, nausea and vomiting
- Endotoxin filter
  - Pyrogenic reaction

AAMI Water Standards to Know

- Water cultures
  - <100 CFU/mL
- Action level for water cultures
  - 50 CFU/mL
- Endotoxins (LAL)
  - <0.25 EU/mL
- Action level for endotoxin LAL
  - 0.125 EU/mL
- Chloramines
  - 0.1 mg/L

AAMI Standards

Chloramines and Chlorine

- Check after worker carbon tank at beginning of the day, before every patient shift, or every 4 hours
- If bleedthrough occurs after worker tank, check after polisher tank
  - If negative after polisher, may continue to dialyze but must check for chloramines more frequently (q1-2 hours)
  - If positive after polisher, STOP dialysis! Remove all patients from machine immediately (do not rinse back blood)

Water Treatment: Question

If breakthrough of chloramines or chlorine is detected or in the water exiting the first carbon tank, then the next action taken should be to

A. Test after the second carbon tank for chloramine and chlorine breakthrough
B. Stop all hemodialysis treatments and divert patients to another facility
C. Take no further action at this time and retest in 2 hours
D. Both a and b

Water Treatment: Answer

If breakthrough of chloramines or chlorine is detected or in the water exiting the first carbon tank, then the next action taken should be to

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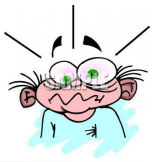
Severe Dialysis Complications

- Air embolism
- Hemolysis
- Dialysis disequilibrium syndrome (DDS)
- Suspected pyrogen reaction
- Hypertension
- Hypotension
- Loss of consciousness
- Blood loss
- Cramping

Dialysis Disequilibrium Syndrome (DDS)



- Occurs when the BUN is decreased too quickly
- Decrease in plasma concentration too quickly creates an osmotic gradient that promotes water movement
- Permeability of the blood-brain barrier in the presence of an osmotic gradient causes a shifting of water from the intravascular compartment into the brain cells, leading to cerebral edema
- S/S include change in LOC, N/V, vision changes, headache, increased pulse pressure, seizures, dysrhythmias, coma, and even death
- Tx: Prevention is key
- If it occurs, stop dialysis or decrease efficiency of dialysis
- Administration of Mannitol to increase serum osmolality

Infection Prevention

- Proper hand hygiene/PPE compliance is a must
- Machines are wiped down with appropriate disinfectant after each dialysis treatment
- Inner pathways are disinfected (i.e. bleached) after clients with known HBV and those whose status is unknown

Hemodialysis Complication: *Question*

Hemolysis during dialysis is related to exposure of the patient's blood to

A. Chloramines and nitrosamines
B. Formaldehyde
C. High dialysate temperatures
D. All of the above

Hemodialysis Complication: *Answer*

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B. Formaldehyde
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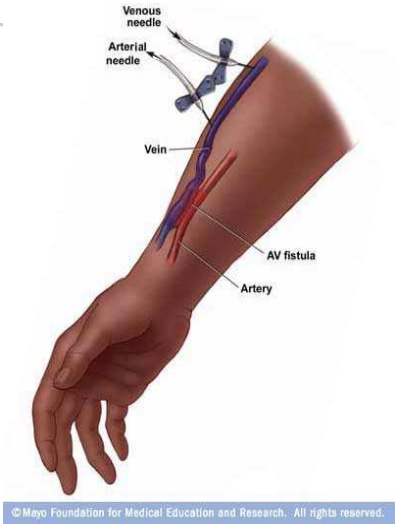
DIALYSIS VASCULAR ACCESS OVERVIEW

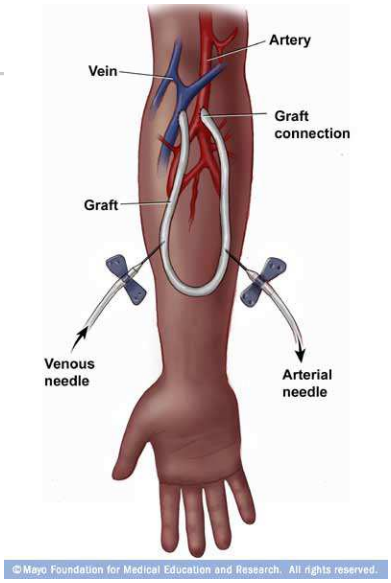
AV Fistula

- Anastamosis of patient's own artery and vein
- Gold standard for dialysis access
- Better blood flow rates (better dialysis) than other forms of access
- Performed in OR, takes 6-8 weeks to mature before it is able to be used
- Least chance of infection
- Typically placed in forearm



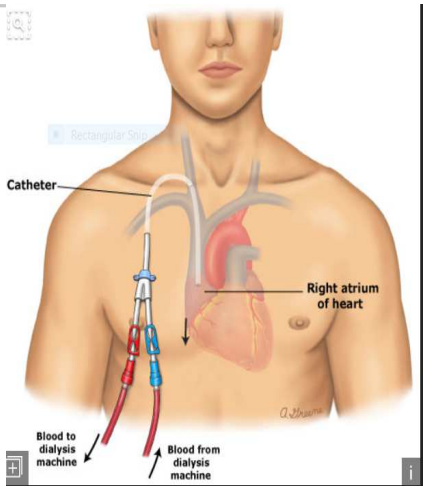
AV Graft

- Hollow synthetic tube that is surgically placed that connects an artery and a vein
- Usually placed in forearm or thigh of patient



Dialysis Catheters

- Tunneled, Cuffed Catheters (TCCs)
  - AKA Permcaths, Perma-caths, Permacaths or CVC
- Non-tunneled, non-cuffed catheters (NCCs)
  - AKA Vascaths



Chronic Catheters

Adequate catheter function is **BFR of greater than 300 mL/min**

- **Mechanical** the ability to sustain a **malfunction**
  - Blood cannot be withdrawn from the catheter
  - Saline cannot be infused into it
  - Low flow rates
  - High pressures

- **Obstruction**
  - Kinking of the catheter
  - Tight suture
  - Catheter pushed against the vessel wall)
  - Thrombotic
- **Differentiating**
  - Clinical evaluation
  - Cathogram

Chronic CVC Management Options

- Consider Heparin block change from 1000 U/mL to the 5000:1 U/mL
- Add Plavix 75mg 1 po qd/ASA Daily
- Dwell Activase in CVC overnight 1st
  - If no result then refer to Access Center: Cathogram/CVC exchange

- **Consider change HD order from Heparin dwell to Activase dwell qHD**

Comparison of Different Kinds of Dialysis Access

	Location	Advantages	Disadvantages

Access Evaluation – *Access Flows*

AVF access flow is less than 400 mL/min

AVG access flow is less than 600 mL/min

Arterial Pre-pump pressure is more than negative 250 mm Hg

25% decrease access flow from baseline

Inability to reach prescribed blood flow rate (including immature access)

Venous pressures is greater than ½ blood flow rate

Access Evaluation Details: *Where to Send?*

- **Access Center**
  - Ultrasound/Fistulogram/PC: Insert/Removal/Cathogram
  - Maturation visit/Initiate cannulation/Road maps
- **Hospital/IR**
  - No insurance
  - Can't stand/transfer to bed
  - Unable to lie flat
  - Weight limits
  - Central Stenosis
  - Unable to hold Coumadin/Bridge needed
- **Vascular Surgeon**
  - Initial/Re-evaluation
  - Aneurysmal evaluation
  - HeRO AVG issues

Procedure Details:

- ***NPO 6 hrs prior***
- ***Driver needed***
- ***Sedation used: Fentanyl/Versed***
- ***Hemodynamically stable***
- ***Coumadin → Hold 2 days vs. Heparin bridge***
- ***Avoid NSAIDs prior to procedure***
- ***Bring list of home meds***

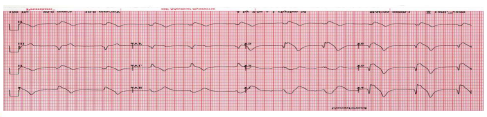
COMPLICATIONS OF ESRD

Uremia/Inadequate Symptoms

- Confusion
- Anorexia
- Nausea
- Vomiting
- Angina
- Dyspnea
- Insomnia
- Loss of Libido
- Uremic Frost
- Acidosis
- Pericarditis
- Pericardial Effusion
- Pericardial Tamponade
- Hyperkalemia
- Pruritis/Itching
- RLS
- Peripheral Neuropathy

Hyperkalemia (K^+)

- 98% of total body potassium is intracellular; remaining 2% is in serum
- s/s of hyperkalemia: weakness, ECG disturbances (with bradycardia), cardiac arrest
- **For every decrease in pH by 0.1, there is an increase of K^+ by 0.6**



- Management of hyperkalemia in patients are dialysis is aimed at ensuring compliance with dialysis treatments and limiting foods high in potassium
- Remove K+ from body
  - Cation exchange resin (Kayexalate)
  - Loop or thiazide diuretic
  - Fludrocortisone (artificial aldosterone—usually used in the non-acute setting)
  - Hemodialysis

CVD & Dialysis Patients

- Hemodialysis patients have higher rates of cardiovascular disease than the general population
- Therapeutic interventions to prevent and treat cardiovascular disease do not yield the same benefits in the hemodialysis population
- ACE-I/ARB's: benefits in cardiovascular mortality are less in dialysis patients

- **Aspirin:** has not been shown to reduce cardiovascular events in dialysis patients.
  - Am J Kidney Dis. 2007 Oct;50(4):602-11
- **Statins:** do not improve cardiovascular outcomes in dialysis patients.
  - Cochrane Database Syst Rev. 2013 Sep 11;9:CD004289.
- **Beta Blockers**: no benefit on cardiovascular outcomes
  - Nephrol Dial Transplant. 2012 Apr;27(4):1591-8.

Anemia of ESRD

- **Medicare Improvements for Patients and Providers Act of 2008 (MIPPA) = BUNDLE**
  - Medications given with dialysis are no longer billed for separately by dialysis companies
  - **1/1/2011:**
    - The bundle payment includes dialysis treatments, dialysis labs and injectable medications like EPO & iron.
    - Oral iron will also be included for patients who perform their dialysis at home.

- **ESAs:** Epogen/Aranesp/Micera
- **IV Iron:** Venofer/Ferrlecit/Feraheme
- **New Anemia Treatment Parameters:**
  - **Hemoglobin 10 – 11.5 g/dL**
  - **Ferritin < 1200**
  - **Transferrin Saturation > 20% & < 50%**

Mineral Bone Metabolism in ESRD

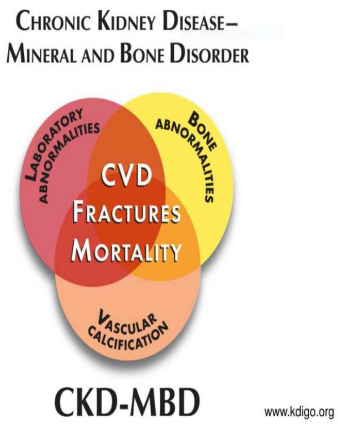
	KDOQI	KDIGO
Frequency of measurement of serum calcium and phosphorus		
Target serum calcium		
Target serum phosphorus		
Calcium intake		
Populations requiring specific types of binders		

KDOQI = Kidney Disease Outcomes Quality Initiative; KDIGO = Kidney Disease: Improving Global Outcomes; PTH = parathyroid hormone.

Kovesdy CP. *Semin Dial.* 2011;24:35-36.

Mineral Bone Metabolism in ESRD: *Treatments*

- Treatment of secondary hyperparathyroidism
  - Oral Calcitriol
  - IV Hectoral/Zemplar
  - Oral Sensipar
  - IV Parsabiv
- Treatment of hyperphosphatemia
  - Phosphorus binders



Parathyroidectomy in ESRD

INDICATIONS

- Severe hypercalcemia
- Progressive hyperparathyroid bone disease
- Consider if iPTH > 800 & resistant to therapy
- Progressive calcification
- Development of calciphylaxis
- Severe pruritis

SURGERY OPTIONS

- Subtotal parathyroidectomy
- Total parathyroidectomy with autotransplantation

Post Parathyroidectomy: *Hypocalcemia*

Chvostek Sign

- Spasm of facial muscles elicited by tapping on facial nerve
- Described as numbness/tingling

Trousseau's Sign

- Wrist spasm induced by inflating BP cuff on upper arm to a pressure exceeding systolic BP and leaving BP inflated for 3 minutes

Hypocalcemia – Chvostek & Trousseau

Chvostek

Eliciting Chvostek's sign

Begin by telling the patient to relax his facial muscles. Then stand directly in front of him, and tap the facial nerve either just anterior to the earlobe and below the zygomatic arch or between the zygomatic arch and the corner of his mouth. A positive response varies from twitching of the lip at the corner of the mouth to spasm of all facial muscles, depending on the severity of hypocalcemia.

Trousseau

KDOQI Nutrition Guidelines

- Protein Intake
  - CKD: 0.6gm/kg/day
  - Maintenance HD: 1.2gm/kg/day
  - PD and Acute Illness: 1.2-1.3gm/kg/day
- Caloric Requirements
  - Less than 60 years old: 35 kcal/kg/day
  - Greater than 60 years old: 30-35 kcal/kg/day

Take advantage of Oral Nutritional Supplement Programs (ONSP) if available
Indications: Albumin ≤ 3.5

DIALYSIS ADEQUACY
OVERVIEW

What is URR?

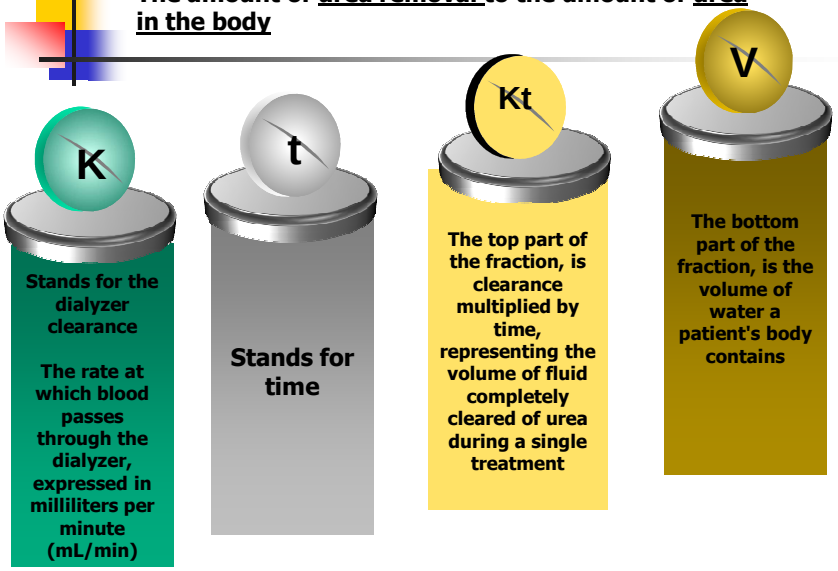
- URR stands for urea reduction ratio, meaning the reduction in urea as a result of dialysis
- URR is one measure of how effectively a dialysis treatment removed waste products from the body and is commonly expressed as a percentage
- Blood Urea Nitrogen (BUN) measures the urea concentration in the blood actually measures the **nitrogen content of the urea**

Example

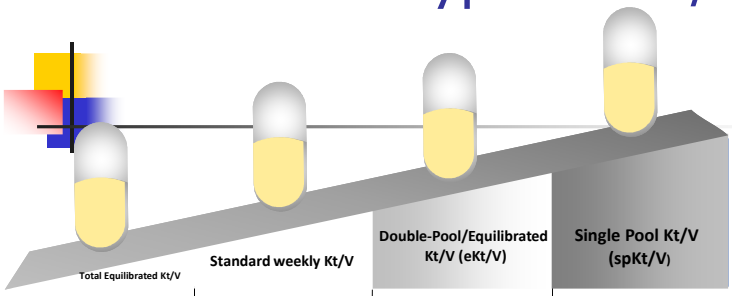
- Predialysis BUN is 50 mg/dL and the postdialysis BUN was 15 mg/dL
- The amount of urea removed was (PreBUN) 50 mg/dL – (Post BUN) 15 mg/dL = 35 mg/dL
- **URR is (PreBUN – PostBUN) 35/(PreBUN) 50 = 0.70 * 100 → 70%**

What is Kt/V?

- ✓ Kt/V is another way of measuring dialysis adequacy
- ✓ The amount of urea removal to the amount of urea in the body



Different Types of Kt/V's

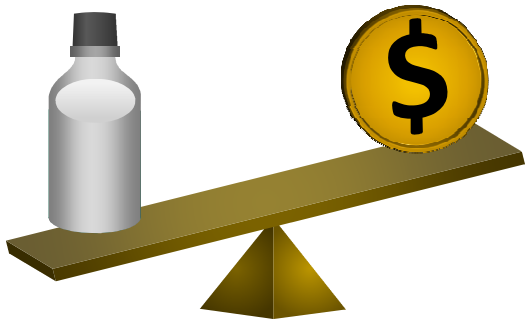


Total Equilibrated Kt/V	Standard weekly Kt/V	Double-Pool/Equilibrated Kt/V (eKt/V)	Single Pool Kt/V (spKt/V)
• Includes residual renal function	• Accounts for the total dialysis provided by multiple treatments in the week. • Allows "apples-to-apples" comparison of different HD treatment frequencies	• Allows for urea from the muscle to equilibrate with the blood (-0.2 lower) • eKtV takes into account the rebound (increase) of BUN that occurs just after stopping dialysis • Venous sample post dialysis 30 minutes • Tattersall equation estimates eKt/V, while UKM actually solves for eKt/V	• Non-equilibrated • Arterial blood drawn at the end of dialysis from the circuit • Daugirdas II equation (used in billing) calculates spKt/V

Adequacy Standards

In November of 2015, the National Kidney Foundation published an update to KDOQI standards, and included a recommendation that the target value be a spKt/V of 1.4 with a minimum value of 1.2

With the advent of the CMS Quality Incentive Program (QIP) and 5–Star classifications, the industry moved to a minimum value of spKt/V =1.2



KDOQI Clinical Practice Guideline for Hemodialysis Adequacy: 2015 Update. AJKD. November 2015; Volume 66. Issue 5. 884–930

Finalized PY 2018 Clinical Measure

Kt/V Dialysis Adequacy Measure Topic: Hemodialysis

Hemodialysis Adequacy Clinical Performance Measure III: Hemodialysis Adequacy--HD Adequacy-- Minimum Delivered Hemodialysis Dose Higher rate desired	
Measure Description	Percentage of hemodialysis patient-months with spKt/V greater than or equal to 1.2 NQF#0249
Numerator	Patient-mon… asurement period.
Denominator	Number of Medicare patient-months at the facility during the measurement period. Exclusions: 1. Patients younger than 18 years 2. Peritoneal patients 3. Patients on dialysis for fewer than 90 days 4. Patients dialyzing 4 times or more per week on average 5. Patients dialyzing 2 times or fewer per week on average 6. Patients having a spKt/V value less than 0.5 7. Patients having a spKt/V value greater than 2.5 8. Patients treated at the facility fewer than seven times during the claim month 9. Patients not on chronic dialysis as defined by a completed 2728 form, a REMIS/CROWNWeb record, or a sufficient amount of dialysis reported on dialysis facility claims
Minimum Claims	1
Data Source(s)	1. Medicare Claims 2. REMIS, CROWNWeb, and other CMS ESRD administrative data (form 2728 to obtain the diagnosis date of ESRD and date of birth)
Additional Information	1. Calculated from the last measurement of the month. 2. Must be calculated using UKM or Daugirdas II method. 3. Dialysis sessions per week is calculated as the number of dialysis sessions in the claim divided by the time period covered by the claim, with no rounding for the number of sessions per week. Frequent dialysis (4 or more sessions per week) is determined by (i) calculated sessions per week is 4 or more; (ii) Kt/V is 8.88 on claim; (iii) Other administrative data (e.g. CROWNWeb) indicates 4 or more sessions per week. 4. The reported spKt/V should not include residual renal function. 5. Patients with missing spKt/V values or spKt/V=9.99 (not reported) are included in the denominator.

Percentage of hemodialysis-patient-months with spKt/V greater than or equal to 1.2

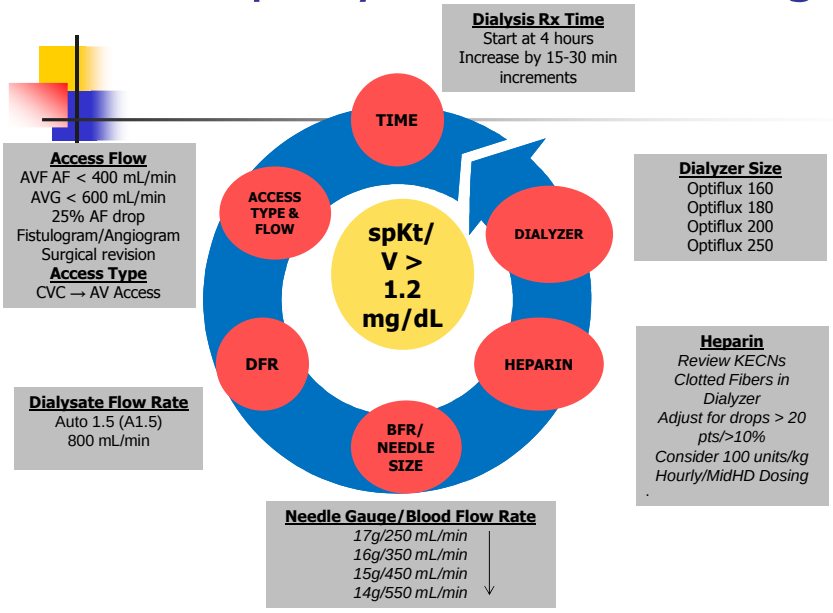
Optimal Amount of Dialysis

- Kt/V remains the preferred method for measurement of the dialysis dose
- Target a single-pool Kt/V of approximately 1.4 in order to ensure that a minimum spKt/V ≥1.2 is achieved

2006 Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines for hemodialysis patients with minimal residual renal function (<2 mL/min per 1.73 m^2):

- ✓ Minimally adequate dose should be a single-pool Kt/V of 1.2
- ✓ Target recommended dose should be a single-pool Kt/V of 1.4

Adequacy Troubleshooting



Hemodialysis Adequacy: *Question*

Harold is a 48 y/o ♂ with PKD who has been on HD X 6 mos. His dialysis RX is as follows: High flux dialyzer, 3:00, 3x/weekly, Q_B 400mL/min, access = AVF. He gains 3-5kg btwn each tx. Labs are as follows: Kt/V 1.2, URR 64%, Hgb 11.5g/dl, Hct 35%, Albumin 4.2.

In assessing Harold, which of the following may need to be adjusted?

A. Protein intake
B. Dialysis time
C. Epogen therapy
D. Antihypertensives

Hemodialysis Adequacy: *Answer*

Harold is a 48 y/o ♂ with PKD who has been on HD X 6 mos. His dialysis RX is as follows: High flux dialyzer, 3:00, 3x/weekly, Q_B 400mL/min, access = AVF. He gains 3-5kg btwn each tx. Labs are as follows: Kt/V 1.2, URR 64%, Hgb 11.5g/dl, Hct 35%, Albumin 4.2.

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Recap

- Review general principles of hemodialysis including fluid management in ESRD
- Discuss complications associated with ESRD & dialysis therapy
- Differentiate types of dialysis vascular accesses
- Review dialysis adequacy markers and troubleshooting techniques to achieve adequacy

Hilda! Remember to *unhook* the patients before discarding the tubing.

THANK YOU!

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