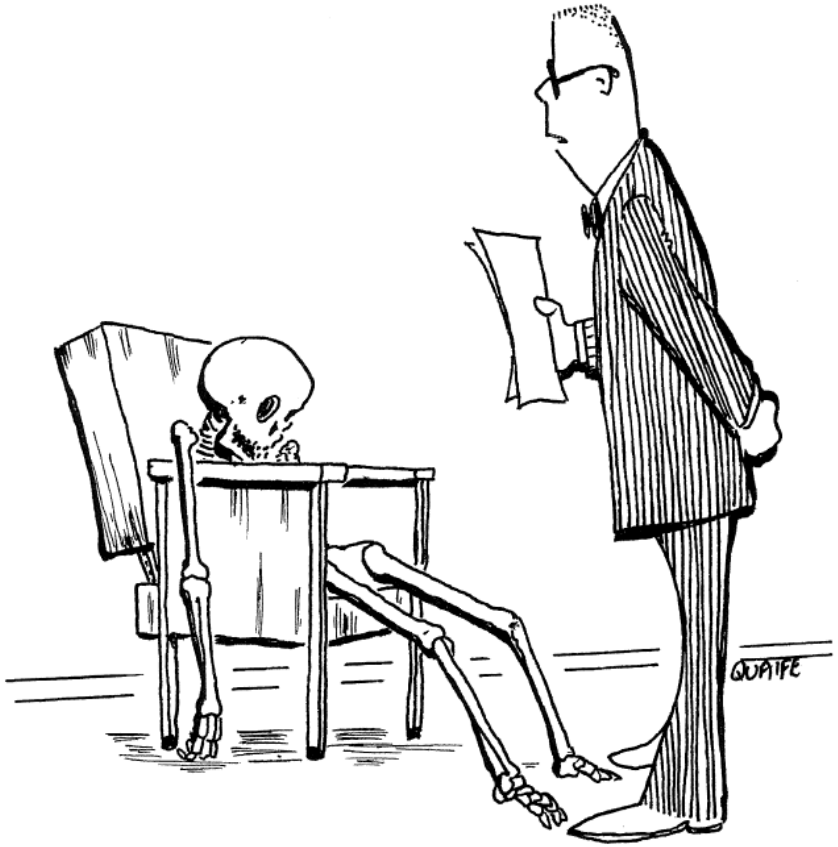
Good Assessment and Documentation Skills Can Lead to Improved Clinical Outcomes for Patients

Lynda K. Ball, MSN, RN, CNN

Objectives

1. Identify sources of non-dietary sodium that can potentially increase a patient's blood pressure.
2. Discuss how oxygen needs impact a dialysis patient's treatment.
3. Describe the impact of good physical assessment to achieve/exceed benchmark clinical quality indicators.
4. Explain how good documentation can legally protect staff.

Evaluating the Patient



I think we will have to lower your dry weight.

Source: Jazz Communications

Prescription

Definition:

- A written order, especially by a physician, for the preparation and administration of a medicine or other treatment.

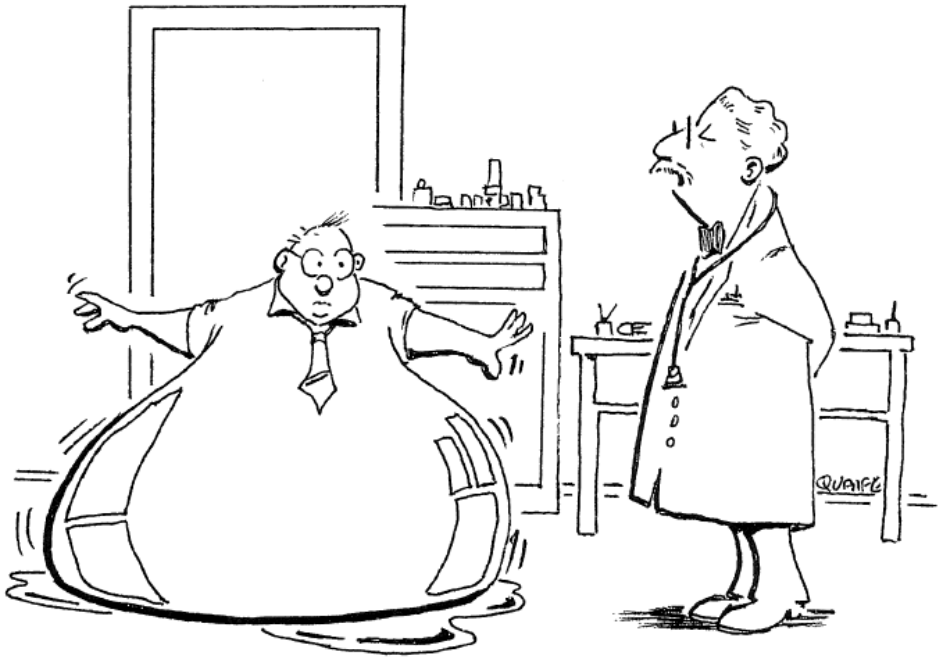
Source: yourdictionary.com

In Dialysis….

- Dialyzer size
- Bath (e.g., 2 K+, 2.5 Ca++)
- Time
- Blood flow rate
- Needle gauge
- Medications
- Standing orders

NURSING ASSESSMENT

Evaluating the Patient



Your tests reveal that
you are retaining fluids!

Source: Jazz Communications

Nursing Considerations

- Assessment of patients on hemodialysis:
  - Pre-dialysis
  - Intradialytic
  - Post-dialysis
- Sodium modeling
- Essential laboratory values
- Anemia management
- Hematocrit-based blood volume monitoring
- Morbidities and mortalities related to volume retention
- Patient education
- Correct weight documentation pre- and post-dialysis

Jugular Vein Distention

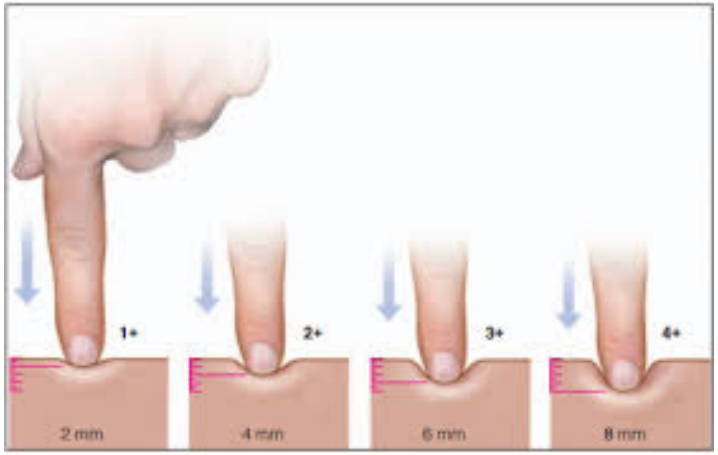
Source: emsbasics.com

Assessment for Edema

Source: osceskills.com

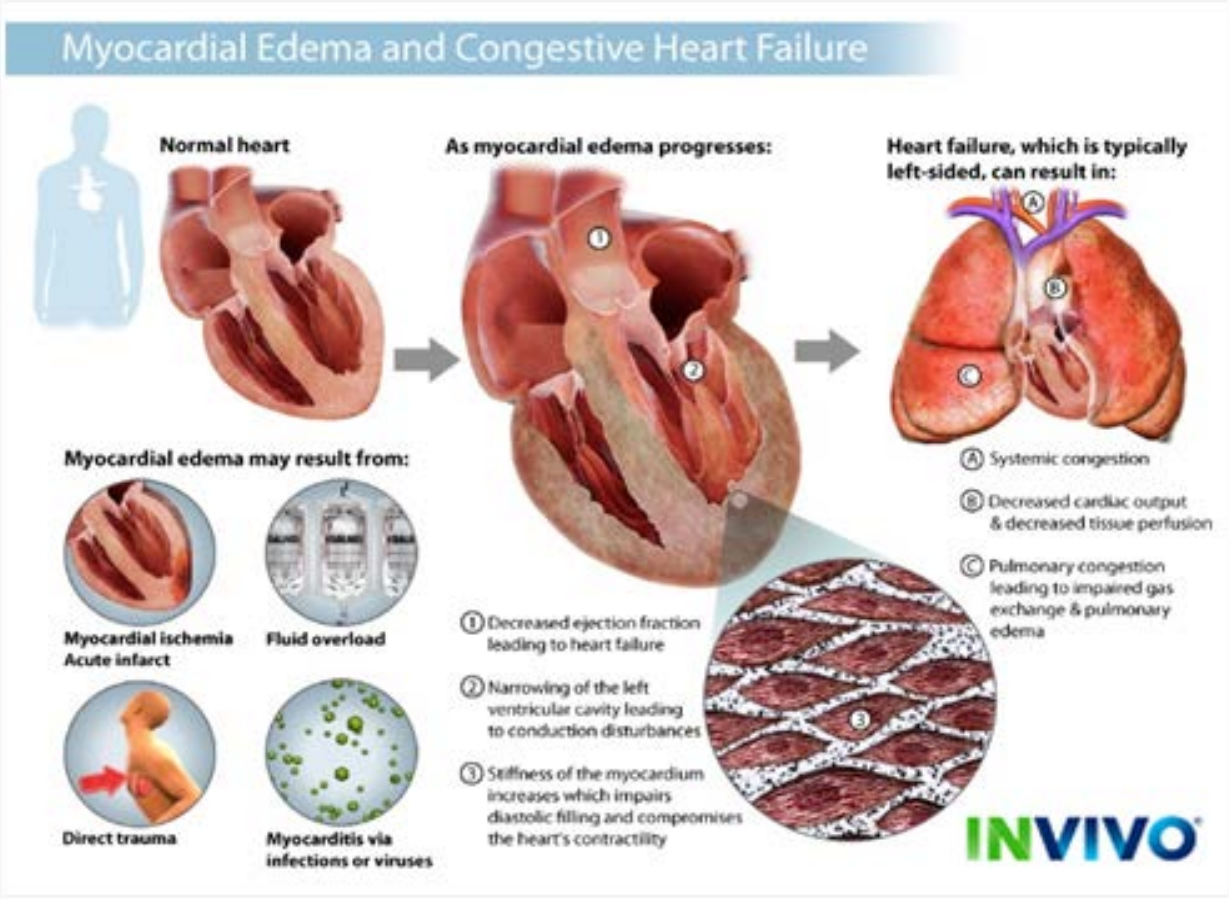
Source: imgbucket.com

Source: progressivehealth.com



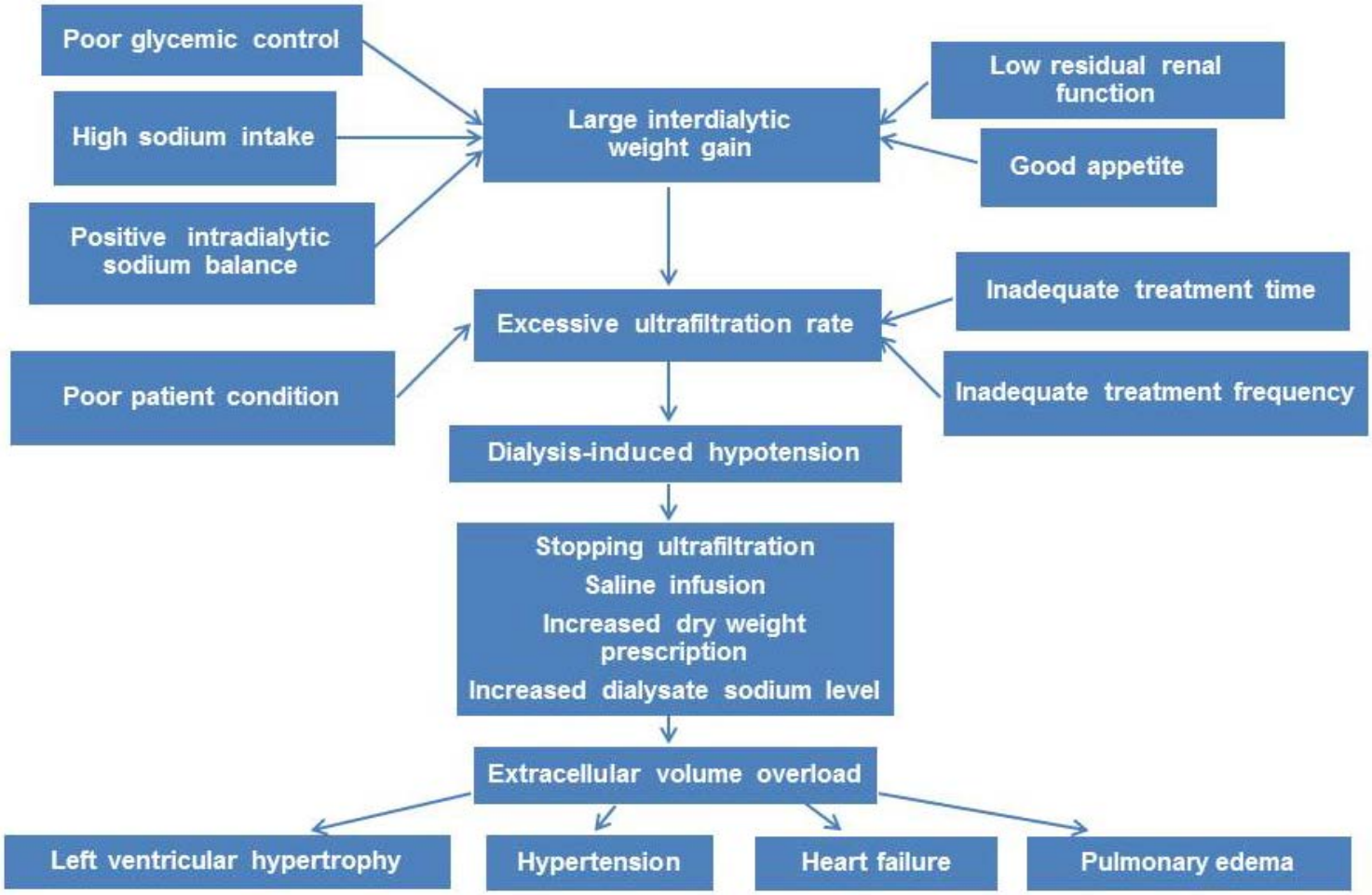
Source: med-health.net

Lung & Heart Sounds



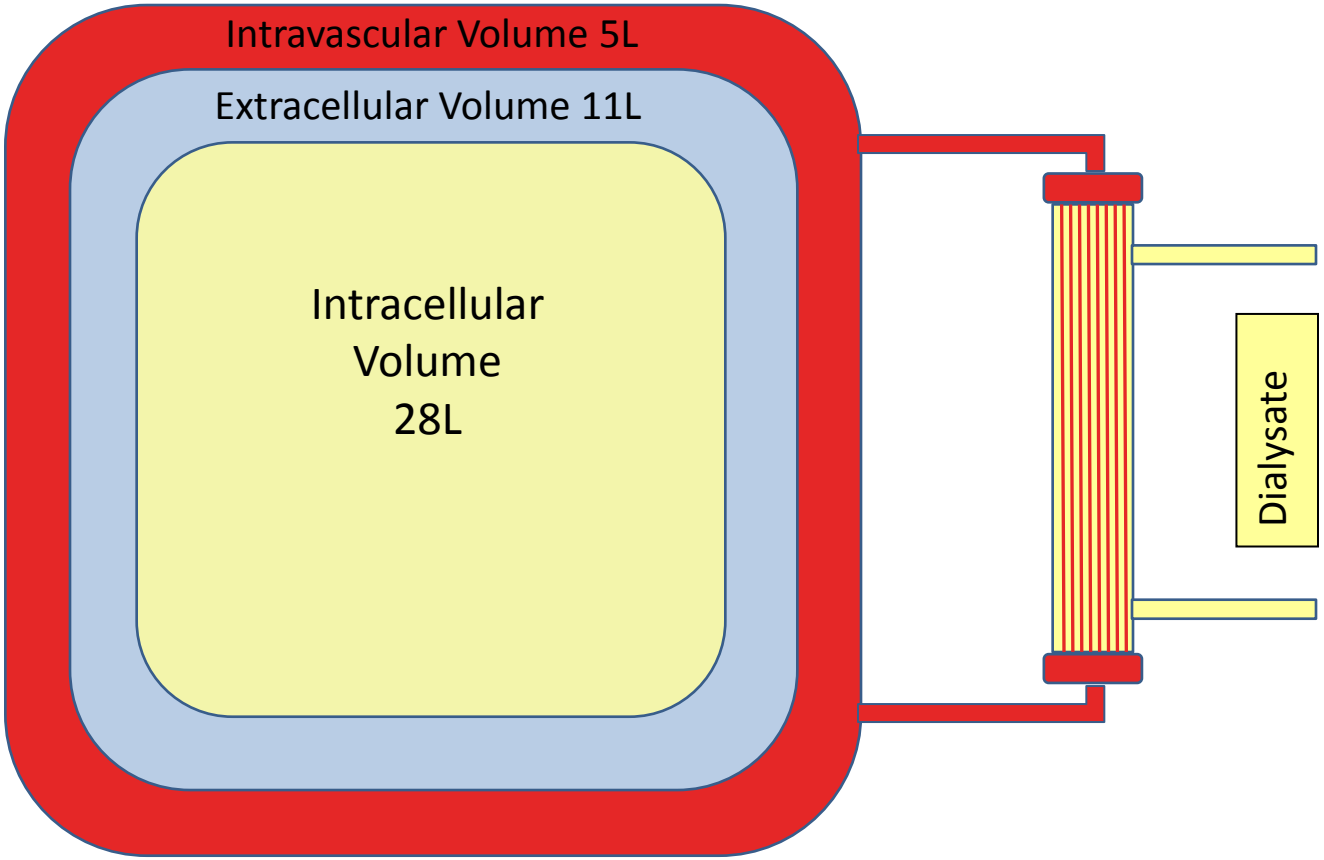
Source: Invivo.com

Relationship Between Ultrafiltration, Fluid Overload, Hypotension, and Dialysis Time



Source: Chazot & Jean, 2008

Three-compartment Fluid Model



Source: S. Ahmad, MD

Symptomatic Hypotension

Source: Meade, D.

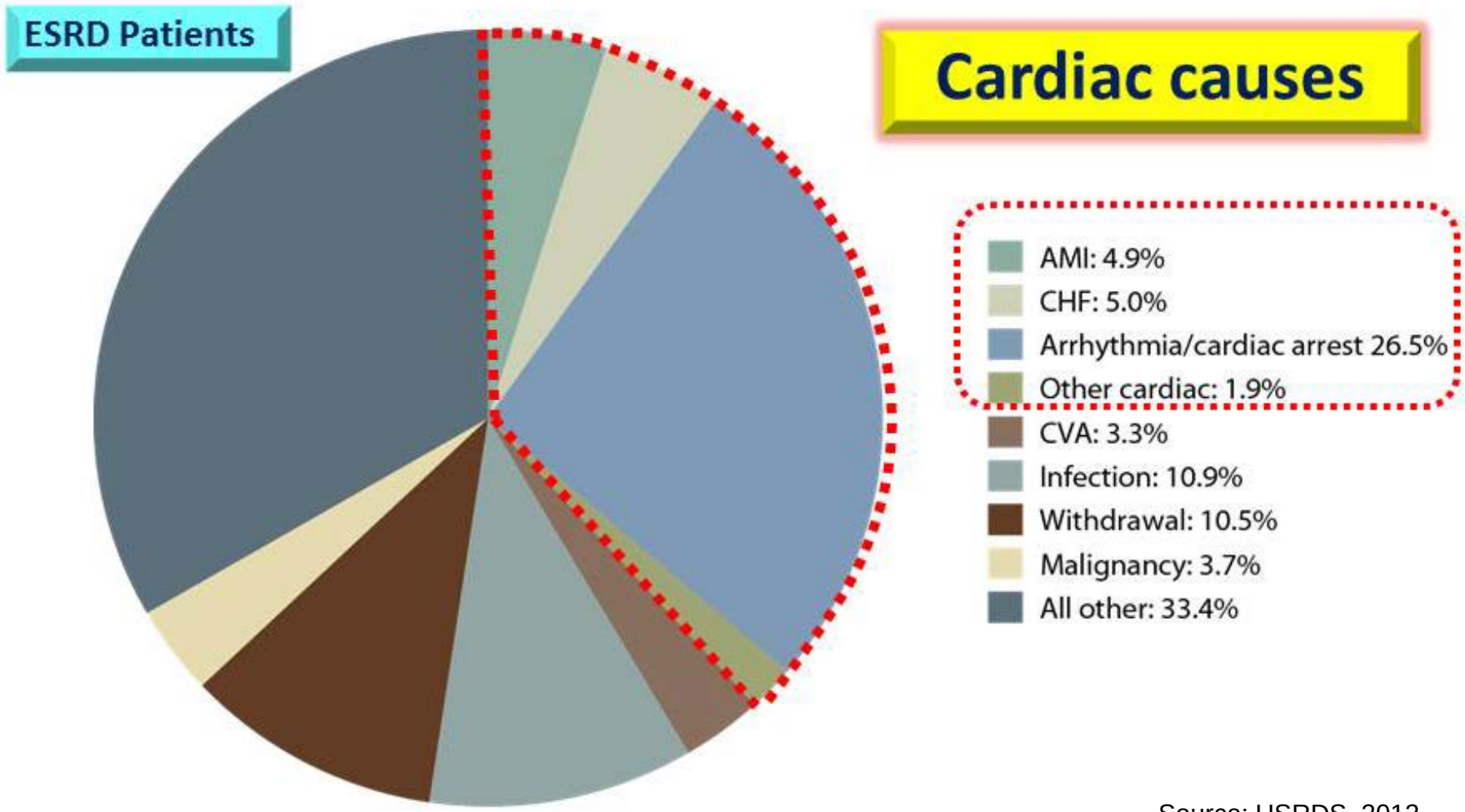
Independent Mortality Factors

Independent factors that increase mortality rates:

- Hypotension during dialysis; and
- Orthostatic hypotension post-dialysis.

(Shoji,Tsubakihara, Fujii, & Imai, 2004)

Causes of Death in Prevalent Dialysis Patients, 2008–2010



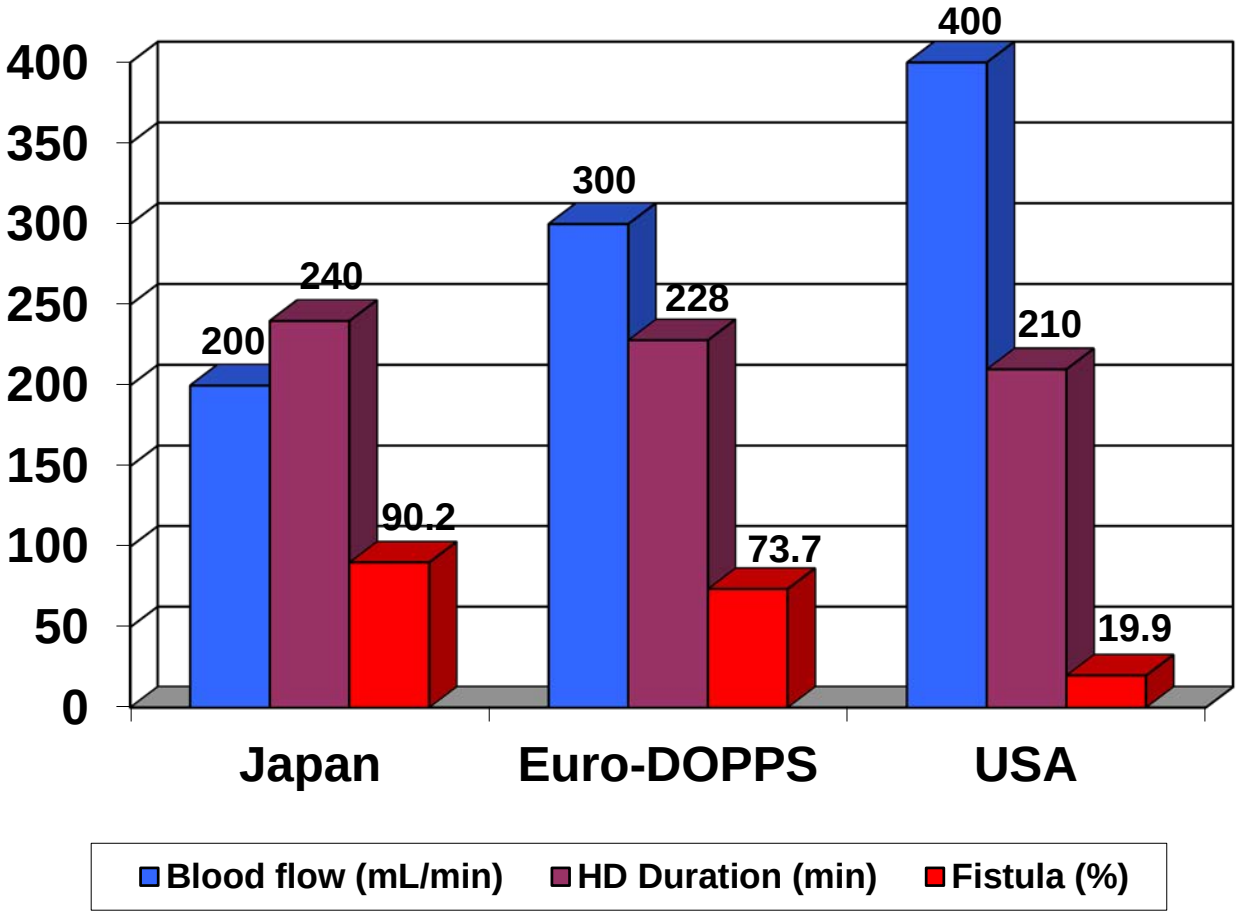
Source: USRDS, 2012

Historical Perspective

	Sodium mEq/L	Outcomes
Kolff	126.6	• Longer Time • ↓ HTN 10 -30 % • ↓ Thirst • ↓ IDWG
1960	130 - 135	
1970	130 - 135	
1980	135 - 145	
Current	>140	• Shorter Time • ↓ Hypotension? • ↓ Muscle Cramps? • ↓ Disequilibrium Syndrome?

Source: Flannigan, 2004

Dialysis Outcomes and Practice Pattern Study (DOPPS) Comparison Data



Source: P. Held

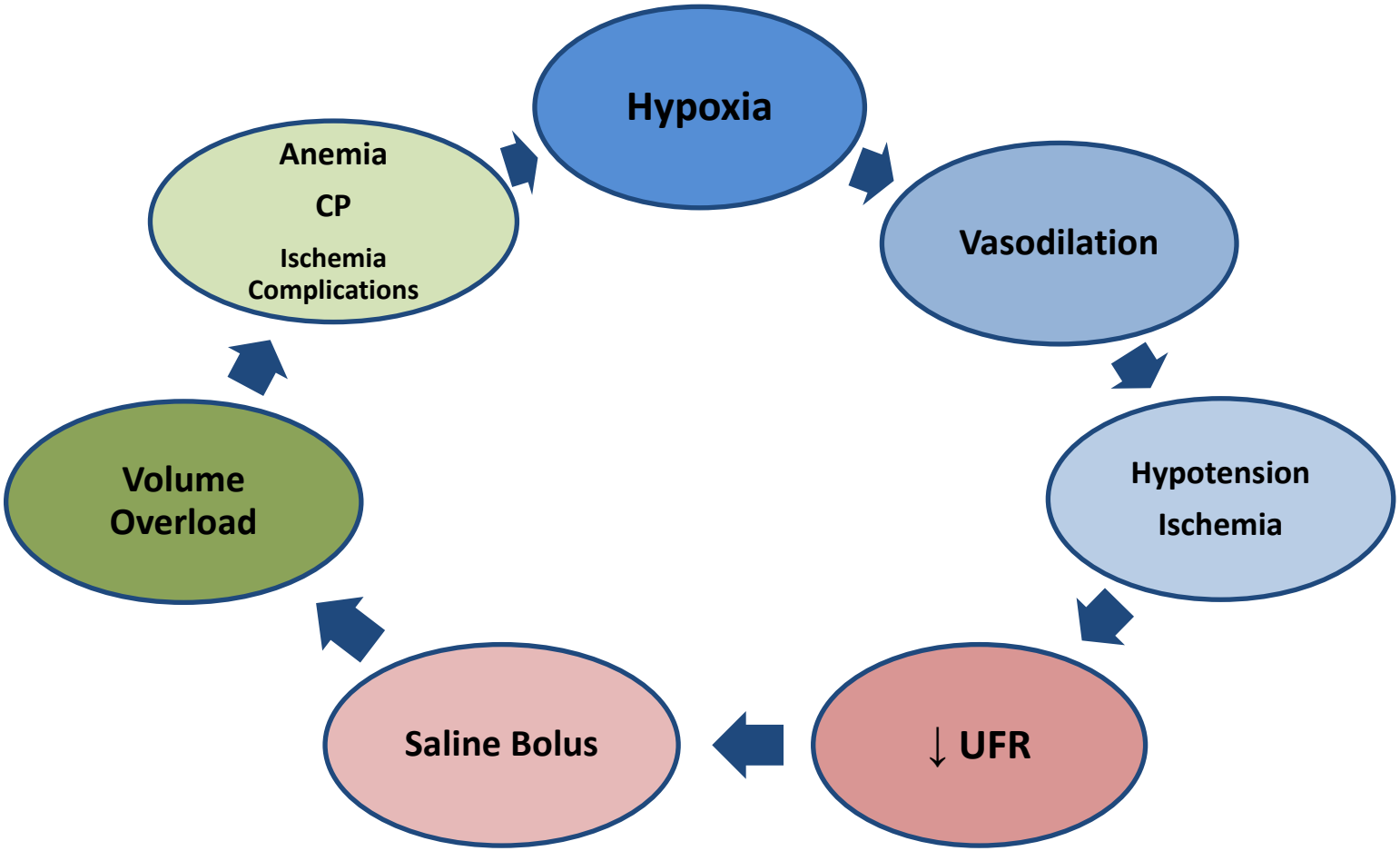
Do High Ultrafiltration (UF) Rates Impact Cardio-Vascular Outcomes?

High UF rates are associated with:

- Overall mortality in patients on hemodialysis when the UF rate is greater than 10-12 milliliters/kilogram/hour.
- Increased rate of patients with cardiovascular complications.
- Cardiac stunning and potential long-term cardiac damage and increased mortality.
- Increased rate of intradialytic hypotension.

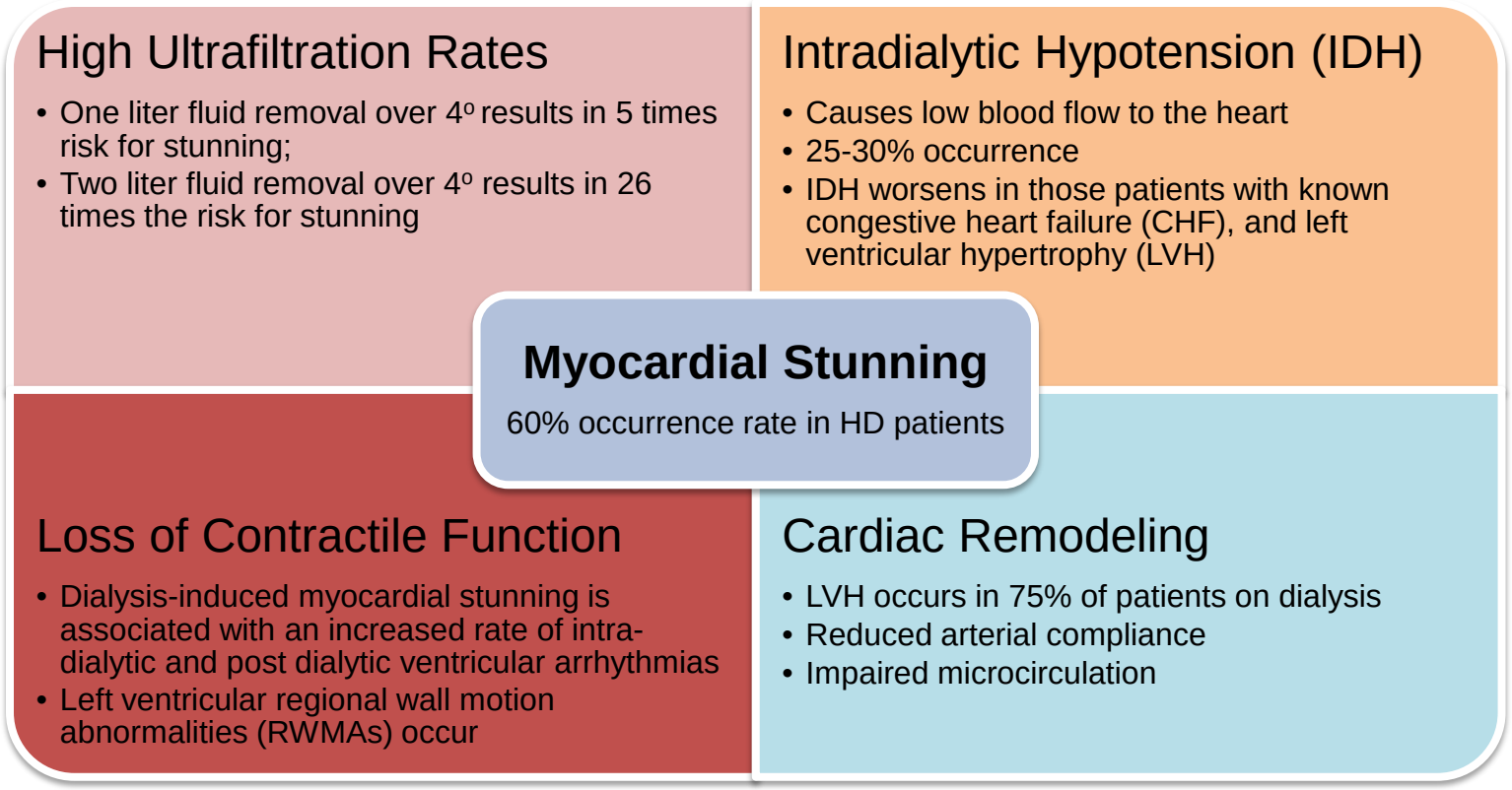
YES!

Effects of Hypoxia During Dialysis



(Thorn et al., 2011; Gheuens et al., 2000; Diroll, 2013)

Myocardial Stunning



Source: McIntyre

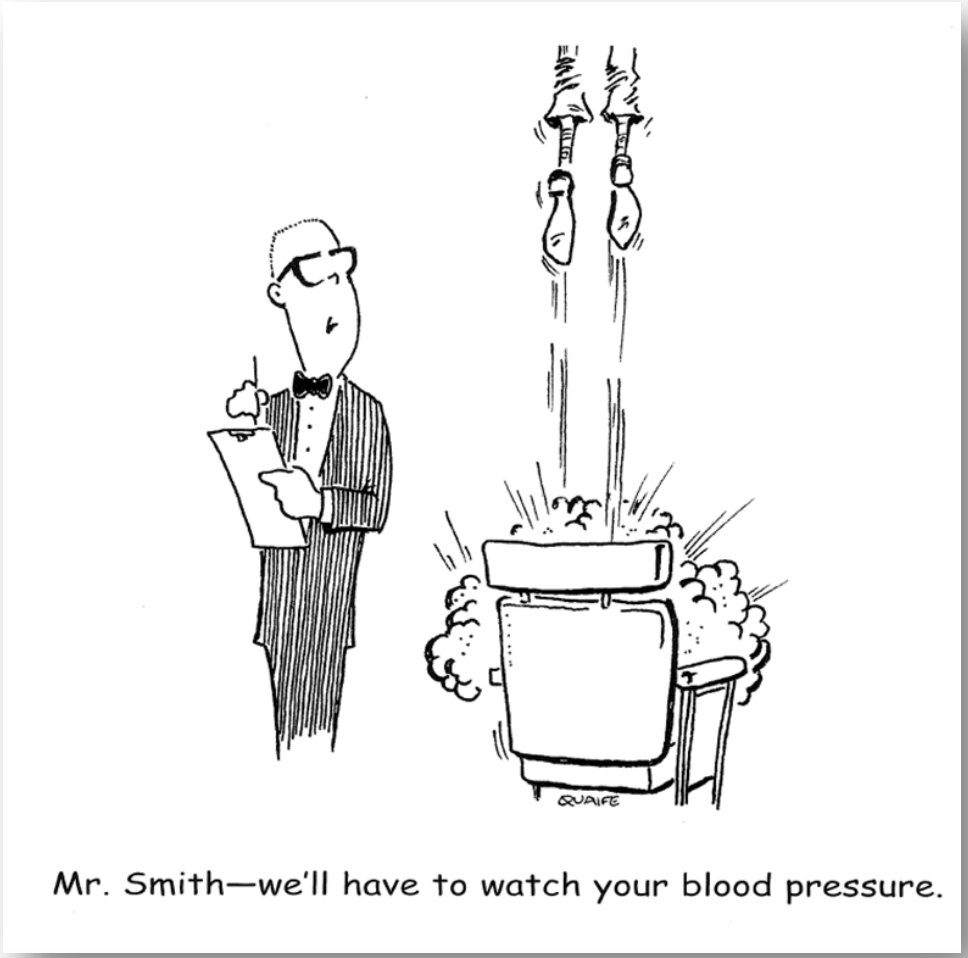
THE IMPACT OF SODIUM

Etiology of Hypertension in Renal Disease

Etiology

- Excess fluid and sodium contributing to vascular volume overload
- Malfunction of the Renin-Angiotensin (R-A) System

A Common Scene in Dialysis



Source: Jazz Communications

Management of Hypertension

- Management of hypertension needs to occur from several perspectives:
  - Control fluid and salt intake
  - Dialysis to remove fluid and sodium
  - Antihypertensive medications
  - Angiotensin-Converting Enzyme (ACE) Inhibitors to control the Renin-Angiotensin system

Electrolyte Imbalance Sodium (Na+)

- Hypernatremia is too much sodium that can cause:
  - Water in the cells to exit resulting in shriveling called crenation
  - Tissue swelling or edema
- Hyponatremia is too little sodium that can cause:
  - Water to move into the cells resulting in cell rupture called hemolysis.

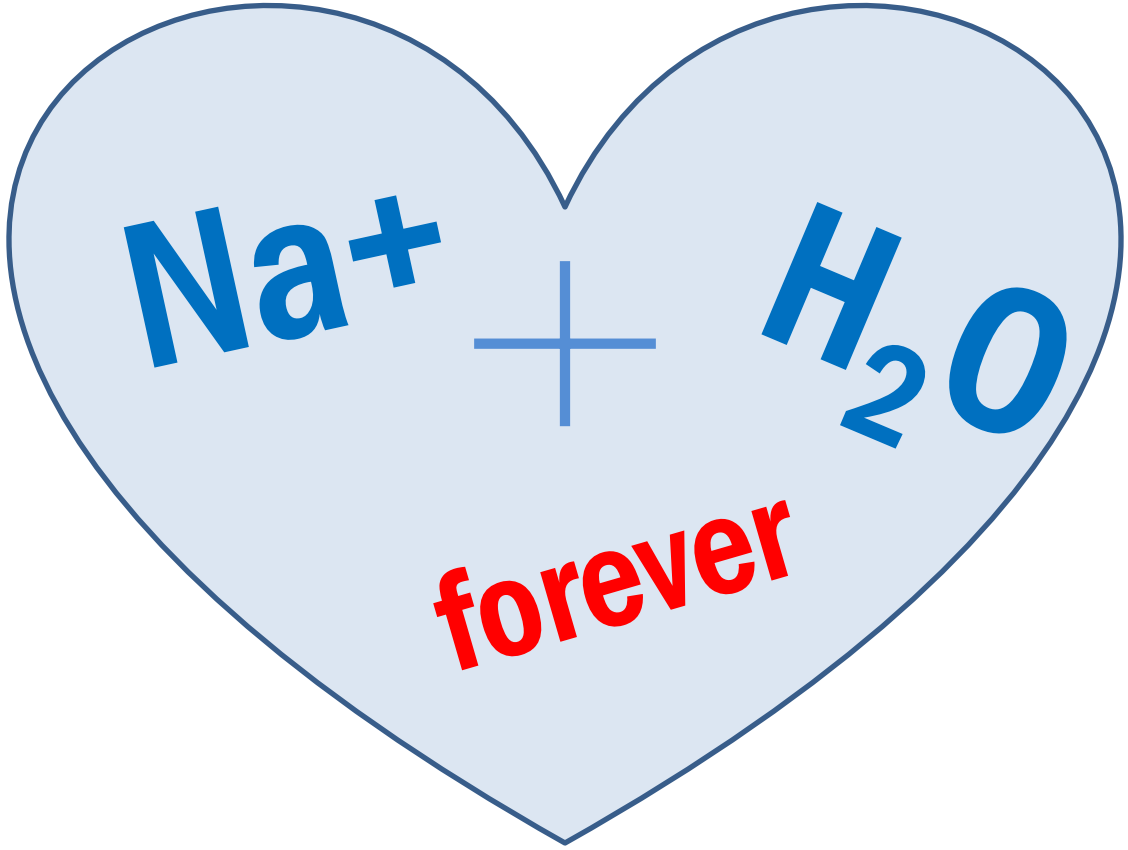
Sodium

- Sodium is the leading cause of HTN and fluid retention.
- Sodium regulates water and fluid balance.
- Many foods, especially “fast foods” contain sodium, or are preserved with sodium.

85-90% of HTN is volume dependent

Source: Mailloux

The Romance of a Dialysis Lifetime



Source: L. Ball

High Sodium Foods

Canned foods	Ham/ bacon	Cold cuts	Dried fish	Pickles
Fast foods	Frozen foods	Garlic salt	Soy sauce	Bouillon cubes
Pretzels	Nuts	Popcorn	Crackers	Smoked meats

Why Is Fluid Control So Important?

- Adherence to fluid restriction decreases risk of heart failure
- No matter how much IDWG is considered “acceptable,” time on dialysis limits the amount of fluid that can be safely removed for a given treatment.

Symptoms of Fluid Build–up

- Shortness of breath
- Dizziness
- Nausea
- Headaches
- High Blood Pressure
- Damage to the heart
- Swelling
- Decreased appetite
- Fatigue

Removal of Large Amounts of Fluid

- Low Blood Pressure
- Cramping
- Nausea and Vomiting
- Headaches
- Lightheadedness
- Trigger for life-threatening arrhythmias

Source: A. Dingle, RD

Non-dietary Sodium

The sources of non-dietary sodium for patients on dialysis include:

- The prime at the start of dialysis
- Saline flushes during dialysis
- Rinse back at the end of dialysis
- Medications
- Dialysate sodium
- Sodium modeling
- Hypertonic saline

RECOMMENDATIONS AND GUIDELINES

Conditions for Coverage (CfC)

- Patients need to be assessed to see if the dialysis prescription is appropriate, including blood pressure and management of fluid status.
  - Appraise each patient's requirement for fluid management strategies;
  - Examine trends over time;
  - Avoid intradialytic complications; and
  - Investigate potential barriers to managing volume status.

(Department of Health and Human Services, 2008)

Cardiovascular Disease Guidelines

- Kidney Disease Outcomes Quality Initiative (KDOQI) CVD Guidelines state:
  - Increasing the hematocrit with recombinant erythropoietin (rhEPO) can lead to several adverse side effects, including worsening of hypertension.
  - Patients who are at greater risk for developing hypertension during rhEPO therapy are those with severe anemia, those in whom anemia is corrected too rapidly, and those with pre-existing hypertension.
  - It has been suggested that blood pressure of less than 150/90 mmHg is a reasonable goal for most patients undergoing HD.

ANNA Scope and Standards

The *Nephrology Nursing Scope and Standards of Practice* section on Fluid Balance and Congestive Heart Failure lists the following six outcomes:

- The patient will be euvolemic and normotensive.
- The patient will be on minimal antihypertensive medications.
- The patient will not develop congestive heart failure.
- The patient will not be hospitalized for fluid related issues.
- The patient will maintain residual kidney function.
- The patient will demonstrate knowledge of the implications of optimal fluid balance.

(Gomez, 2011)

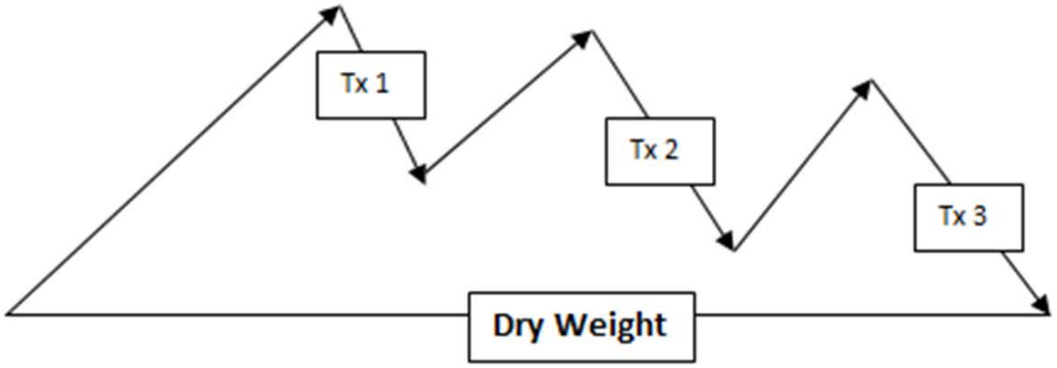
Other Recommendations

- The National High Blood Pressure Education Program Work Group on chronic renal failure and renovascular hypertension recommend a goal blood pressure of 130/85 mmHg.
- In a prospective study performed in the dialysis population, identified that a blood pressure of 140/90 mmHg minimized the occurrence of LVH and death (Foley et al., 1996).

SCENARIOS

“Volume Rollercoaster”

- Ideally, patients should leave each dialysis treatment *<u>at</u>* their dry weight.
- Unfortunately, excess fluid gains prevent achievement of dry weight:
  - Non-adherence to dialysis prescription;
  - Too-short dialysis duration; and/or
  - Excess dietary sodium.



Source: Doss

Scenario #1

Patient AB has a history of hypertension, and is on several antihypertensive medications. She has been on dialysis for two years. For the last two weeks, AB's dialysis treatments have looked like following treatment sheet:

Time	BP	BFR	VP	Comments
0600	195/99	450	270	Dialysis initiated.
0630	200/99	450	270	
0700	202/101	450	265	No c/o.
0730	203/104	450	275	RN notified of BP.
0800	205/103	450	268	EPO 3,000 units IV.
0830	208/110	450	275	
0900	209/110	450	275	Dialysis completed.

Scenario #2

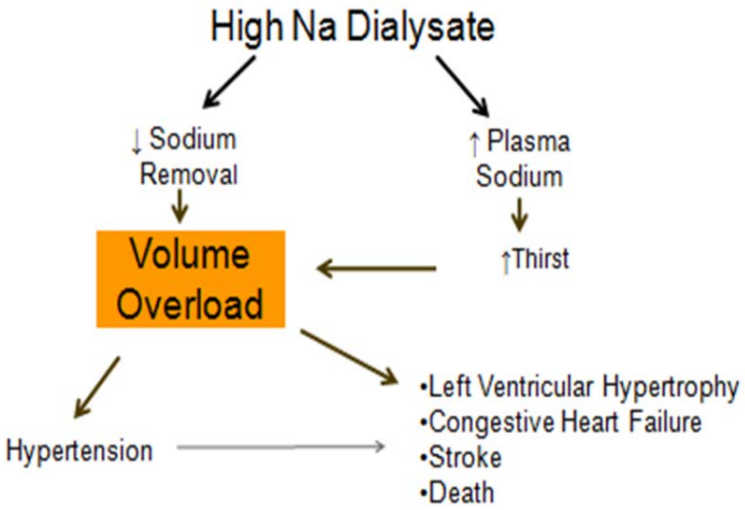
Mr. YZ has been in your dialysis unit for six years. He typically gains 4 kg during the week, and 8 kg over the weekend. He has a history of hypertension and diabetes. He is 8 kg over EDW. One of his treatment records is below:

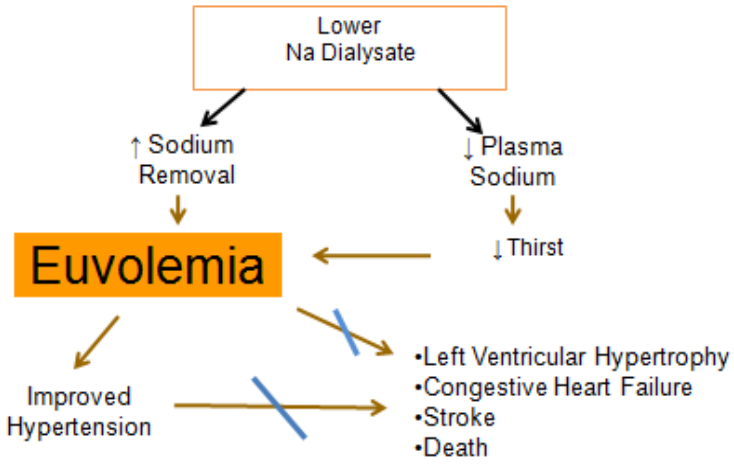
Time	BP	BFR	UFR	Comments
1000	205/110	500	2.5	Dialysis initiated.
1030	200/108	500	2.5	
1100	198/99	500	2.5	
1130	184/94	500	2.5	
1200	185/90	400	1.5	Pt. c/o cramping.
1230	180/93	400	1.5	Pt. off early.

Tools to Improve Safe Fluid Removal

Source: A. Sinha

High versus Lower Sodium Dialysate





Source: Santos & Peixoto, 2008

Lowering Dialysate Sodium Level

Author	Intervention	IDWG	BP Control	ID BP Drop
Cybulsky 1985	133, 144	Improved	Improved	Worsened
Song 2002	138, 140, 147	Improved	Improved	Worsened
DePaula 2004	138, adjusted	Improved	Improved	Improved
Oliver 2004	132, 137	Improved	N/A	N/A
Thein 2007	138, 141	No change	Improved	N/A

Five prospective studies (n>10)
Decrease of IDWGs and improvement of BP control
Increase in the risk of intradialytic hypotension (?)

Source: E. Ok

Sodium Neutral Modeling

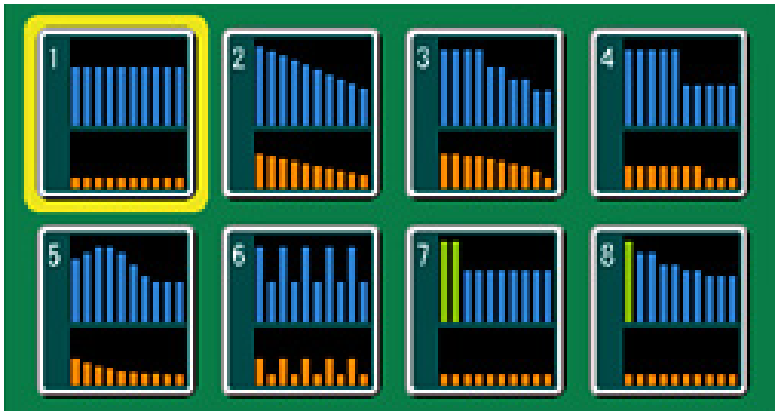
- Sodium modeling when utilized should return the patients sodium level to a level equal to their plasma sodium “set-point.”
- Plasma sodium concentrations remain stable over time, which is why they are termed sodium set-points.
- Determine the plasma sodium model that best suits the patient to achieve baseline plasma sodium level at the end of treatment.

Sequential or Isolated Ultrafiltration

- No dialysate flow;
- Solute movement by convection (“drag” only);
- Extends treatment time; and
- Blood pressure assisted:
  - Decreased in temperature of the extracorporeal blood; and
  - Maintaining a high solute gradient.

Ultrafiltration Profiling

- Tapers the ultrafiltration rate to accommodate individual plasma refill rates (PRR).
- Can be used alone or in conjunction with sodium modeling.
- Segments represent period of time on treatment, and helps to correlate the appropriate profile.



Source: Ashai Kasei Medical

Patients' Position During Dialysis

- Most Japanese and many European patients are dialyzed in beds in the supine position.
- Most U.S. patients are dialyzed while sitting in chairs:
  - Psychologically patients would feel better.
  - Would be more comfortable sitting in chairs.
- Sitting in a chair for a long time is uncomfortable:
  - Translocation of body fluids to the lower extremities.
  - Hypotensive episodes are more likely, especially during the second half of HD.

Additional Dialysis Treatment

- Minimizes complications during treatment, allowing patients to stay on their entire treatment.
- Focus:
  - Reduce stress on the heart
  - May decrease left ventricle hypertrophy
  - Gets patient back to their dry weight
  - Never state this will allow patients more freedom with fluids

Medication Evaluation

- Antihypertensives should be evaluated as a contributing factor to intradialytic hypotension. It is recommended that short-acting antihypertensives be avoided prior to dialysis.
- Osmotic agents:
  - Hypertonic Saline (23.4% Na Cl)
  - Dextrose 50% (not recommended in diabetics)
  - Mannitol 25%
  - Albumin

Modality Change

- A modality change should be considered when the patient is unable to tolerate adequate fluid removal to achieve euvolemia.
  - Hemodiafiltration;
  - Hemofiltration; or
  - Peritoneal dialysis.

The Take Away Message…

Source: Shuttercock

Seek an Individualized Approach to Patient Care

References

Agarwal, R. (2012) How can we prevent intradialytic hypotension? *Current Opinions in Nephrology and Hypertension*, 21: 593-599. doi: 10.1097/MHN.Ob013e3283588f3c

Burton, J. O., Jeffries, H. J., Selby, N. M. & McIntyre, C. W. (2009). Hemodialysis-Induced Cardiac Injury: Determinants and Associated Outcomes. *Clinical Journal of the American Society of Nephrology,* 4(5): 914-920. doi: 10.2215/CJN.03900808

Bos, W.J., Bruin. S., van Olden, R.W., et al. (2000). Cardiac and hemodynamic effects of hemodialysis and ultrafiltration. *American Journal of Kidney Disease*, 35: 819-826.

References

Centers for Medicare and Medicaid Services (CMS). (2008). *Conditions of coverage for ESRD facilities: Final rule.* Retrieved from http://www.cms.gov/Regulations-and-Guidance/Legislation/CFCsAndCoPs/downloads/ESRDfinalrule0415.pdf

Chazot, C. & Jean, G. (2012). The advantages and challenges of increasing the duration and frequency of maintenance dialysis sessions. *Nature Clinical Practice Nephrology,* 5(1), 34-44.

Dale, W. (2012). Education on fluid management and encouraging critical thinking skills. *Nephrology Nursing Journal, 39*(6), 510-512.

References

Daugirdas, J. T. (2001). Pathophysiology of dialysis hypotension: an update. *American Journal of Kidney Disease*, 38(4): S11-S17. doi: 10.1053/j.ajkd.2001.28090

Diroll, A. (2013). Why a fluid manager makes sense in your dialysis clinic. *Nephrology News & Issues.* Retrieved from http://www.nephrologynews.com/articles/print/109507-why-a-fluid-manager-makes-sense-in-your-dialysis-clinic.

Doss-McQuitty, S. (2014). Strategies for removing fluids during hemodialysis. *Nephrology Nursing Journal*, 41(3), 257-263.

References

Flythe, J. E., Kimmel, S. E. & Brunelli, S. M. (2010). Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. *Kidney International*, 79: 250-257. doi: 10.1038/ki.2010383

Kaddoura, M. (2011). Critical thinking skills of nursing students in lecture-based teaching and case-based learning. *International Journal for the Scholarship of Teaching and Learning*, 5(2). Retrieved from http://hdl.handle.net/10518/3659.

References

Kalantar-Zadeh, K., Regidor, D. L., Kovesdy, C. P., Van Wyck, D., Bunnapradist, S., Horwqich, T. B. & Fonarow, G. C. (2009). Fluid Retention Is Associated With Cardiovascular Mortality in Patients Undergoing Long-term Hemodialysis. *Circulation*, 119: 671-679. doi: 10.1161/CIRCULATIONAHA.108.807362

Mees, E. (2004). Adequacy of dialysis: An inadequately applied concept. *Dialysis and Transplant, 33*(22), 739-748.

McIntyre, C.W. (2009). Effects of hemodialysis on cardiac function. *Kidney International*, 76(4):371–375.

References

San Miguel, S. . (2010). Haemodialysis dry weight assessment: A literature review. *Renal Society of Australasia Journal, 6*(1), 19-24. Retrieved fromhttp://www.renalsociety.org/RSA/journal/mar10/San Miguel.pdf.

Trower, C.A. (2009). Traditionalists, boomers, xers, and millennials: Giving and getting the mentoring you want. Presented at Brown University on October 16, 2009.

For More Information

Lynda K. Ball, MSN, RN, CNN

Quality Improvement Director

405-948-2241

lball@nw13.esrd.net

www.network13.org

DIALYSIS PRESCRIPTION

Romanita Nica M.D.
AKDHC

DIALYSIS PRESCRIPTION

- New studies about different aspects of dialysis prescription
- New outcomes of dialysis patients
- Tools to implement dialysis prescriptions

DIALYSIS PRESCRIPTION

- An alphabet soup of orders: Adequacy, BFR, Calcium bath, Dialysate sodium etc.
- On a regular basis each dialysis treatment has approximately 30 individual orders .
- Monthly orders: about 50 individual orders

DIALYSIS PRESCRIPTION

- Most of the dialysis orders follow a protocol

- The orders that seems to affect the patient's outcomes: BFR, Target Weight, Time of Dialysis , BP Control, Sodium Dialysate.

DIALYSIS PRESCRIPTION
Blood Pressure

- The prevalence of hypertension (defined as 1-week average pre-dialysis SBP >150 mmHg or DBP >85 mmHg or the use of antihypertensive medications) was noticed to be around 85% even in most recent trials (1).
- Among HD patients, the relationship of BP with cardiovascular outcomes and mortality is still the subject of much controversy. The controversy relates to the specific relationship between the BP measurement times and technique (predialytic, postdialytic, or intradialytic BP measurements or interdialytic ambulatory BP) and outcomes. Studies suggest an association of high BP with strokes, cerebral atrophy, cardiovascular events, complex cardiac arrhythmias, the development of congestive heart failure, but not clear correlation with all-cause mortality.(4)

DIALYSIS PRESCRIPTION
Blood Pressure

- There are many studies that suggest that low BP (SBP< 120mmHg) measured either predialysis or postdialysis is associated with increased mortality(4).
- The phenomenon of lower BP being associated with increased mortality has been labeled as the reverse epidemiology of hypertension. This has raised concerns regarding the lowering of BP among hypertensive HD patients.

DIALYSIS PRESCRIPTION
Dry Weight

- The management of dry weight poses several challenges.
- First there is no universally agreed-upon definition of dry weight. Based on the most common definition, dry weight is the lowest tolerated post dialysis weight achieved via gradual change in post dialysis weight at which there are minimal signs or symptoms of either hypovolemia or hypervolemia.

DIALYSIS PRESCRIPTION
Dry Weight

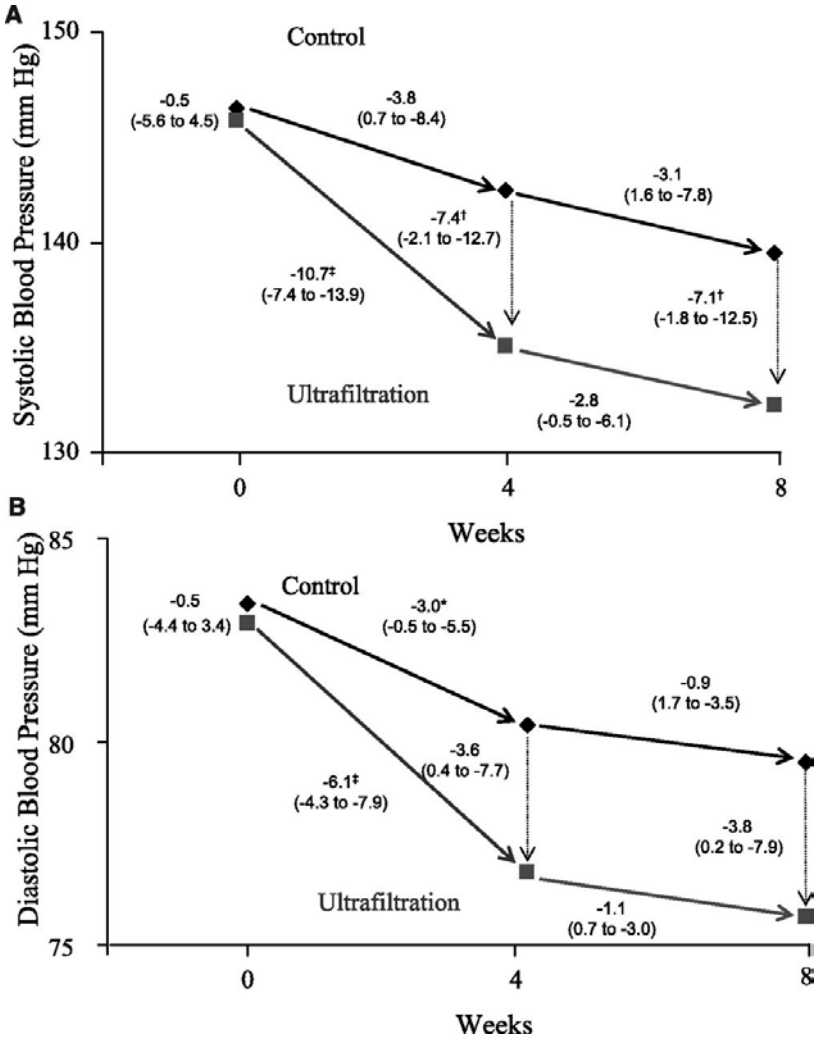
- Physical examination is notoriously unreliable in excluding volume overload. For example, pedal edema does not correlate with fluid status of the patient very well.
- The assessment and achievement of dry weight is a continuous process that can often provoke uncomfortable intradialytic symptoms such as dizziness, cramping, nausea, and vomiting.

DIALYSIS PRESCRIPTION
Dry Weight

- Despite the challenge, patients benefit from attempting to reach the dry weight.

- In a recent randomized, controlled trial of hypertensive HD patients, dry weight was probed without changing the dialysis time (6). Notably, in this study patients with obvious volume overload were excluded.

The effect of dry weight reduction on interdialytic ambulatory SBP and DBP in hypertensive HD patients.



Rajiv Agarwal et al. JASN 2014;25:1630-1646

DIALYSIS PRESCRIPTION
Dry Weight

- Studies among HD patients suggest that managing intradialytic relative plasma volume (RPV) may reduce the number of hospital admissions caused by fluid overload (7), improve BP control (8), and decrease hypotension-associated dialysis symptoms (9).
- However, there are studies that show the opposite outcomes: the multicenter randomized Crit-Line Intradialytic Monitoring Benefit (CLIMB) trial demonstrated that RPV-guided therapy was associated with worse outcomes, contrary to the original hypothesis (2).

DIALYSIS PRESCRIPTION
Dry Weight

- This shows that there are potential hazards related to probing dry weight too, such as an increased risk of clotted dialysis access, reduction in residual renal function, and complications related to intradialytic hypotension.
- Intradialytic hypotension can be complicated by cerebral hypoperfusion, seizures, myocardial dysfunction, and mesenteric ischemia. Furthermore, it has been associated with mortality.

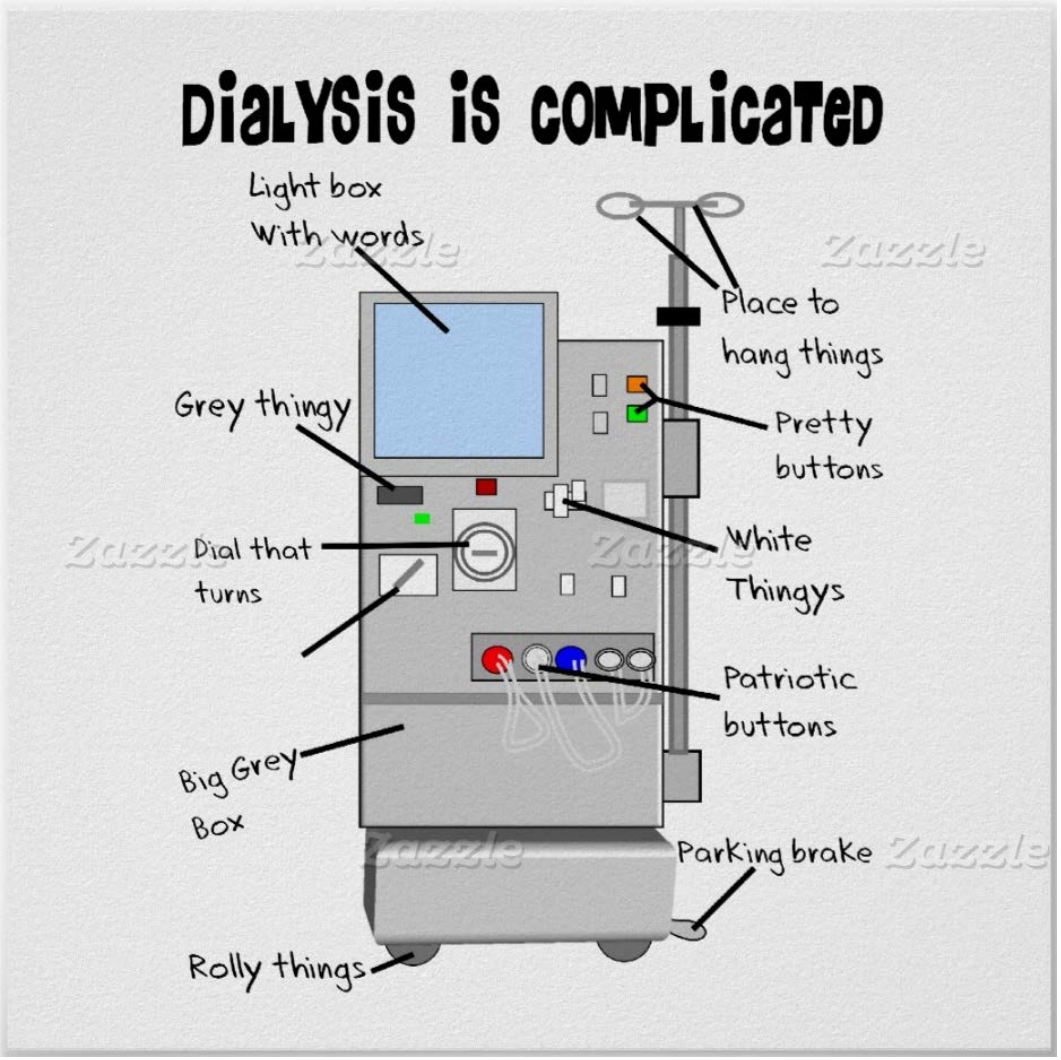
DIALYSIS PRESCRIPTION
Sodium in the Dialysate

- The pre-dialysis serum sodium concentration appears to be unaffected by the dialysate sodium concentration. The relationship between serum, dialysate sodium, and mortality appears to be variable. Further research is warranted to determine the biological mechanisms for these associations and to re-examine the total body sodium handling in hemodialysis (10).

DIALYSIS PRECRIPTION
Sodium in Dialysate

- Sodium Lowering In Dialysate (SoLID) trial: a randomized controlled trial of low(135) versus standard(140) dialysate sodium concentration during hemodialysis for the regression of left ventricular mass →The trial will evaluate the hypothesis that lower dialysate [Na+] during HD results in lower left ventricular (LV) mass (11).
- Since it's inception, observational evidence has suggested an increased mortality risk with lower dialysate [Na+], possibly due to exacerbation of intra-dialytic hypotension and subsequent myocardial injury (12).

DIALYSIS PRESCRIPTION



DIALYSIS PRESCRIPTION

- There is a continuous struggle to find the best dialysis prescription: not too wet/not too dry, not too high BP/ not too low BP, not too much salt / or not enough salt.

- Most will probably not find an answer for everybody but applications of current information to each dialysis patient, **individualized care**, will be most successful.

- “The heart of the matter - Cardiac adequacy in hemodialysis.”
- “The best Cardiologist for a dialysis patient is still the Nephrologist.”

DIALYSIS PRESCRIPTION

- Mortality rates in end-stage renal disease (ESRD) and dialysis populations are declining even though they remain much higher than in the general population, according to the 2013 Annual Data Report from USRDS
- The adjusted mortality rate among ESRD patients (per 1,000 patient years at risk) decreased from 351 in 1996 to 241 in 2011, a decline of 31.3%
- The death rates fell by 15% in the first year of treatment in new patients, and by about 19% in prevalent patients-National Kidney Foundation News Release, March 26,2015

DIALYSIS PRESCRIPTION

- There are many reasons for the decline in death rates of the dialysis patient: better drug-based management of heart disease, higher vaccination rates, and changes in treatment of anemia, but overall the improvements seems to be related to better overall dialysis prescription.

DIALYSIS PRESCRIPTION

- ***The Most Common State Citations:***
  - ***1.Dialysis***
  - 2.Infection Control
  - 3.Administration
  - 4.Environment and Physical Plant
  - 5.ER
- ***The Most Common Federal Citations:***
  - 1.Infection Control
  - ***2.Patient Assessment***
  - 3.Water Quality
  - 4.Physical Environment
  - 5.Plan of Care

DIALYSIS PRESCRIPTION

- Why are dialysis orders not followed?
  - Nobody intentionally tries not to follow the orders.

- How can we solve/improve this problem?
  - Better dialysis order protocols, better and easier to access computer programs
  - Most important tools: **education, documentation, and communication**

DIALYSIS PRESCRIPTION

- Education:
  - Patients– by physicians, nurses ,dieticians, etc.
  - Dialysis personnel--by physicians, nurses, educational programs etc.
- Communication:
  - Patients, physicians nurses and dialysis personal
- Documentation:
  - Every change to the existing order

DIALYSIS PRESCRIPTION

- ***EDUCATION:***
  - Team approach: nurses, physicians, dieticians, and social workers .
  - Sitting down rounds every month .

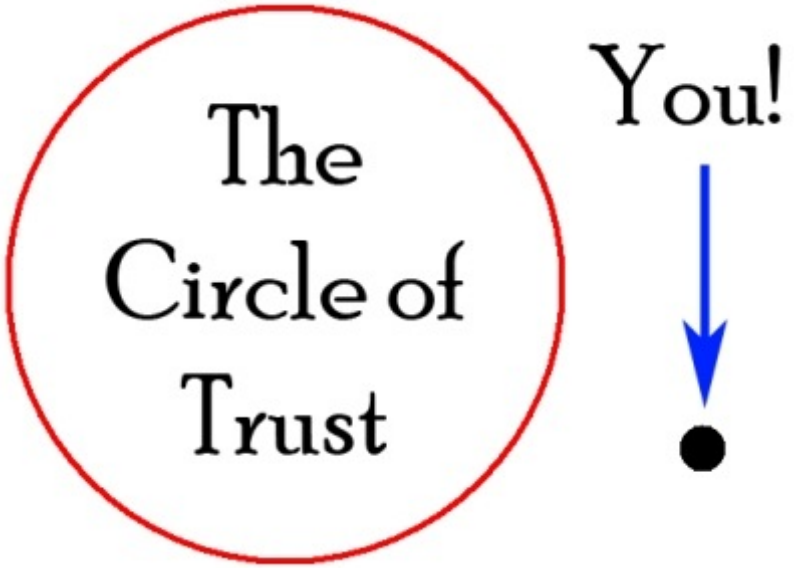
I don't care what day it is.
Four hours is four hours.

DIALYSIS PRESCRIPTION

- ***DOCUMENTATION*** :
  - Is important from a practicing stand point
  - Is important from the patient care stand point, continuity of care, etc.
  - Needs to be easy to do.

DIALYSIS PRESCRIPTION

- ***COMUNICATION:***
- The circle of trust:
- Nurse→ Patient→ Physician→ Dialysis Team



DIALYSIS PRESCRIPTION

- Communication is essential in patient centered care not just with the physician, but with the patient and patient families.

- Technology, Transparency, and Attitude can improve dialysis practice for patients and dialysis units.

REFERENCES

- 1.Agarwal R, Nissenson AR, Batlle D, Coyne DW, Trout JR, Warnock DG*: Prevalence, treatment, and control of hypertension in chronic hemodialysis patients in the United States. Am J Med 115: 291–297, 2003pmid:12967694.*
- 2.Reddan DN, Szczech LA, Hasselblad V, Lowrie EG, Lindsay RM, Himmelfarb J, Toto RD, Stivelman J, Winchester JF, Zillman LA, Califf RM, Owen WF Jr*: Intradialytic blood volume monitoring in ambulatory hemodialysis patients: A randomized trial. J Am Soc Nephrol 16: 2162–2169, 2005pmid:15930095*
- 3.Foley RN, Gilbertson DT, Murray T, Collins AJ*: Long interdialytic interval and mortality among patients receiving hemodialysis. N Engl J Med 365: 1099–1107, 2011pmid:21992122*

REFERENCES

- 6.Agarwal R, Alborzi P, Satyan S, Light RP:Dry-weight reduction in hypertensive hemodialysis patients (DRIP): A randomized,controlled trial. Hypertension 53: 500–507,
- 7. Goldstein SL, Smith CM, Currier H: Noninvasiveinterventions to decrease hospitalization
- and associated costs for pediatric patients receiving hemodialysis. J Am SocNephrol 14: 2127–2131, 2003
- 8. Rodriguez HJ, Domenici R, Diroll A, Goykhman I: Assessment of dry weight by monitoring changes in blood volume during hemodialysis using Crit-Line. Kidney Int 68: 854–861, 2005

REFERENCES

- 9. Patel HP, Goldstein SL, Mahan JD, Smith B, Fried CB, Currier H, Flynn JT: A standard, noninvasive monitoring of hematocrit algorithm improves blood pressure control in pediatric hemodialysis patients. Clin J Am Soc Nephrol 2: 252–257, 2007
- 10. Dialysate sodium, serum sodium and mortality in maintenance hemodialysis-Finnian R. McCausland, Steven M. Brunelli, and Sushrut S. Waikar-2012
- 11. Rationale and design of the Sodium Lowering In Dialysate (SoLID) trial: a randomised controlled trial of Low versus standard dialysate sodium concentration during hemodialysis for regression of left ventricular mass. Dunlop JL, Vandal AC, de Zoysa JR, Gabriel RS, Haloob IA, Hood CJ, Matheson PJ, McGregor DO, Rabindranath KS, Semple DJ, Marshall MR, BMC Nephrol. 2013 Jul 15;14:149. doi: 10.1186/1471-2369-14-149.

REFERENCES

- 12.Rationale and design of the Myocardial Microinjury and Cardiac Remodeling Extension Study in the Sodium Lowering in Dialysate trial (Mac-SoLID study).Dunlop JL, Vandal AC, de Zoysa JR, Gabriel RS,Gerber LM, Haloob IA, Hood CJ, Matheson PJ, Mc Gregor DO, Rabindranath KS, Schollum JB, Semple DJ, Marshall MR. BMC Nephrol 2014 Jul 21;15:120. doi: 10.1186/1471-2369-15-120