Fluid Management

Looking beyond "You're gaining too much fluid"

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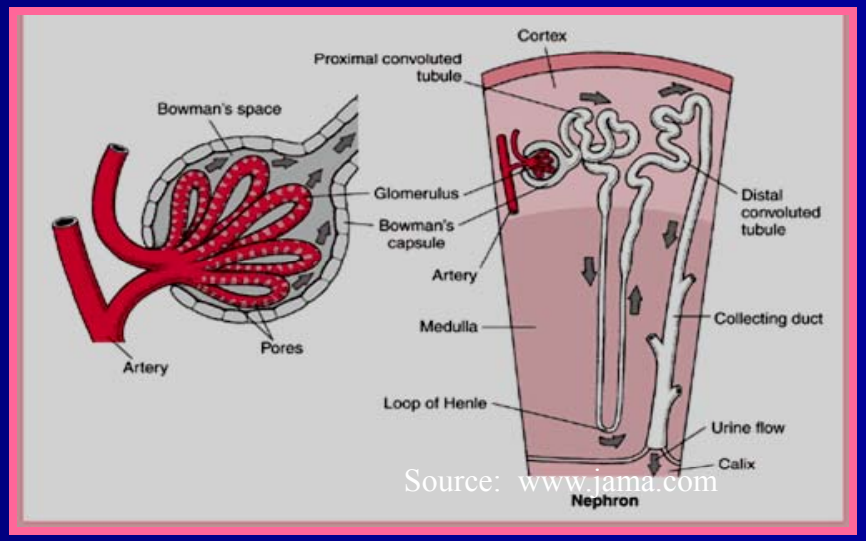
Objectives

- Discuss causes of large fluid gains in many hemodialysis patients
- Discuss strategies in reducing inter dialytic weight gain in hemodialysis patients
- Discuss fluid management techniques during hemodialysis

- Nephron – basic functional unit
- Approximately 1 million nephrons in each kidney



Source: www.jama.com

Functions of the Kidney

- **Primary purpose –regulate composition of blood and other body fluids as blood circulates through the kidneys**

1. Removes end products of metabolism – urea, creatinine, uric acid
2. ***Regulates vascular and extra vascular volume by controlling the amount of water excreted***
3. Regulates acid base balance
4. Electrolyte regulation
5. Regulates blood pressure through production of renin
6. RBC synthesis – erythropoetin
7. Synthesizes vitamin D to its active form

Chronic Kidney Disease

Chronic Kidney Disease

1. Progressive
2. Irreversible loss of kidney function

Occurs over varying periods of time in varying stages.

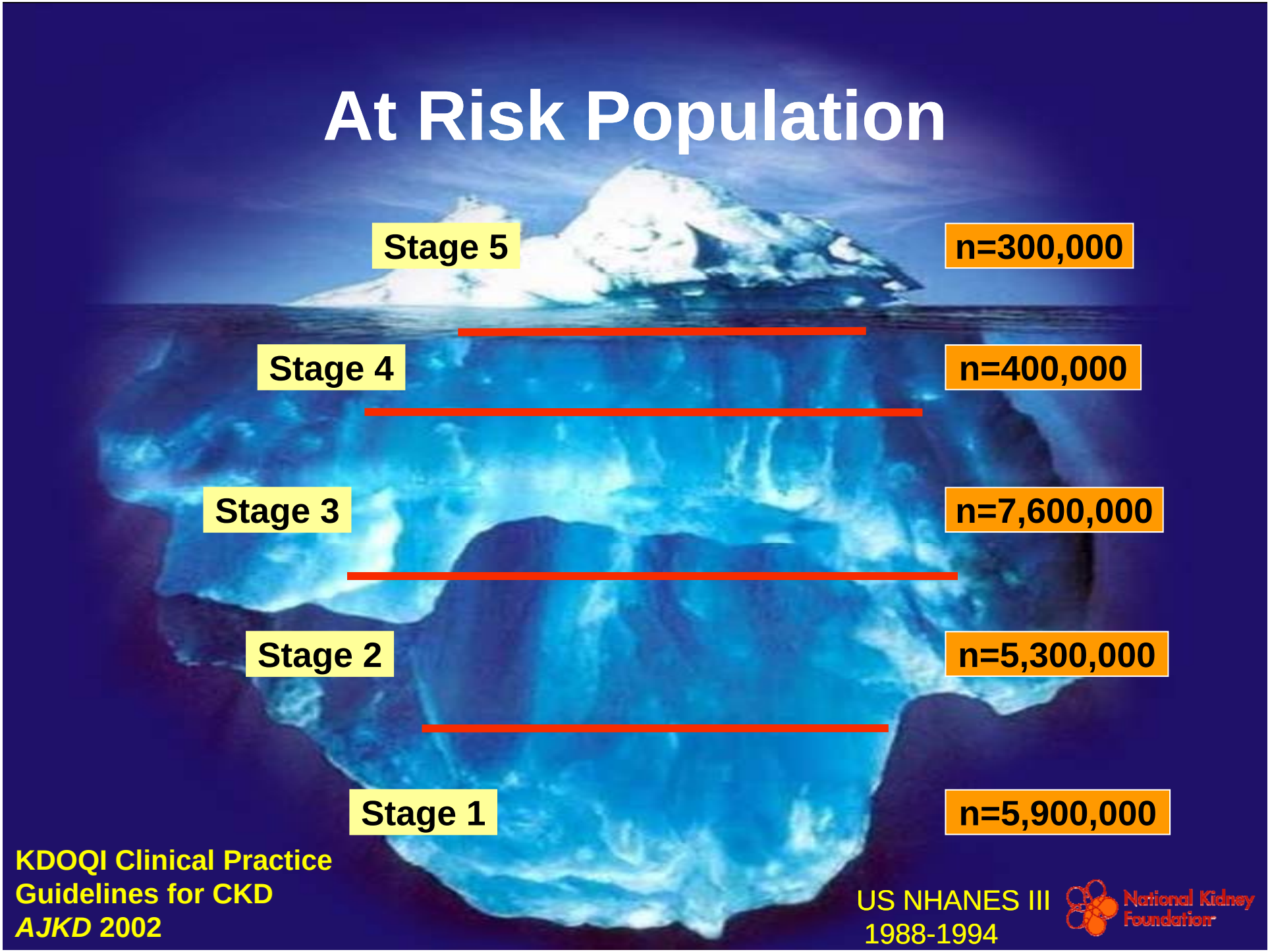
ALEXANDER TSIARAS
AUTHOR OF FROM CONCEPTION TO BIRTH

Chronic Kidney Disease

What do we know?

- 26 million Americans have it (1 in 9) and is a public health problem
- It should be detected early and treated early
- CVD more often leads to death than dialysis
- If detected and treated early will improve patient outcomes
- Patients who do progress to CKD Stage 5 will be in better shape for dialysis

At Risk Population

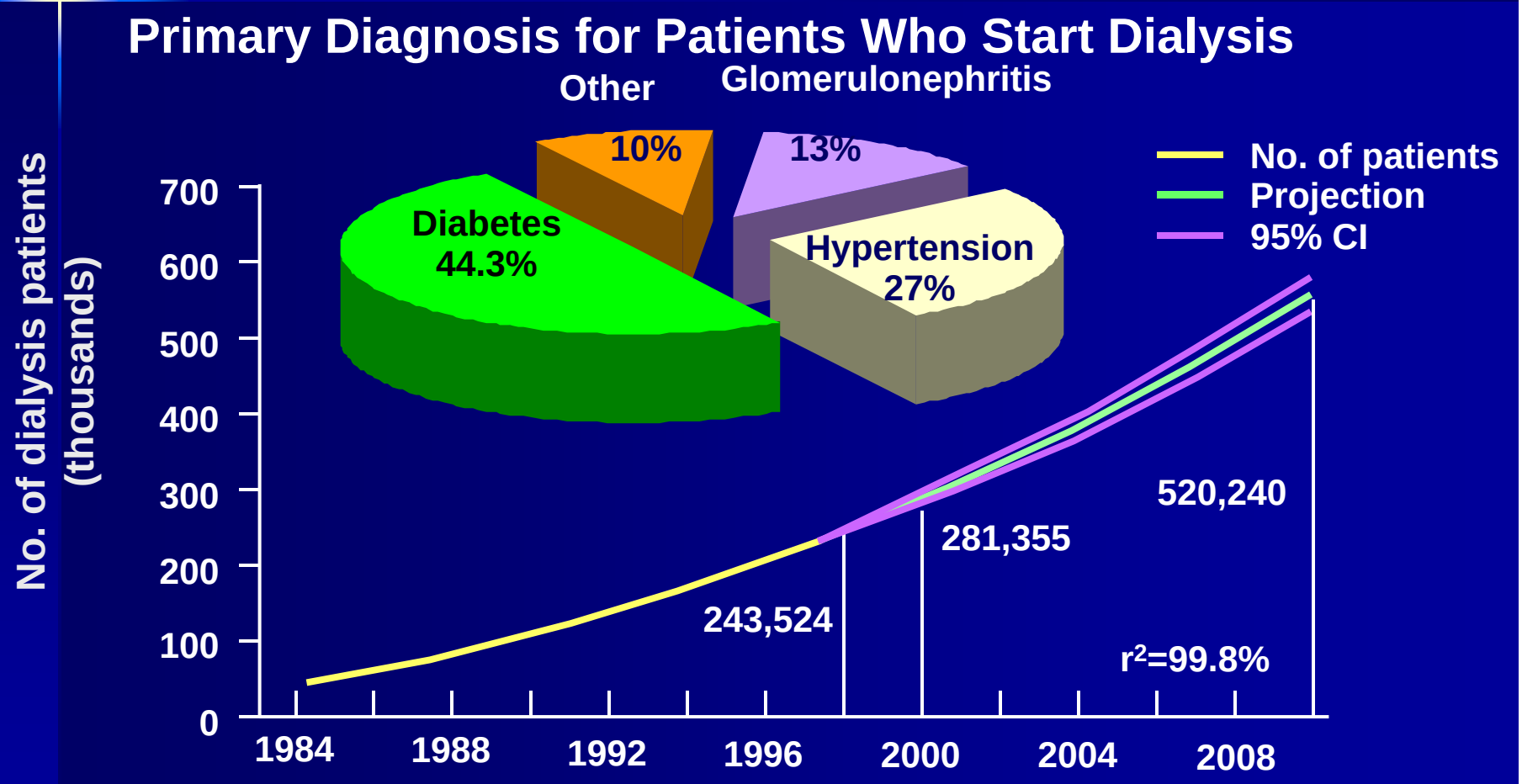


KDOQI Clinical Practice Guidelines for CKD
***AJKD* 2002**

US NHANES III
1988-1994

National Kidney Foundation

Diabetes: The Most Common Cause of ESRD



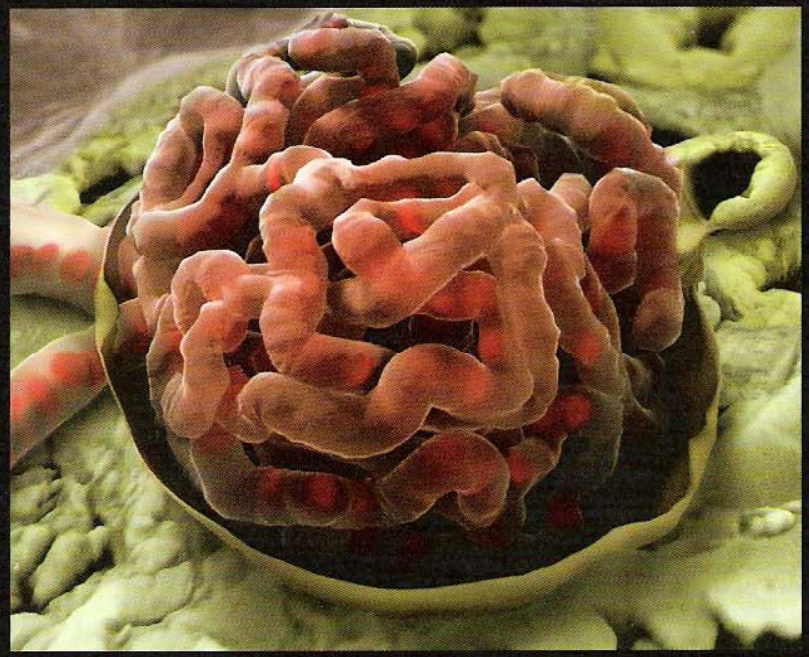
United States Renal Data System. Annual data report. 2000.

Table 1. Classification and Management of Blood Pressure for Adults Aged 18 Years or Older

BP Classification	Systolic BP, mm Hg*		Diastolic BP, mm Hg*	Management*		
				Lifestyle Modification	Initial Drug Therapy	
					Without Compelling Indication	With Compelling Indications†
Normal	<120	and	<80	Encourage		
Prehypertension	120-139	or	80-89	Yes	No antihypertensive drug indicated	Drug(s) for the compelling indications‡
Stage 1 hypertension	140-159	or	90-99	Yes	Thiazide-type diuretics for most; may consider ACE inhibitor, ARB, β-blocker, CCB, or combination	Drug(s) for the compelling indications Other antihypertensive drugs (diuretics, ACE inhibitor, ARB, β-blocker, CCB) as needed
Stage 2 hypertension	≥160	or	≥100	Yes	2-Drug combination for most (usually thiazide-type diuretic and ACE inhibitor or ARB or β-blocker or CCB)§	Drug(s) for the compelling indications Other antihypertensive drugs (diuretics, ACE inhibitor, ARB, β-blocker, CCB) as needed

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin-receptor blocker; BP, blood pressure; CCB, calcium channel blocker.
*Treatment determined by highest BP category.
†See Table 6.
‡Treat patients with chronic kidney disease or diabetes to BP goal of less than 130/80 mm Hg.
§Initial combined therapy should be used cautiously in those at risk for orthostatic hypotension.

Visualizations on this page are reconstructed from SEM and 2-photon fluorescence microscopy



NORMAL CAPILLARIES OF A GLOMERULUS, THE SMALLEST FUNCTIONAL FILTRATION UNIT OF THE KIDNEY. THE BLOOD FLOWS EASILY THROUGH THE GLOMERULAR CAPILLARIES.

GLOMERULUS WITH HYPERTENSIVE DAMAGE: THE BOWMAN'S CAPSULE AND THE GLOMERULAR BASEMENT MEMBRANE THICKENS WHILE EXTRACELLULAR MATRIX PROTEINS, SUCH AS COLLAGEN, EXPAND. THE GLOMERULAR TUFT SHRINKS AS CAPILLARY WALLS WRINKLE AND SCAR, LEAVING THE GLOMERULUS UNABLE TO FUNCTION.

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AUTHOR OF FROM CONCEPTION TO BIRTH

NEW ICD-9 CODES FOR CHRONIC KIDNEY DISEASE

FIND IT, STAGE IT, CODE IT, ACT!

Stage	ICD-9-CM Code	Description	Classification of CKD by Severity			Action*
			GFR (mL/min/1.73 m²)	Clinical Presentations*	Classification by Treatment**	
1	585.1 Chronic kidney disease, Stage I	Kidney damage with normal or ↑ GFR	≥90	Markers of damage (Nephrotic syndrome, Nephritic syndrome, Tubular syndromes, Urinary tract symptoms, Asymptomatic urinalysis abnormalities, Asymptomatic radiologic abnormalities, Hypertension due to kidney disease)	T	Diagnosis and treatment, Treatment of comorbid conditions, Slowing progression, CVD risk reduction
2	585.2 Chronic kidney disease, Stage II (mild)	Kidney damage with mild ↓ GFR	60–89	Mild complications	T	Estimating progression
3	585.3 Chronic kidney disease, Stage III (moderate)	Moderate ↓ GFR	30–59	Moderate complications	T	Evaluating and treating complications
4	585.4 Chronic kidney disease, Stage IV (severe)	Severe ↓ GFR	15–29	Severe complications	T	Preparation for kidney replacement therapy
5	585.5 Chronic kidney disease, Stage V 585.6 ESRD	Kidney failure	<15 (or dialysis)	Uremia, Cardiovascular disease	T D	Replacement (if uremia present)

Adapted from National Kidney Foundation. K/DOQI Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification and Stratification. Am J Kidney Dis 39, 2002 (suppl 1).
Levey, A.S., et al. Definition and Classification of Chronic Kidney Disease: A position statement from Kidney Disease: Improving Global Outcomes (KDIGO). Kidney International 67, 2005, 2089-2100.

***Includes presentations and actions from preceding stages. Chronic kidney disease is defined as either kidney damage or GFR <60 mL/min/1.73 m² for ≥3 months. Kidney damage is defined as pathologic abnormalities or markers of damage, including abnormalities in blood or urine tests or imaging studies.**

****Classification 'T' is added for all kidney transplant recipients, at any level of GFR (CKD stages 1-5); Classification 'D' is added for CKD stage 5 patients treated by dialysis.** *Abbreviations: CVD, cardiovascular disease; ESRD, end stage renal disease; GFR, glomerular filtration rate.*

Additional Codes

585 Chronic kidney disese
Use additional codes to identify kidney transplant status, if applicable (V42.0)

585.9 Chronic kidney disese, unspecified
Chronic renal disease
Chronic renal failure NOS
Chronic renal insufficiency

285.2 Anemia in chronic illness
285.21 Anemia in chronic kidney disease
Anemia in end stage renal disease

403 Hypertensive kidney disease *(see note below)*
Use additional code to identify the stage of chronic kidney disease (585.1-585.6), if known

The following fifth-digit subclassification is for use with category 403:
0 without chronic kidney disease
1 with chronic kidney disease

404 Hypertensive heart and kidney disease *(see note below)*
Use additional code to specify type of heart failure (428.0-428.43), if known
Use additional code to identify the stage of chronic kidney disease (585.1-585.6), if known

The following fifth-digit subclassification is for use with category 404:
0 without heart failure or chronic kidney disease
2 with chronic kidney disease
3 with heart failure and chronic kidney disease

NOTE: Following the finalization of the titles it has been determined that since the codes under category 585 include the entire continuum of CKD it will be necessary to modify the titles for the fifth digits in categories 403 and 404 again to reflect this. **All patients with hypertensive kidney disease have both hypertension and some stage of CKD, so the current code titles for fifth-digit 0 for categories 403 and 404 are invalid. Until new titles become effective only fifth-digit 1 for category 403 should be used. For category 404 only fifth-digits 2 and 3 should be used for patients with CKD.**

When using any code under category 403 with fifth-digit 1 and any code under category 404 with fifth-digits 2 or 3, a secondary code from category 585 should be used to identify the stage of CKD.

Please review the full ICD-9-CM official coding guidelines for full sequencing instructions. The address for the **NCHS classification website is http://www.cdc.gov/nchs/icd9.htm**

UNDIAGNOSED CKD CAN KILL.

How many of *YOUR* patients with diabetes, hypertension or cardiovascular disease have undiagnosed chronic kidney disease?

What Can You Do?

1. Determine Risk
- Diabetes
- Hypertension
- Family history of diabetes, hypertension or CKD
- U.S. ethnic minority status

2. Do 3 Simple Tests
- Urinalysis to detect protein
- Blood Pressure Measurement
- *Serum Creatinine to estimate GFR*

3. Implement an Action Plan (see reverse)

4. Consider co-management with a nephrologist
if the clinical action plan cannot be carried out.
Refer to a nephrologist when GFR <30 mL/min/1.73 m².

The recommended method to estimate GFR is the MDRD Study equation:

Estimated GFR (mL/min/1.73m²)

= 186 x $(S_{Cr})^{-1.154}$ x $(Age)^{-0.203}$ x (0.742 if female) x (1.210 if African - American)

= exp[(5.228–1.154xln(S_{Cr})–0.203xln(Age)–(0.299 if female)+(0.192 if African-American)]

S_{Cr}, serum creatinine in mg/dL; age, in years.

- ***GFR is usually accepted as the best overall index of kidney function in health and disease.*** Normal GFR varies according to age, sex, and body size; in young adults it is approximately 120–130mL/min/1.73 m² and declines with age. A decrease in GFR precedes the onset of kidney failure; therefore a persistently reduced GFR is a specific indication of CKD. Below 60 mL/min/1.73 m², the prevalence of complications of CKD increases, as does the risk of cardiovascular disease.

- The MDRD Study equation has not been validated in children (age <18 years), pregnant women, the elderly (age >70 years), racial or ethnic subgroups other than Caucasians and African Americans, in individuals with normal kidney function who are at increased risk for CKD, or in normal individuals. Despite these limitations, **GFR estimates using equations are more accurate than serum creatinine alone.**

- ***There are several significant limitations to estimating kidney function solely from serum creatinine.*** Serum creatinine concentration is affected by factors other than GFR, such as tubular secretion, generation and extra-renal excretion of creatinine. Due to variation in these processes amongst individuals and over time within individuals, especially creatinine generation, there is a relatively wide range for serum creatinine in normal persons. As well GFR must decline to approximately half the normal level before the serum creatinine concentration rises above the upper limit of normal.

ONLINE AND DOWNLOADABLE TOOLS FROM THE NATIONAL KIDNEY FOUNDATION FOR IMPROVING PATIENT OUTCOMES

GFR Calculator
Clinical Action Plans for CKD with/without hypertension and/or diabetes
KDOQI Clinical Practice Guidelines
www.kidney.org/kls/professionals/tools.cfm

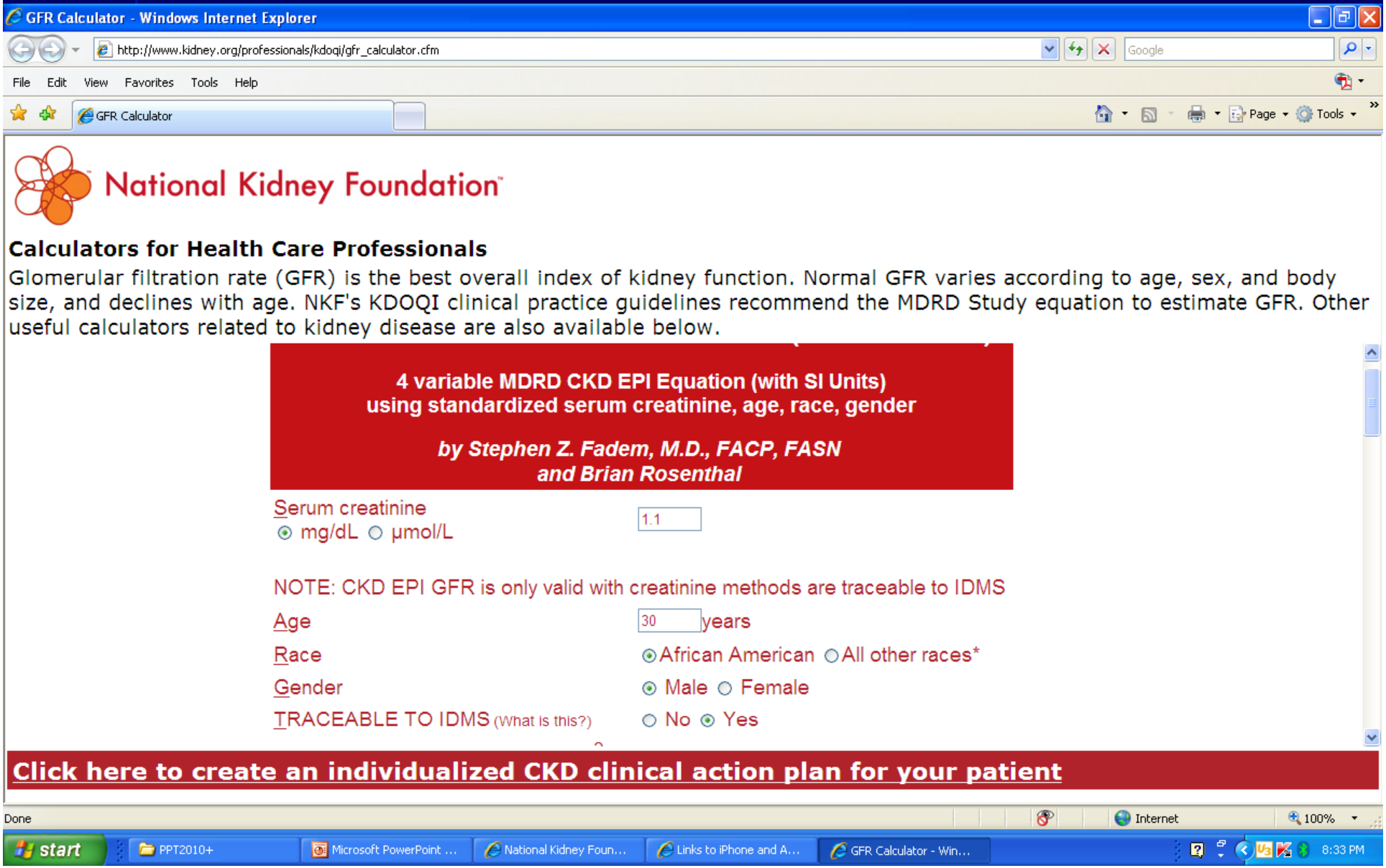
Frequently Asked Questions about GFR Estimates
www.kidney.org/professionals/kls/gfr.cfm

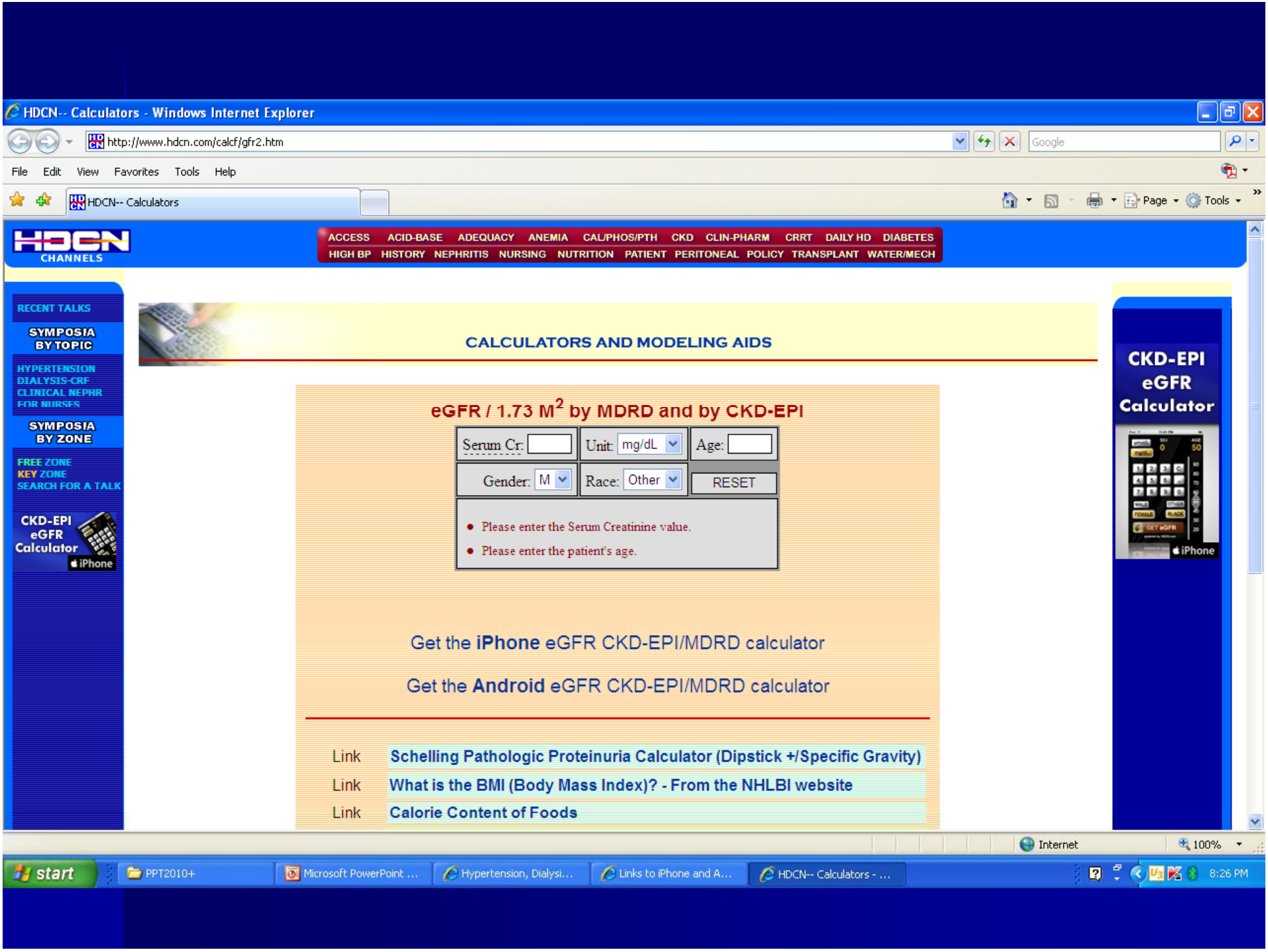
Free community screening: Kidney Early Evaluation Program (KEEP)
www.kidney.org/news/keep/index.cfm

National Kidney Foundation®

www.kidney.org
800.622-9010

eGFR Calculations




HDCN-- Calculators - Windows Internet Explorer
http://www.hdcn.com/calcf/gfr2.htm
File Edit View Favorites Tools Help
HDCN-- Calculators
HDCN CHANNELS
ACCESS ACID-BASE ADEQUACY ANEMIA CAL/PHOS/PTH CKD CLIN-PHARM CRRT DAILY HD DIABETES
HIGH BP HISTORY NEPHRITIS NURSING NUTRITION PATIENT PERITONEAL POLICY TRANSPLANT WATER/MECH
RECENT TALKS
SYMPOSIA BY TOPIC
HYPERTENSION
DIALYSIS-CRF
CLINICAL NEPHR
FOR NURSES
SYMPOSIA BY ZONE
FREE ZONE
KEY ZONE
SEARCH FOR A TALK
CKD-EPI eGFR Calculator
iPhone
CALCULATORS AND MODELING AIDS
eGFR / 1.73 M2 by MDRD and by CKD-EPI
Serum Cr:
Unit: mg/dL
Age:
Gender: M
Race: Other
RESET
Please enter the Serum Creatinine value.
Please enter the patient's age.
Get the iPhone eGFR CKD-EPI/MDRD calculator
Get the Android eGFR CKD-EPI/MDRD calculator
Link Schelling Pathologic Proteinuria Calculator (Dipstick +/Specific Gravity)
Link What is the BMI (Body Mass Index)? - From the NHLBI website
Link Calorie Content of Foods
CKD-EPI eGFR Calculator
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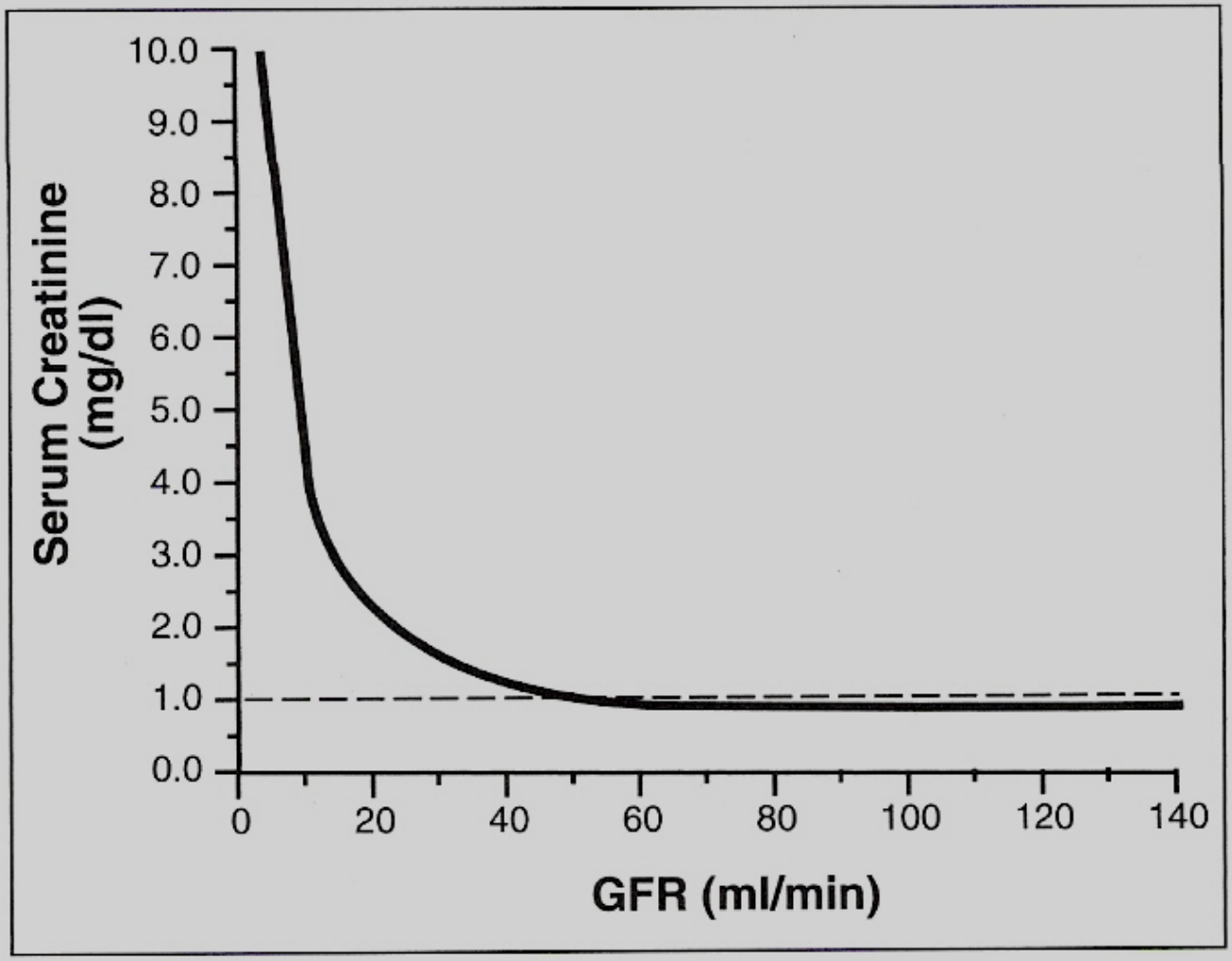
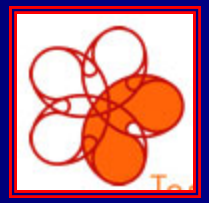


ANNA Core Curriculum 1994

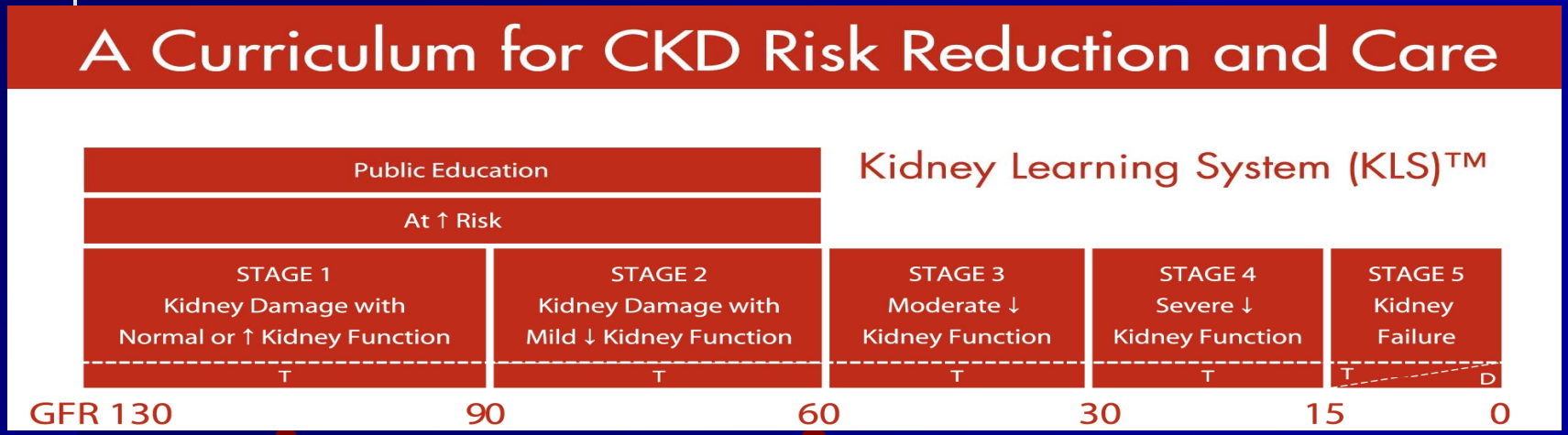
There is a Lot to Manage!

CKD

Interventions that delay progression	Prevention of uremic complications	Modification of comorbidity	Preparation for KRT
ACE inhibitors	Malnutrition	Cardiac disease	Education
BP control	Anemia	Vascular disease	Informed choice of KRT
Blood sugar control	Osteodystrophy	Neuropathy	Timely access
Protein restriction?	Acidosis	Retinopathy	Timely initiation of dialysis
Lipid Control			



Complications of CKD Associated with Level of GFR



Dyslipidemia

Hypertension

Anemia

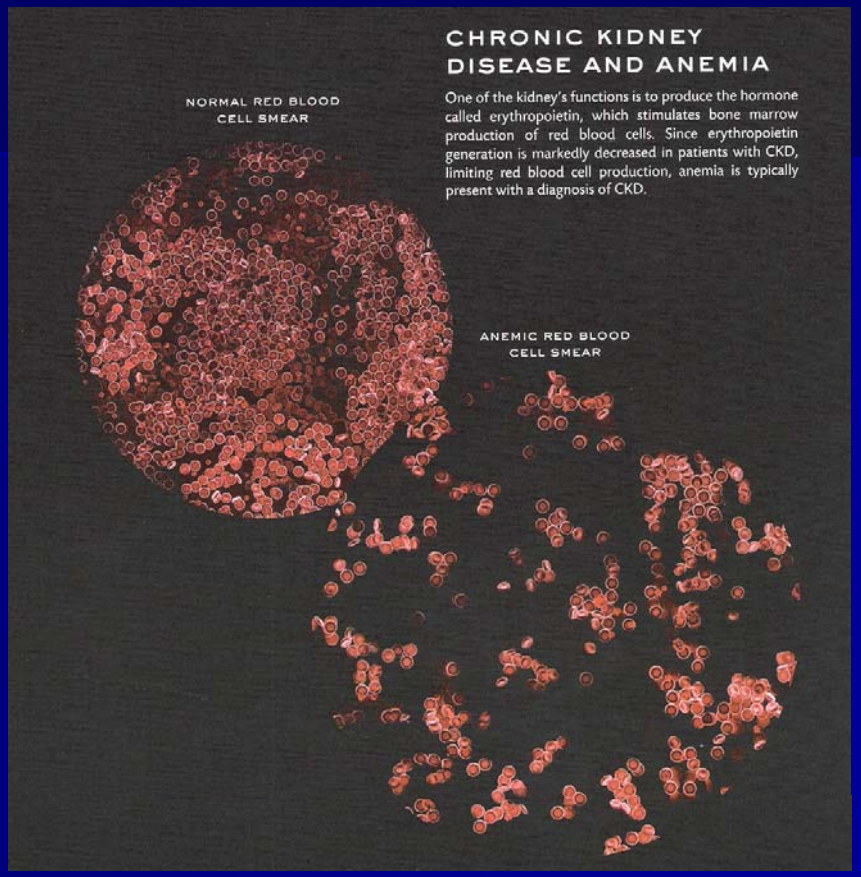
Nutrition

Bone Disease

Neurological Changes

Functioning & Well-being

- ANEMIA
- Decreased O^2
- LVH – left ventricular hypertrophy
- Heart remodels
- Heart Failure



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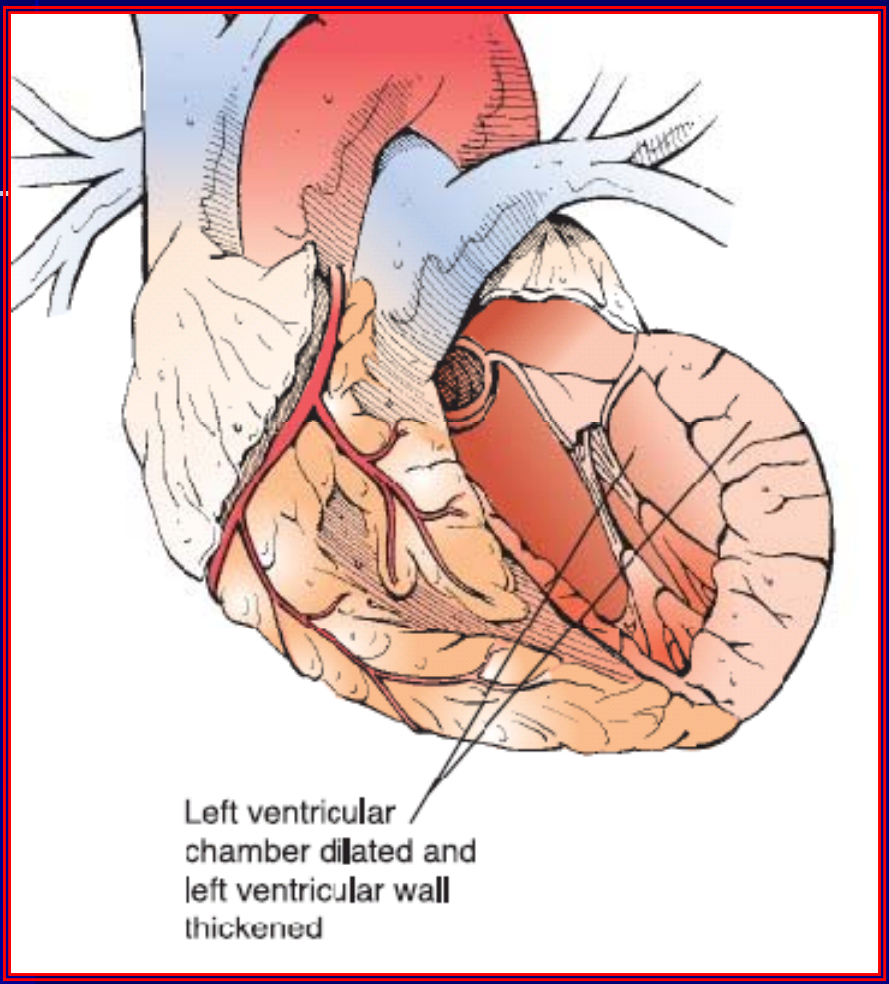


Decreased erythropoietin leads to anemia and increased cardiac preload and decreased vascular resistance. Resulting high cardiac output causes left ventricular hypertrophy and dilatation.

Consequences of Poor Phosphorus and Calcium Control

METASTATIC CALCIFICATION

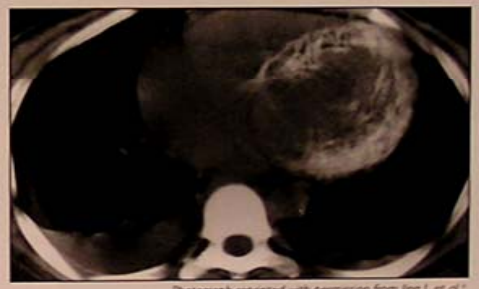
Elevated phosphorus and calcium × phosphorus (Ca × P) product place dialysis patients at risk for metastatic calcification.[1-5] Calcium deposits may form in the joints, organs, and elsewhere in the body. Patients may notice red eyes and itchy skin.

Photograph courtesy of Sharon M. Moe, MD.

Articular metastatic calcification

Photograph courtesy of Sharon M. Moe, MD.

Visceral metastatic calcification



Photograph reprinted with permission from Jing J, et al.[7] American Journal of Roentgenology. 1998;170:903-905.

Calcification of the heart

CALCIPHYLAXIS

Calciphylaxis causes severe skin lesions that may bleed or become infected. This condition may occur in patients with elevated phosphorus, calcium, and (often) parathyroid hormone (PTH).[7] The risk may be greatest in patients who are obese.

Photograph courtesy of Francisco Llach, MD. Reprinted with permission from Massry SG, et al.[8] American Journal of Medicine. 1970;49:416-422.

Calciphylaxis of the toes

genzyme

CMS CfC V543

- The plan of care must address, but not limited to, the ff:

Dose of dialysis. The interdisciplinary team must provide the necessary care and services to manage the patient's volume status……..

CMS CfC V504 – *Blood pressure and fluid needs*

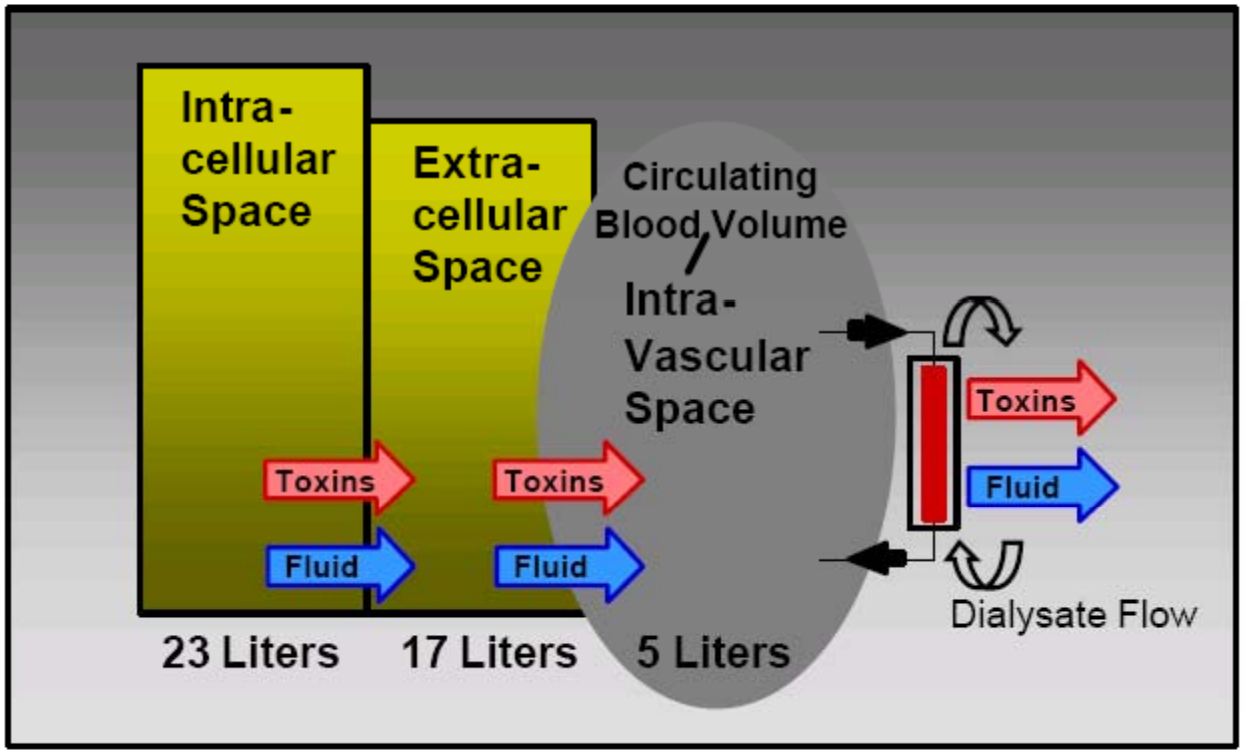
IDT comprehensive assessment

1. pre/intra/post and interdialytic BP
2. IDWG
3. EDW or target weight
4. Intradialytic symptoms – root causes

Human body ~ 60% Water

- Sodium (major extracellular cation) – influences extracellular fluid volume
- IDWG – constant challenge in ESRD
- Difficult to achieve euvolemia

Three Compartment Model



HEMA METRICS

Adverse effects of fluid accumulation

- Hypertension
- Left ventricular hypertrophy
- Cardiovascular complications
- Respiratory symptoms
- Peripheral edema
- Ascites
- Hospitalizations

Why do we drink?

- Physical need
- Customs
- Socialization
- **Alleviate thirst**
- Disease
- Take prescribed medications

Salt and Sodium are not the same

- Salt – essential in small amounts (fluid balance, transmit nerve impulses, muscle contraction)
- ~ 40 % sodium

Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association®

Learn and Live℠

The Importance of Population-Wide Sodium Reduction as a Means to Prevent Cardiovascular Disease and Stroke: A Call to Action From the American Heart Association

Lawrence J. Appel, Edward D. Frohlich, John E. Hall, Thomas A. Pearson, Ralph L. Sacco, Douglas R. Seals, Frank M. Sacks, Sidney C. Smith, Jr, Dorothea K. Vafiadis and Linda V. Van Horn

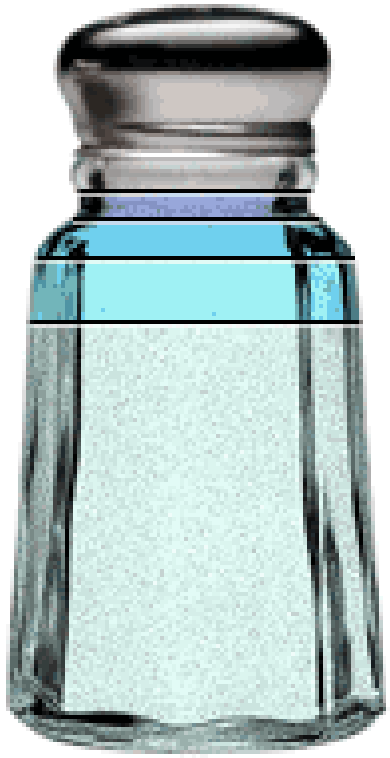
Circulation published online Jan 13, 2011;
DOI: 10.1161/CIR.0b013e31820d0793
Circulation is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514

 Print ISSN: 0009-7322. Online ISSN: 1524-4539

Table. Key Points

- Elevated blood pressure (BP) is a leading, preventable cause of mortality and morbidity in the United States and throughout the world.
- The relation of BP and adverse health outcomes is direct, progressive, consistent, continuous, independent, and etiologically relevant throughout the range of usual BP starting at a level of approximately 115/75 mm Hg.
- A diverse body of evidence has implicated excess sodium intake in the pathogenesis of elevated BP.
- Independent of its effects on BP, excess sodium intake adversely affects the heart, kidneys, and blood vessels.
- Current intake of sodium greatly exceeds 1500 mg/d, the upper level of intake recommended by the American Heart Association and the 2010 Dietary Guidelines Scientific Advisory Committee.
- The potential public health benefits of sodium reduction are enormous and extend to virtually all Americans.

u10423075 fotosearch.com



- 5% added while cooking
- 6% added while eating
- 12% from natural sources
- 77% from processed and prepared foods

http://www.mayoclinic.com/health/sodium/NU00284

http://www.nal.usda.gov/fnic/foodcomp/Data/SR17/wtrank/sr17a307.pdf

USDA National Nutrient Database for Standard Reference, Release 17

Sodium, Na (mg) Content of Selected Foods per Common Measure, sorted alphabetically

NDB_No	Description	Weight (g)	Common Measure	Content per Measure
14006	Alcoholic beverage, beer, light	354	12 fl oz	14
14003	Alcoholic beverage, beer, regular	355	12 fl oz	14
	Beef, top sirloin, separable lean only, trimmed to 1/8" fat, all grades, cooked, broiled	85	3 oz	52
11090	Broccoli, raw	88	1 cup	29
11099	Brussels sprouts, cooked, boiled, drained, without salt	156	1 cup	33
11143	Celery, raw	40	1 stalk	32
11143	Celery, raw	120	1 cup	96
21098	Fast foods, cheeseburger, large, single patty, with condiments and	219	1 sandwich	1108
01121	Yogurt, fruit, low fat, 10 grams protein per 8 ounce	227	8-oz container	132
01117	Yogurt, plain, low fat, 12 grams protein per 8 ounce	227	8-oz container	159
01118	Yogurt, plain, skim milk, 13 grams protein per 8 ounce	227	8-oz container	175
01116	Yogurt, plain, whole milk, 8 grams protein per 8 ounce	227	8-oz container	104

Same Foods – BIG Difference in Sodium

The amount of sodium in processed foods varies a LOT by brand.

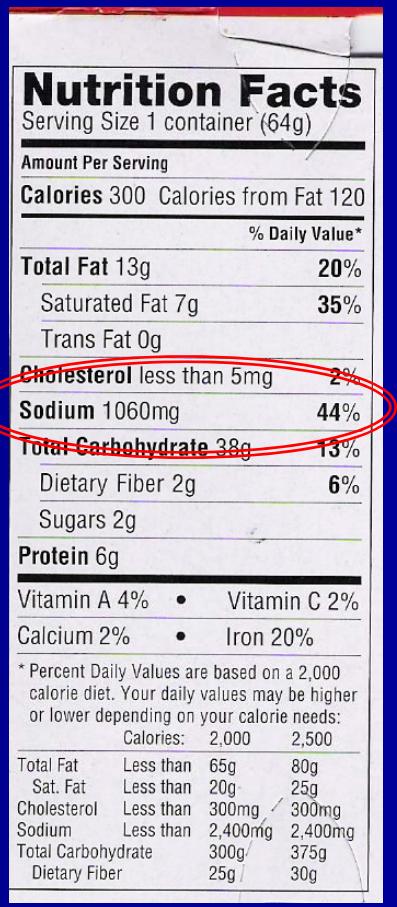
	Serving Size	Range of Sodium (mg) per Serving*
Canned soup	1 cup	50-950
Canned vegetables	½ cup	10-550
Sliced bread	1 slice	100-240
Frozen cheese pizza	1 slice	510-1090
Frozen meals	6-10 ounces	330-1130
Tomato juice	8 ounces	140-680
Salad dressing	2 tablespoons	80-620
Salsa	2 tablespoons	90-250
Potato chips	1 ounce	10-380
Pretzels	1 ounce	50-610

*Based on a convenience sample

http://www.nyc.gov/html/doh/html/cardio/cardio-salt-ads.shtml

IDWG is influenced by sodium consumption

- **DIETARY SODIUM RESTRICTION**
- **Read labels – portion size**
- **Processed foods**
- **Eating out**



Nutrition Facts
Serving Size 1 container (64g)

Amount Per Serving

Calories 300 Calories from Fat 120

	% Daily Value*
Total Fat 13g	**20%**
Saturated Fat 7g	**35%**
Trans Fat 0g	
Cholesterol less than 5mg	**2%**
Sodium 1060mg	**44%**
Total Carbohydrate 38g	**13%**
Dietary Fiber 2g	**6%**
Sugars 2g	
Protein 6g	

Vitamin A 4% • Vitamin C 2%

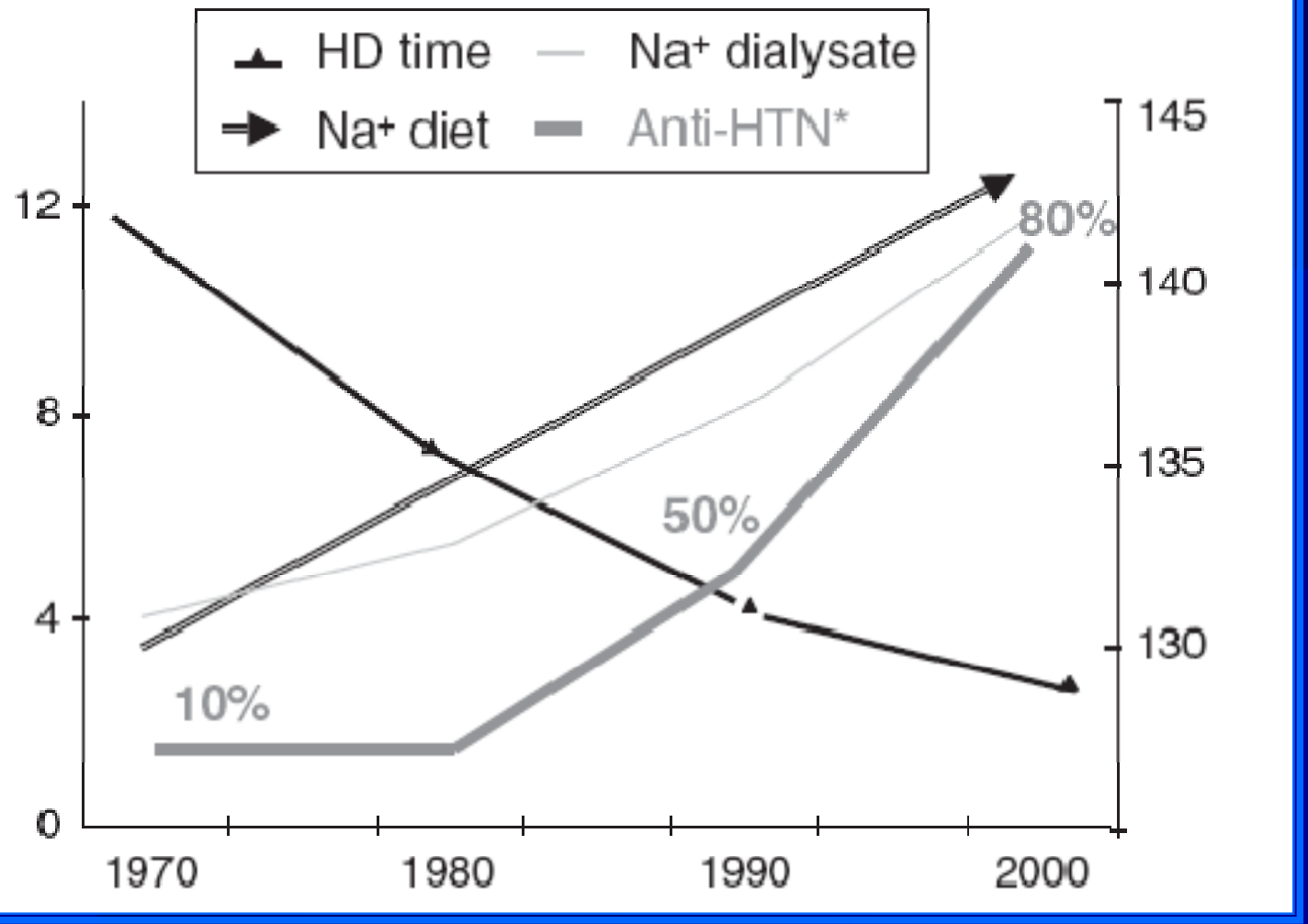
Calcium 2% • Iron 20%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat. Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Hypertension

- Studies have shown that 80% of all HTN in dialysis patients → chronic hypervolemia
- CV deaths and strokes linked to markers of volume overload



Hemodialysis International 2007; **11**:21–31

Core Curriculum

Fluid balance, dry weight, and blood pressure in dialysis

Bernard CHARRA
Centre de rein artificiel, Tassin, France

Table 1. Classification and Management of Blood Pressure for Adults Aged 18 Years or Older

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Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin-receptor blocker; BP, blood pressure; CCB, calcium channel blocker.
*Treatment determined by highest BP category.
†See Table 6.
‡Treat patients with chronic kidney disease or diabetes to BP goal of less than 130/80 mm Hg.
§Initial combined therapy should be used cautiously in those at risk for orthostatic hypotension.

Examples

100 kg patient

- 3% - 3 Liters IDWG = 1.5 L/day
- 4% - 4 Liters IDWG = 2.0 L/day

50 Kg patient

- 3% - 1.5 Liters IDWG = 750 mL/day
- 4% - 2.0 Liters IDWG = 1.0 L/day

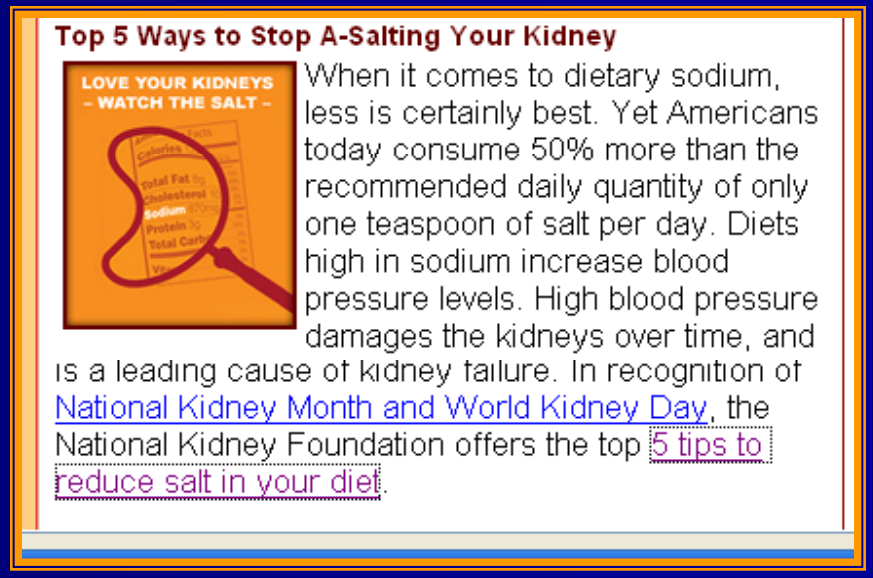
Clin J Am Soc Nephrol. 2010 Jun;5(6):1054-63. Epub 2010 Apr 29.

Hospital treatment for fluid overload in the Medicare hemodialysis population.

Arneson TJ, Liu J, Qiu Y, Gilbertson DT, Foley RN, Collins AJ.

Chronic Disease Research Group, Minneapolis Medical Research Foundation, Minneapolis, MN 55404, USA. tarneson@cdrg.org

CONCLUSIONS: Among U.S. hemodialysis patients, fluid overload treatment is common and expensive. Further study is necessary to identify prevention opportunities.



http://www.kidney.org/news/ekidney/march11/Top5Ways%20_March11.cfm

Pathophysiology and Management of Fluid and Electrolyte Disturbances in Patients on Chronic Dialysis with Severe Hyperglycemia

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DOI: 10.1111/j.1525-139X.2008.00464.x

TABLE 1. Mechanisms causing fluid and solute abnormalities in hyperglycemia

Gain in extracellular solute
Osmotic diuresis
Water intake secondary to thirst
Ketoacidosis
Concomitant diseases

Diabetes

- Polyneuropathy, Autonomic dysfunction,
- Postural hypotension
- Vascular damage
- LVH
- Over hydration

Dialysis Treatment

Current HD Order:

Order Date	Start Date	Prescribed Time (minutes)	Dialyzer	Prescribed BFR	Dialysate	Dry Weight
02/14/2011	02/14/2011	210	Optiflux F160NR	400	Bicarb K+ 1.0; Ca 2.5; Na 141; Bicarb 38; Glucose 100	62.00 kg

Review of last 12 HD Treatments:

Date	Pre-Weight	Post-Weight	Dry Weight	Pre BP Sitting	Pre BP Standing	Post BP Sitting	Post BP Standing
03/07/11	66.70 kg	61.50 kg	62.00 kg	142 / 59	137 / 49	114 / 58	116 / 65
03/05/11	64.50 kg	62.70 kg	62.00 kg	130 / 65	119 / 53	173 / 74	139 / 65
03/04/11	66.90 kg	62.40 kg	62.00 kg	159 / 65	160 / 63	164 / 61	154 / 73
03/02/11	66.40 kg	61.80 kg	62.00 kg	171 / 61	161 / 77	146 / 59	161 / 66
02/28/11	67.00 kg	62.90 kg	62.00 kg	185 / 60	185 / 91	163 / 71	163 / 67
02/26/11	65.80 kg	62.90 kg	62.00 kg	177 / 72	162 / 64	161 / 67	154 / 72
02/25/11	66.80 kg	62.80 kg	62.00 kg	167 / 68	152 / 68	155 / 59	130 / 60
02/23/11	67.10 kg	62.50 kg	62.00 kg	149 / 76	157 / 74	156 / 66	162 / 65
02/21/11	67.50 kg	62.40 kg	62.00 kg	163 / 66	161 / 59	162 / 64	150 / 61
02/18/11	64.70 kg	61.50 kg	62.00 kg	153 / 69	154 / 72	139 / 61	127 / 61
02/16/11	67.00 kg	64.20 kg	62.00 kg	173 / 61	163 / 75	173 / 65	172 / 70
02/14/11	65.90 kg	61.80 kg	63.50 kg	167 / 75	150 / 57	174 / 56	167 / 66

Date	Time	Result	Units	Reference
1/12/11	13:25	9.0 H	%	4.6-6.2
10/13/10	13:10	6.3 H	%	4.6-6.2
8/7/10	06:00	7.5 H	%	4.6-6.2
7/14/10	13:15	7.9 H	%	4.6-6.2
4/14/10	09:50	7.9 H	%	4.6-6.2
1/13/10	17:35	8.1 H	%	4.6-6.2
10/14/09	10:00	8.0 H	%	4.6-6.2
7/15/09	10:00	9.1 H	%	4.6-6.2
4/8/09	10:15	8.3 H	%	4.6-6.2
2/11/09	10:05	9.1 H	%	4.6-6.2
1/14/09	10:00	7.7 H	%	4.6-6.2
10/8/08	13:20	6.4 H	%	4.6-6.2
7/9/08	13:30	6.7 H	%	4.6-6.2

HbA1c Results and Equivalent Average Blood Glucose Level

HbA1c Test Result	Average Blood Glucose in mg/dL	Average Blood Glucose in mmol/L	Notes
4%	65	3.61	Blood glucose average too low for persons with diabetes [1]
5%	100	5.5	Blood glucose may be too tightly controlled[1]
6%	135	6.6	Blood glucose very well managed
7%	170	8.3	Blood glucose very well managed
8%	205	10.0	Marginally managed, take action to lower
9%	240	11.6	Poorly managed, corrective action required
10%	275	13.3	Poorly managed, corrective action required
11%	310	17.2	Poorly managed, corrective action required
12%	345	19.16	Very poorly manage, corrective action required
13%	380	21.2	Very poorly manage, corrective action required

http://www.isletsofhope.com/diabetes/treatment/hba1c_1.html#chart

Assessment of Dry Weight

- EDW (Estimated Dry Weight), Target weight
- “Dry” weight
- Normotensive, minimum to no BP meds, asymptomatic, no edema

IDWG

- IDWG ≥4.8% = ↑mortality

  Blood pressure and long-term mortality in United States hemodialysis patients: USRDS Waves 3 and 4 Study.

Kidney International 2002 Nov; 62(5):1784-90

- Standard ~ 3-5% of EDW

Kidney International advance online publication 6 October 2010; doi: 10.1038/ki.2010.383

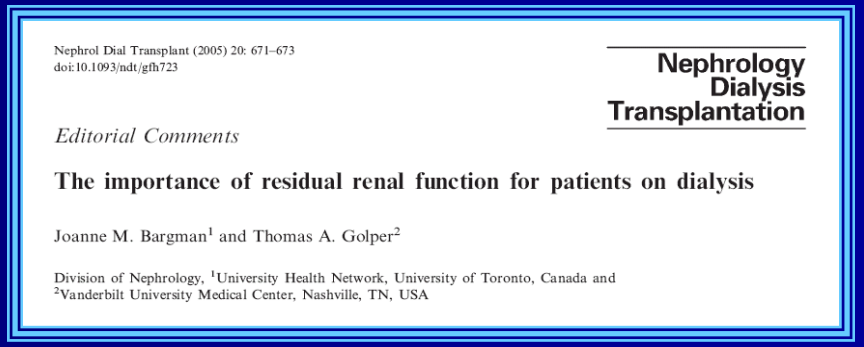
- **Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality**

K/DOQI Guideline for Hemodialysis Adequacy

- VI. *Maximizing patient adherence to hemodialysis prescription*
- Guideline 15 **Optimizing Patient Comfort and adherence** – prevent interdialytic symptoms
- Early termination - 70% cramps, 48% feeling sick, 15% Hypotension
- Early termination – affects adequacy

CLINICAL IMPORTANCE OF RESIDUAL RENAL FUNCTION

- Loss of RRF – patient's volume control and survival outcomes
- Even with low - GFR = can still remove significant uremic toxins
- Urine output facilitates fluid and electrolyte balance



Nephrol Dial Transplant (2005) 20: 671–673
doi:10.1093/ndt/gfh723

Nephrology Dialysis Transplantation

Editorial Comments

The importance of residual renal function for patients on dialysis

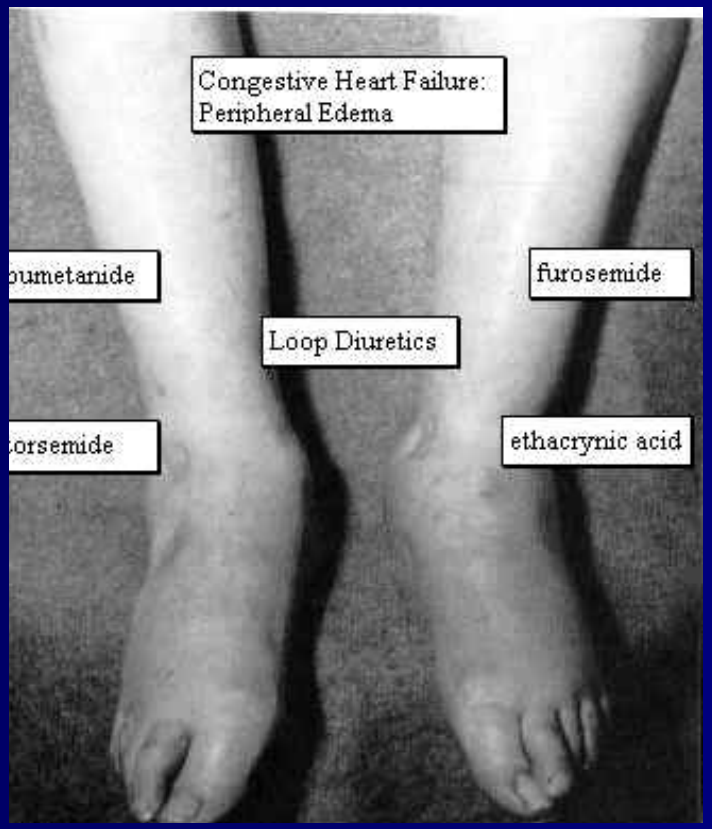
Joanne M. Bargman[1] and Thomas A. Golper[2]

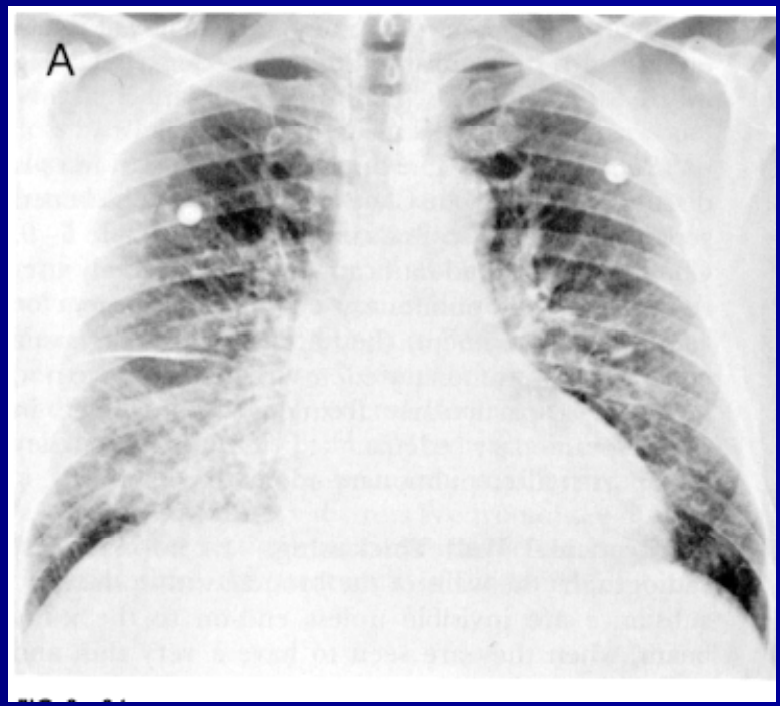
Division of Nephrology, [1]University Health Network, University of Toronto, Canada and [2]Vanderbilt University Medical Center, Nashville, TN, USA

Common Complications

- Hypotension
- Cramps
- Nausea/vomiting
- Seizure (related to hypotension)

Hypotension





Hypotension

- BP Meds
- Heavy Meals – splanchnic vasodilation
- Excessive UF
- Cardiac disease
- BP Cuff size/placement
- Advanced age
- DM
- Low Albumin

BP medications

- Not all BP meds are the same
- Drugs that also cause BP to drop

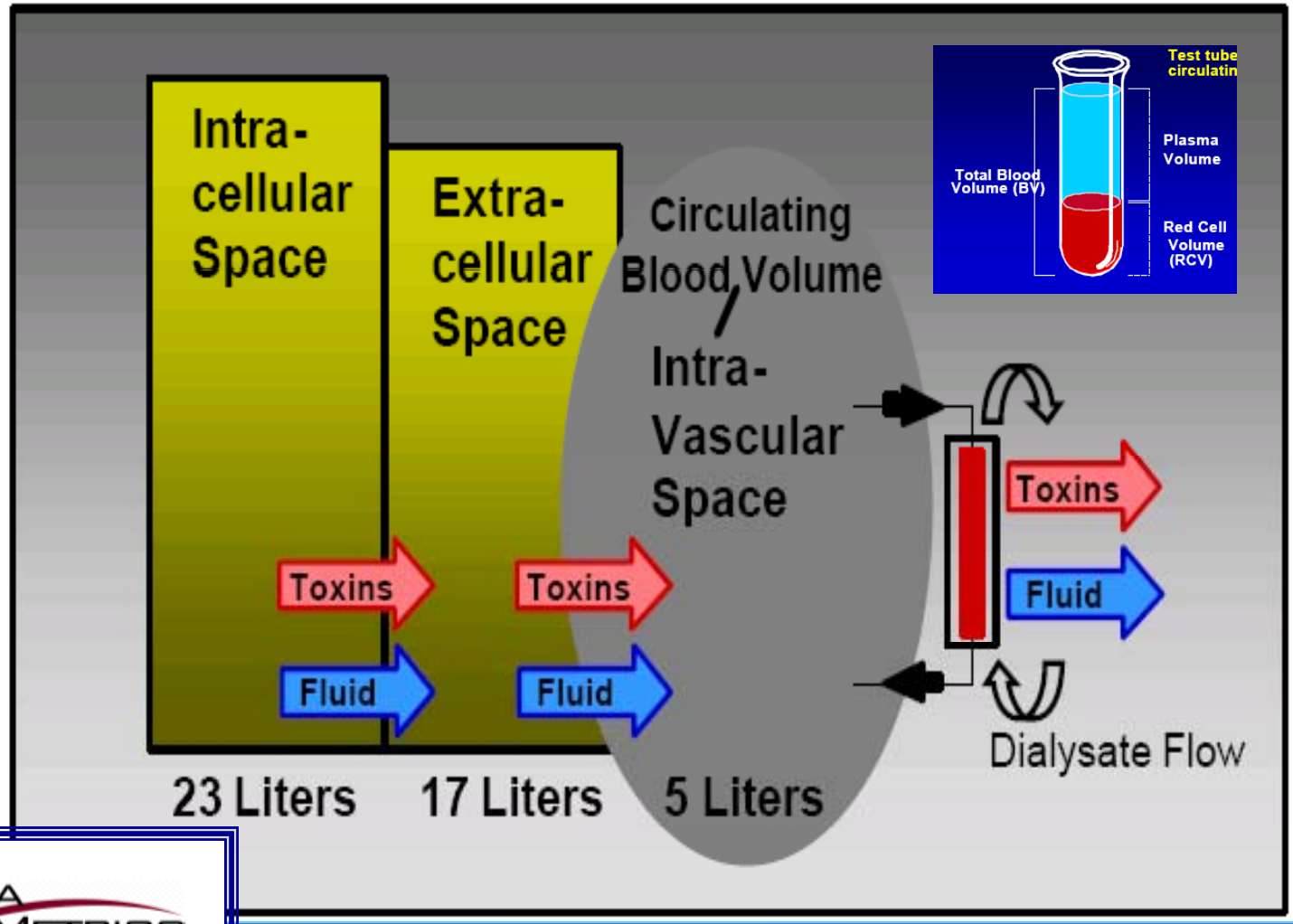
1. Anti arrythmics
2. Beta blockers

- BP meds before HD usually recommended
- Look for patches (Clonidine, Nitro patch

Blood Volume Monitoring

- Excellent tools
- BVM module in Fresenius K machines
- CritLine®

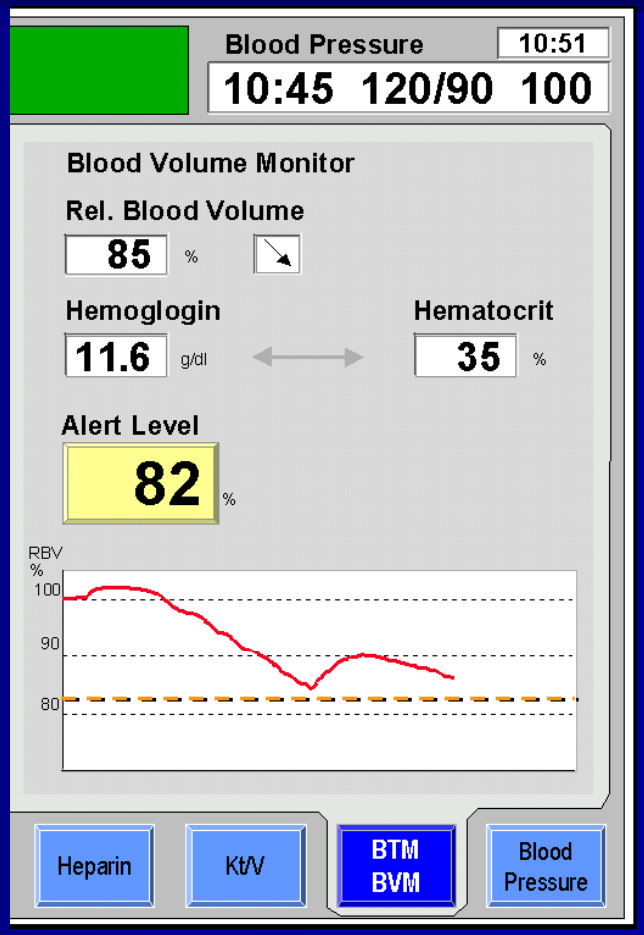
Three Compartment Model



HEMA METRICS

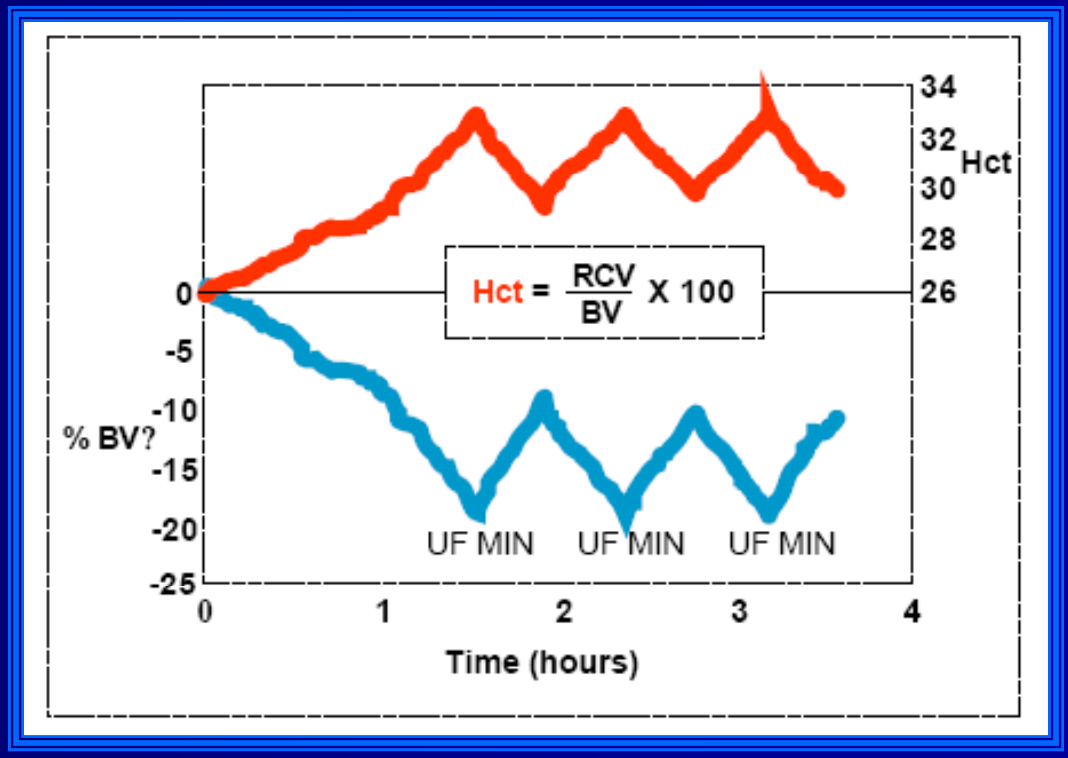
Direct Feedback to the 2008 Machine

- Patient individual alert level
- Audible Warning
- Feedback control stops UF



Blood Volume Monitoring

- Hematocrit
- O2 Saturation



Fresenius Medical Care acquires Hema Metrics' Crit-Line system

3/8/2011

Dialysis products and services provider Fresenius Medical Care AG & Co. announced the acquisition of all assets of Hema Metrics LLC related to its Crit-Line system. Based on its strong dialysis product business and sales organization, Fresenius Medical Care intends to establish this technology as the standard of care for fluid and anemia management in its North American market.

The Crit-Line system, Fresenius announced, is an excellent fit with Fresenius Medical Care North America's 2008K, 2008K2, and 2008T hemodialysis machines.

The Crit-Line system enables noninvasive optical measurement of absolute blood parameters such as percent blood volume change, absolute hematocrit level and continuous oxygen saturation. The Crit-Line system is an effective tool for the clinician to improve fluid management with less clinical complications, such as hypotension. Improved fluid management may lead to fewer hospitalizations for renal patients. The Crit-Line system and its associated products are FDA 510(k) cleared, and carry the CE mark.

No blood Volume Monitor?

- UF Profile
- Na Profile
- Give O2 if known hemoglobin is low especially if UF rate is high
- Longer treatment, sequential UF
- Extra treatment – isolated UF
- At next treatment, increase UF goal in small increments

UF Profile

- Variable settings
- Need to select appropriate for patient
- Increases dialysis tolerance
- Know your patient

Sodium Profile

- Has benefits if utilized properly
- But may also cause patient to be in +Na balance = increase thirst = hypertension
- Need to be sodium neutral at the end
- Know your patient

Assessment/Observation

- Vital signs (Blood Pressure, HR)
- Edema – may be caused my medications also
- Lung sounds
- Co-morbidities - Heart function, Ejection fraction, DM
- Lab values – Hgb, Albumin, blood sugar, Na
- Appetite changes, N/V, diarrhea
- Changes in urine output volume (+/-)
- Meticulous weighing process – same scale, calibrated
- Dialysis "uniform"? – same clothes every dialysis
- Age

Things to consider

- Patients on HD have a very demanding medical regimen
- Knowledge deficits
- Psycho-social issues
- Economics
- Engage patient in self management
- Constant education

Clinical Pearls

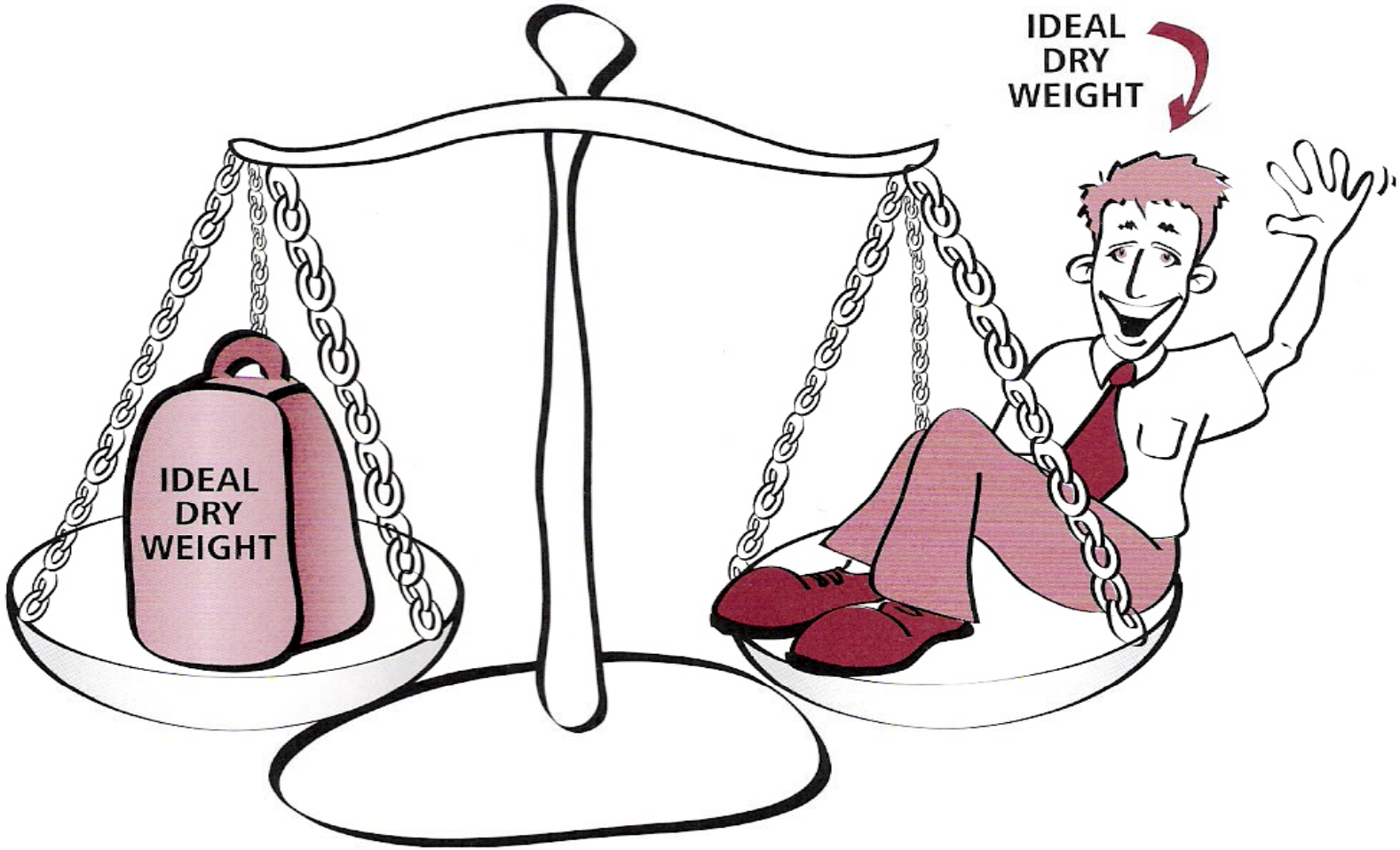
- Blood Volume monitoring
- UF Profiling
- Sodium program
- Lower temperature
- More frequent HD
- Isolated UF, Sequential dialysis
- Frequent assessment of EDW
- Administer Oxygen for lower hemoglobin and PRN

Clinical Pearls

- Hypotension/cramps/other morbid events does not mean EDW was achieved.
- Lag time of a few weeks to months between modification in volume and BP response
- Engage patient in self management

In conclusion

- Fluid overload increases mortality in the ESDR population
- High sodium diet and poor glycemic control lead to fluid over load in the hemodialysis population
- Blood volume monitoring facilitates Ultrafiltration during HD
- Engage patients in self management



HEMA METRICS™

Thank You for the Opportunity and your attention