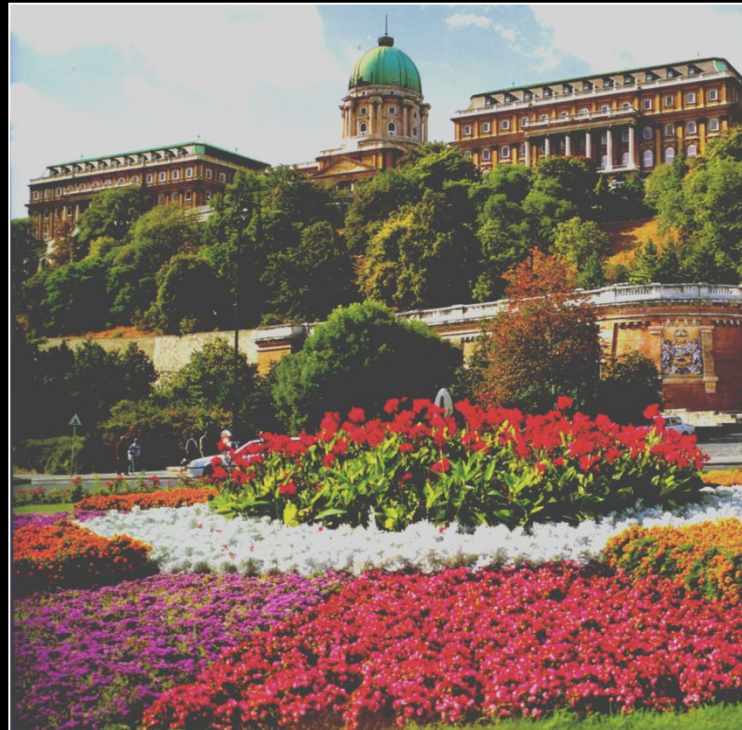
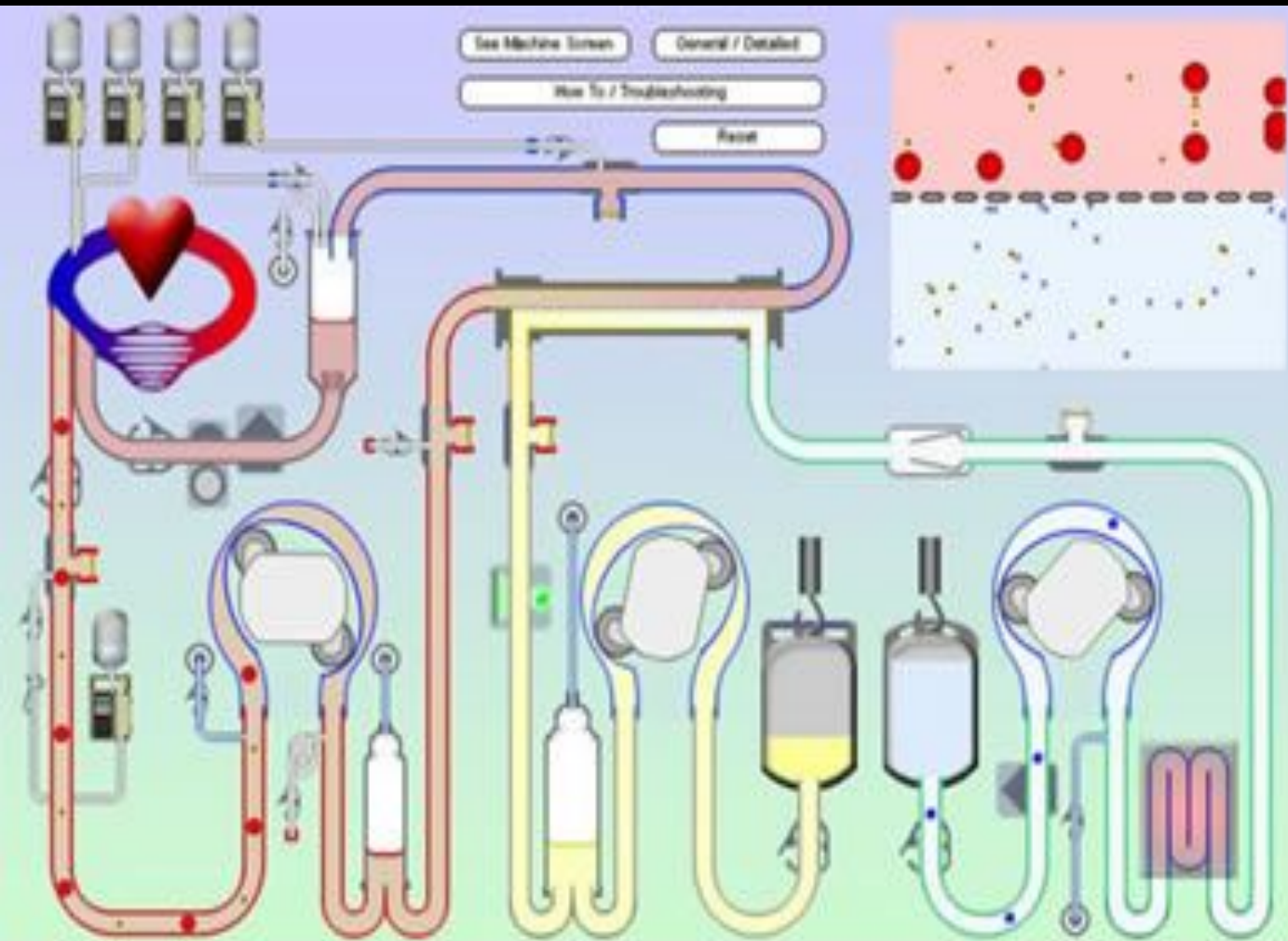


# INTRODUCTION TO THE HEMODIALYSIS PATIENT *2007*

**FOR FIRST YEAR FELLOWS**



# Hemodialysis: the arrangement and weak points



**Hemodialysis is dependent on hemodynamic stability as well as regional blood flow. Efficiency is strongly dependent on mixing between tissues.**

**Uremic toxins are largely unidentified but so far as we know display variability in diffusion and distribution.**

**Viscosity, clotting are important modifiers.**

**Varying resistances on basis of needle/access characteristics.**

# Once upon a time dialysis was simple....

## Since:

low flux, low efficiency dialysis *improve*

## Therefore:

low flux, low efficiency dialysis *must remove*

1. Hyperkalemia →
2. Volume overload →
3. Acidosis →
4. Encephalopathy
5. Pericarditis →
6. Bleeding Diathesis
7. Severe nausea

1. Potassium
2. Salt, water
3. Acid
4. Other low molecular, free solutes *such as urea* that we can name “uremic toxins” (e.g. potassium and small organic acids)

# What is hemodialysis?

- ▣ Hemodialysis is a filter for urea-like uremic toxins so
- ▣ Hemodialysis is able to keep patients alive on *short term* but
- ▣ How about long term?

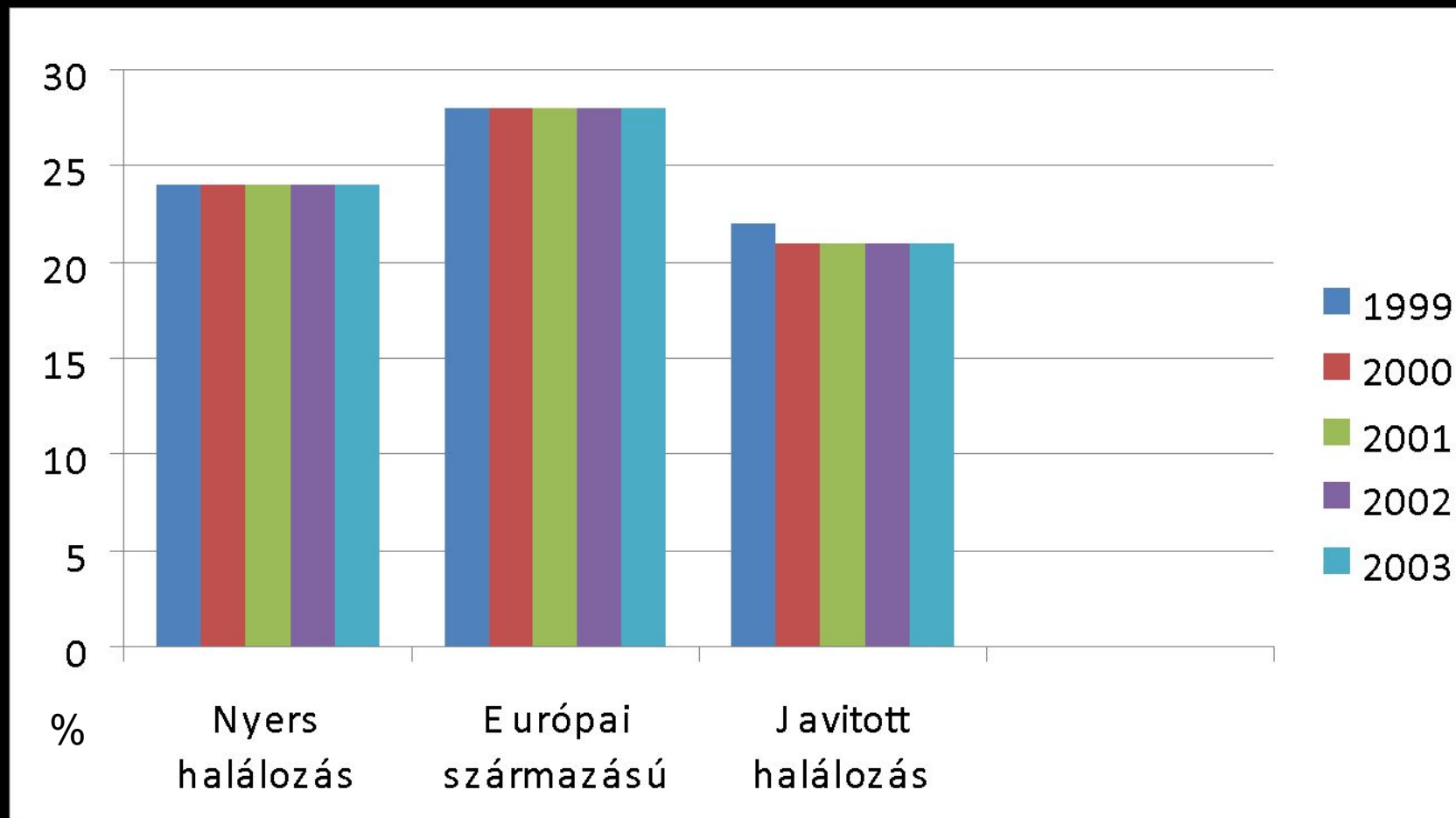
# Function of the Normal Kidney-highlights

1. Removal of toxic materials *(small and middle-size, extra- and intracellular, non-protein bound and protein bound)*
2. Regulation of excess salt, water pressure *(volume, blood pressure)*
3. Influence on sympathetic outflow *(blood pressure, cardiac output)*
4. Regulation of electrolyte concentrations *(K, Mg, P, Ca....etc)*
5. Regulation of acid-base buffer systems
6. Synthesis, conversion of hormones *(erythropoietin, renin, vitamin D)*
7. Metabolism of hormones and medications *(insulin, antibiotics....etc)*
8. Role in maintaining good nutritional state and immunity

# What is hemodialysis?

- Hemodialysis is a complex therapeutic intervention associated with several long term effects and side effects
- Hemodialysis should be **renal replacement therapy** aiming to replace most functions of the failing kidney
- Should improve quality of life and associated conditions
- **Survival is not an adequate goal: goal is rehabilitation**

# Mortality of hemodialysis patients 1999-2003



\* USRDS 2005 Data Report

Prevalent patients(≥90 days) –corrected mortality by age, sex, race, primary diagnosis, vintage.



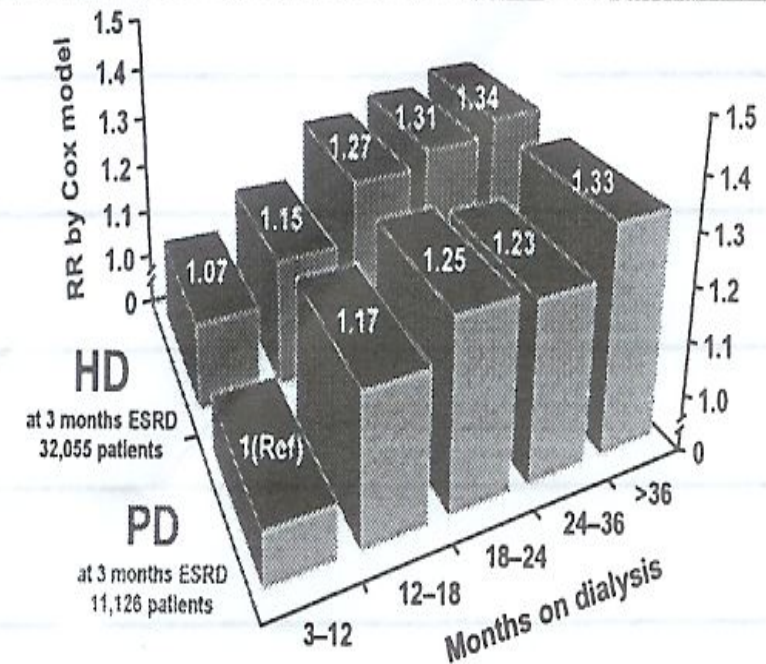
# Mortality and graft loss is influenced by prior dialysis vintage

## Relative risk of mortality by prior dialysis vintage (in years)

- Pre-emptiv (0)  
 0.75 (0.70-0.81) <.0001 Graft Survival  
 0.78 (0.72-0.85) <.0001 Death Censored  
 0.68 (0.61-0.76) <.0001 Death
- 1-<2  
 1.09 (1.04-1.14) 0.0002 Graft Survival  
 1.01 (0.96-1.07) Death Censored  
 1.22 (1.14-1.30) <.0001 Death
- 2-<3  
 1.11 (1.06-1.17) <.0001 Graft Survival  
 0.99 (0.93-1.06) Death Censored  
 1.32 (1.23-1.42) <.0001 Death
- 3+  
 1.16 (1.10-1.22) <.0001 Graft Survival  
 0.97 (0.92-1.04) 0.42 Death Censored  
 1.49 (1.39-1.59) <.0001 Death

USRDS Annual Report 2002

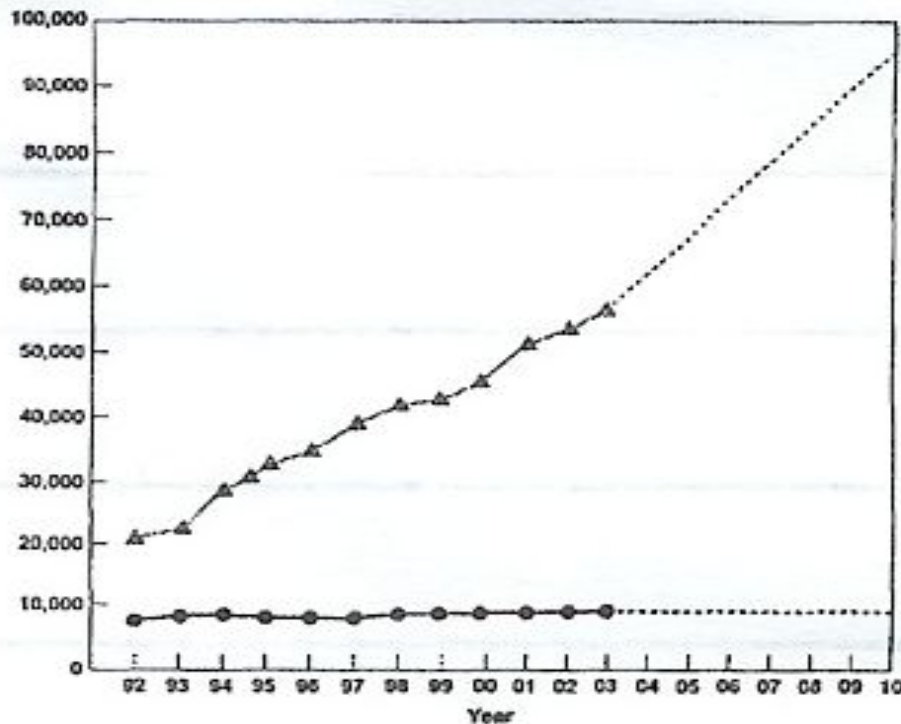
## Relative risk by Cox proportional hazard model for death-censored graft loss



Meler-Kriesche HU, et al. Am J Transplant 2001;1(Suppl. 1):164 (Abstract 116)

# Welcome to the Waiting List!

## Current and projected waitlist for deceased donor kidneys



As of May 2003  
54,000 awaiting CRT  
Projected waitlist  
95,550 in 2010 (Xue et  
al. JASN12:2753,2001)  
Approx 9,000 CRTs  
per annum

# Who benefits most?

Patient Group	Annual Death Rate Among WLD (%)	Days to Equal Risk	Days to Equal Survival	RR <sup>a</sup> (P Value)	Projected Extra Lifetime (yr)
All	6.3	185	531	0.75	5.1
Age (yr)					
18–29	2.2	163	547	0.85	6.4
30–44	5.4	134	309	0.78	4.9
44–54	6.5	196	521	0.70	6.3
55–64	6.5	193	580	0.66	7.3
≥65	10.0	171	475	0.71	3.8
Race					
white	7.5	184	481	0.68	5.9
black	4.8	172	691	0.86	3.1
other	6.3	211	513	0.59	9.9
Gender					
male	6.3	185	526	0.74	5.1
female	6.3	184	528	0.73	5.4
Cause of ESRD					
glomerulonephritis	4.3	192	501	0.82	4.6
hypertension	4.3	169	>700	0.71	8.5
diabetes mellitus	10.8	164	352	0.62	5.6
other diagnoses	4.3	194	663	0.75	6.7

# What is hemodialysis?

- Hemodialysis is a complex therapeutic intervention associated with multiple effects and side effects
- Hemodialysis should be renal replacement therapy aiming to replace *most functions of the failing kidney* and to improve quality of life
- Hemodialysis should bridge the time until a transplant kidney becomes available; it also should preserve residual function as long as possible

# Long term problems associated with Hemodialysis

1. Rapid loss of residual function
2. Poor efficiency in removing non-urea like uremic toxins ( $\beta$ 2M, *P-cresol* etc)
3. Difficulty achieving euvolemia
4. Additional hemodynamic stress due to rapid removal of volume and osmoles
5. Several additional medications needed to control blood pressure and phosphorus
6. Does not replace renal hormones
7. High catabolism, chronic inflammation, immunocompromized state

# Hemodialysis patients-life quality

- Cognitive impairment
- Anxiety
- Depression of chronic disease
- Loss of appetite, substantial dietary restrictions
- Fatigue -multiple etiology, major hemodynamic stress 3x per week w/wo intradialytic hypotension, uncontrolled hypervolemia, anemia
- Variable functional status (cardiac problems, frequent infections)
- Several chronic associated conditions-chronic bone/joint/muscle pain, neuropathy, dyspepsia, PUD, diverticulosis, GI bleed, constipation, accelerated atherosclerosis, chronic inflammation, recurrent infections etc
- Comorbid conditions (often of metabolic origin: diabetes, hyperlipidemia)

# How many medications do you take a day?

- Blood pressure medications ≈5 tablets a day
- Phosphate binders ≈6 tablets a day
- Vitamins, bicarbonate, pain meds, aspirin, diabetic meds, appetite stimulants, antibiotics, calcimimetics, muscle relaxants, sleeping pills, anxiolytics many tablets a day
- Intravenous EPO, vitamin D, iron, heparin  
? side effects: resistant hypertension, clotting, hypercalcemia, worsening infections, iron overload, free radicals, HIT, bleeding....

# Hemodialysis: most of the outcomes are time dependent

- ▣ Dialysis frequency: usually 3x/week except when residual function is still relatively preserved (then it may be rarely 2x/week) or uremic pericarditis, severe uremic symptoms or pregnancy mandate more frequent treatments- but emerging data on superiority of daily hemodialysis
- ▣ Dialysis time: traditionally prescribed to achieve a  $Kt/V_{\text{urea}}$  product of 1.3 or greater; a minimum of 3 hours recommended unless residual function is still present; however, longer times are usually better tolerated and improve fluid status, blood pressure control, nutritional status, phosphorus control, cardiac function, anemia, life quality and survival (possibly also: less inflammation)

# Hemodialysis: dialyzer clearance

- Dialysis membranes: the vast majority of membranes now are high-flux, high-efficiency ( $\uparrow KoA$ ) and “biocompatible” - example is the F160 or F200; these membranes are high surface area and permeability, can accommodate high blood flows and fluid removal rates and are relatively permeable to middle-molecules
- Smaller, less effective membranes may be used for low efficiency dialysis treatments such as continuous treatments in the ICU-however some of the best historical data is with such membranes (Tassin, France)
- Dialyzer reactions may rarely occur- usually dramatic presentation with an anaphylactoid type reaction that is specific to that dialyzer material
- Dialyzer re-use is now less prevalent; may decrease effective dialyzer volume, may increase permeability and may lead to rare cases of re-use solution reaction (e.g. severe hemolytic reaction to renalin)

# Hemodialysis: effective dialyzer clearance

- ▣ Blood flow rate:
  - depends on pump speed, viscosity and resistance within the system
  - usual range 200-500 ml/min, lower in Europe and Japan (note: on machine not actual, use ultrasound dilution to measure!)
  - initial treatments and hemodynamically unstable patients require low blood flows
  - high blood flows require good access flow, needle position, large bore needles
  - high blood flows may not be efficient in poorly functioning catheters and low surface area dialyzers

# Hemodialysis: effective dialyzer clearance-2

- ▣ Dialyzate flow rate: often set either 1.5-2x BFR or it is set at 500 ml/min or 800 ml/min-it is countercurrent to blood flow in dialyzer and high DFR provides an additional 10-15% when BFR is high
- ▣ Rarely temperature may be lower to promote hemodynamic stability
- ▣ Solution is standard: note lower glucose, potassium, magnesium, phosphorus, higher calcium, bicarbonate and sometimes Na concentrations (low K may lead to cardiac risk, dialysis inefficiency; high Na may lead to thirst)

# Hemodialysis prescription- Residual versus hemodialysis clearance

1. Residual renal function: superior to dialysis clearance; preserve by maintaining euvolemia, controlling high BP, giving ACE inhibitors, avoiding nephrotoxic materials, controlling comorbidities (e.g. diabetes)
2. Dialysis clearance: inferior to renal clearance; modify by dialysis time, maintaining good access, high flux dialyzers, high blood flow rate, high dialysis flow rate, larger needles, appropriate needle direction, hemodynamic stability- usually normalized by “urea distribution volume”

# Hemodialysis access types

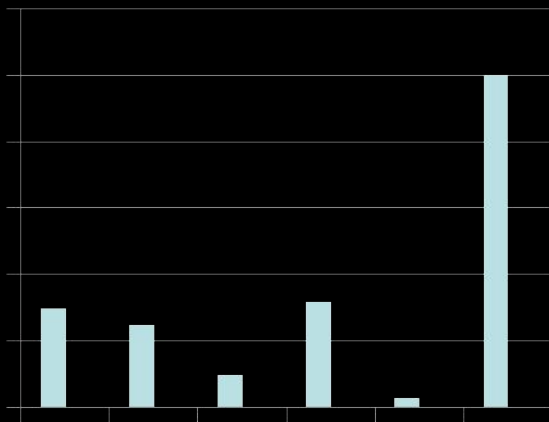
- Native fistula: foreign body, less infections, longer primary (unassisted) patency but frequent primary failure, especially in females, diabetics, elderly patients-if does not mature by 6 weeks revise; usually used after 1-3 months, requires surgical skill
- Synthetic graft: more infections, frequent distal stenosis due to myointimal hyperplasia requiring declotting; surveillance may be of benefit, usually with access flows or static pressures, both may be too variable, especially with unstable

# Hemodialysis access types

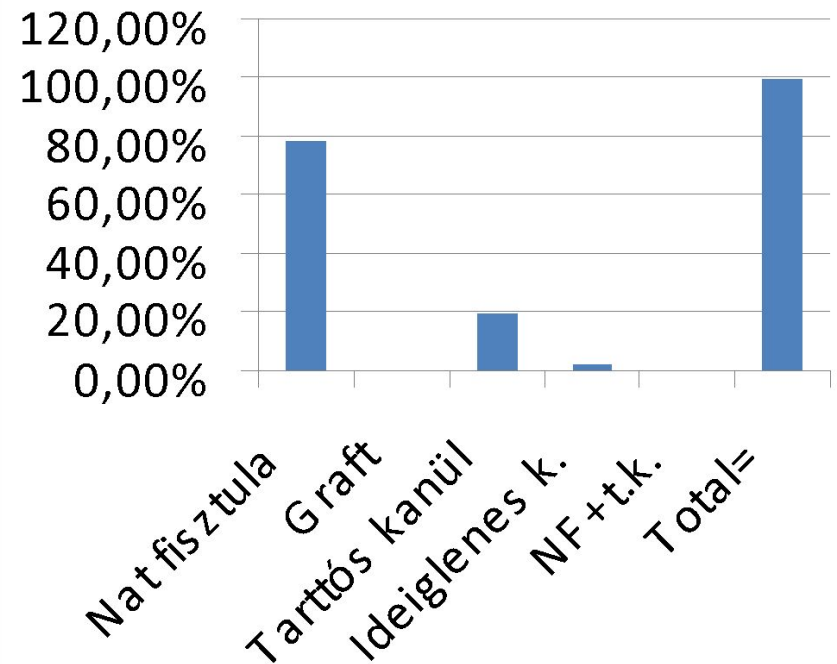
- Semi-permanent dialysis catheters: used as bridge (e.g. in late referral) or as primary access if no good veins available-both dysfunction (clotting, malposition) and especially infections common (note CVS mortality after sepsis!!!!)-blood flows often low, recirculation high-also may cause proximal stenoses and superior vena cava syndrome, difficult to treat
- Temporary catheter: minimize, definitely not more than 3 weeks→endocarditis, epidural abscess; preferably IJ, not subclavian, if infected prompt removal
- Semi-permanent catheter-related bacteremia commonly with staphylococcus species: change catheter when clinically stable, do not save (endocarditis) especially if *S.Aureus* unless veins are very poor-some centers use concurrent antibiotic-lock treatment
- Catheters also slow native fistula maturation

# Vascular Access

A TYPICAL AMERICAN UNIT



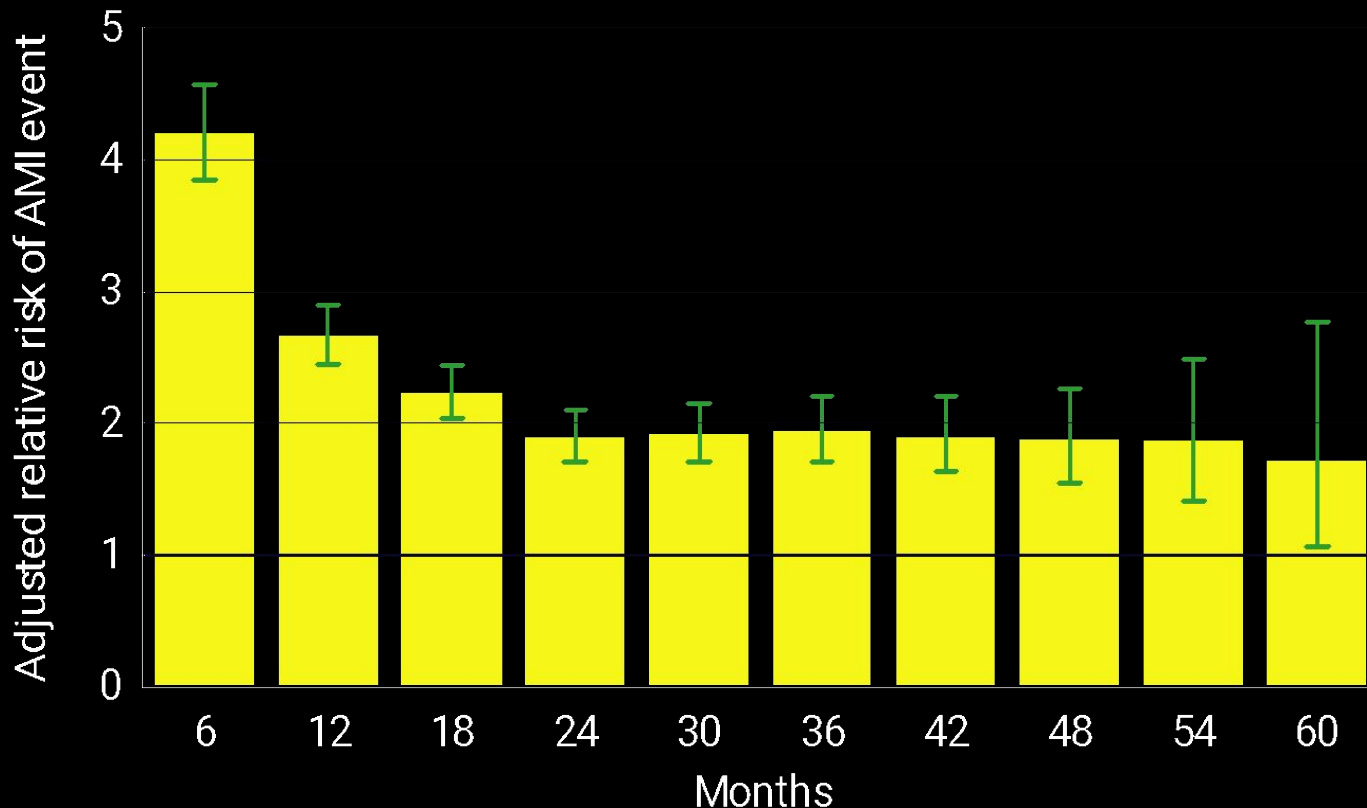
A TYPICAL EUROPEAN UNIT



# Vascular access- more problems

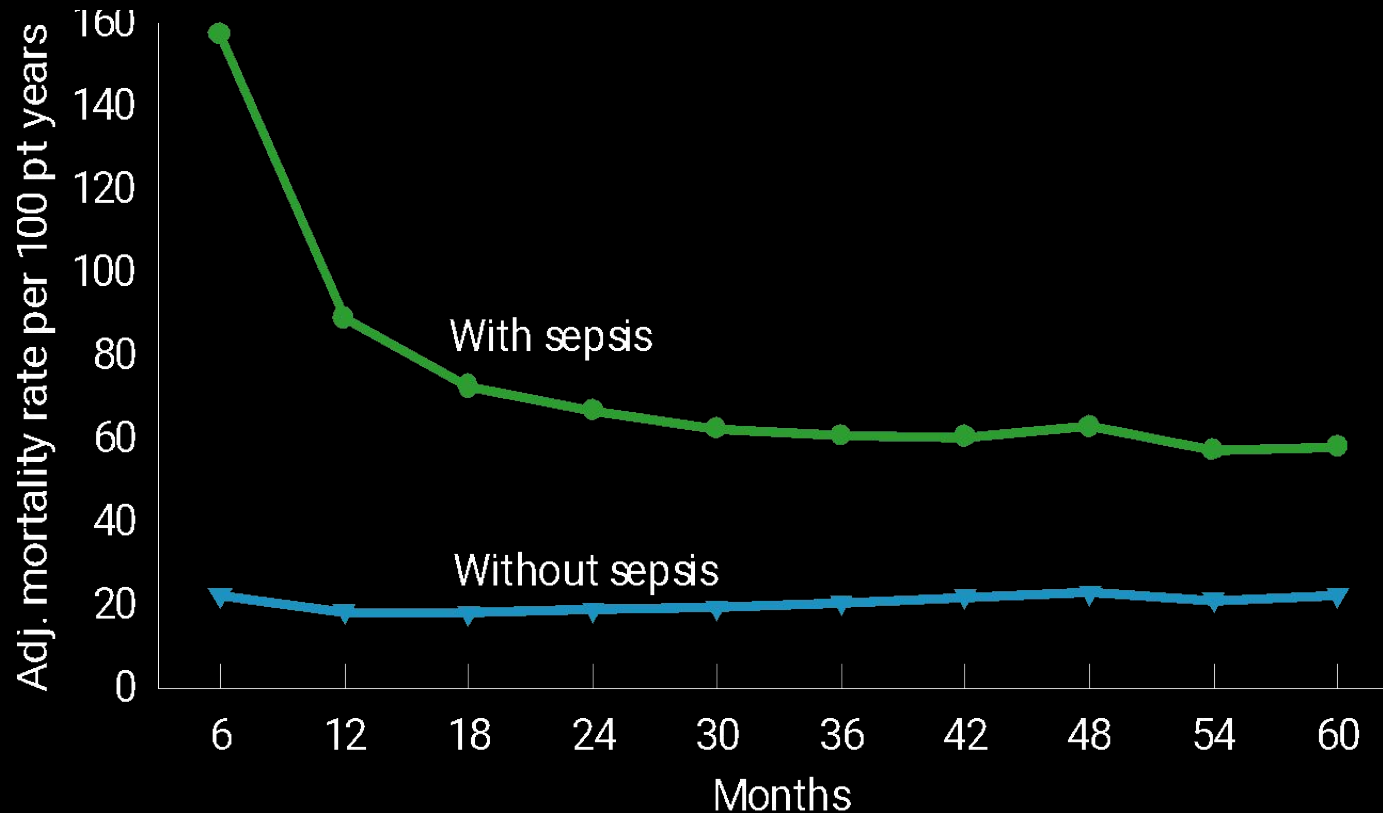
- Trend toward more native fistulae-numbers still low, largely dependent on surgeon's skill
- Grafts: may get infected even when non-functional; access flow monitoring recommended though preventive angioplasty controversial; if clotted prompt declotting needed
- Catheters: avoid but beware-patients (and sometimes staff) may prefer them to fistulae/grafts to avoid needles

# Acute myocardial infarctions after first sepsis event: adjusted relative risk of AMI event



Incident dialysis patients (90-day rule), 1996–1999 combined; adjusted for modality, age, gender, race, & primary diagnosis. Patients with Medicare as a secondary payor or enrolled in an HMO on day 90, & those with AMI claims overlapping the start date of the followup period, are excluded. Reference group: patients without sepsis.

# Mortality after first septicemia event: adjusted mortality rates



Incident dialysis patients (90-day rule), 1996–1999 combined; adjusted for modality, age, gender, race, & primary diagnosis. Patients with Medicare as a secondary payor or enrolled in an HMO on day 90, & those with septicemia claims overlapping the start date of the followup period, are excluded. Reference group: patients without sepsis.

# Hemodynamics-important to remember

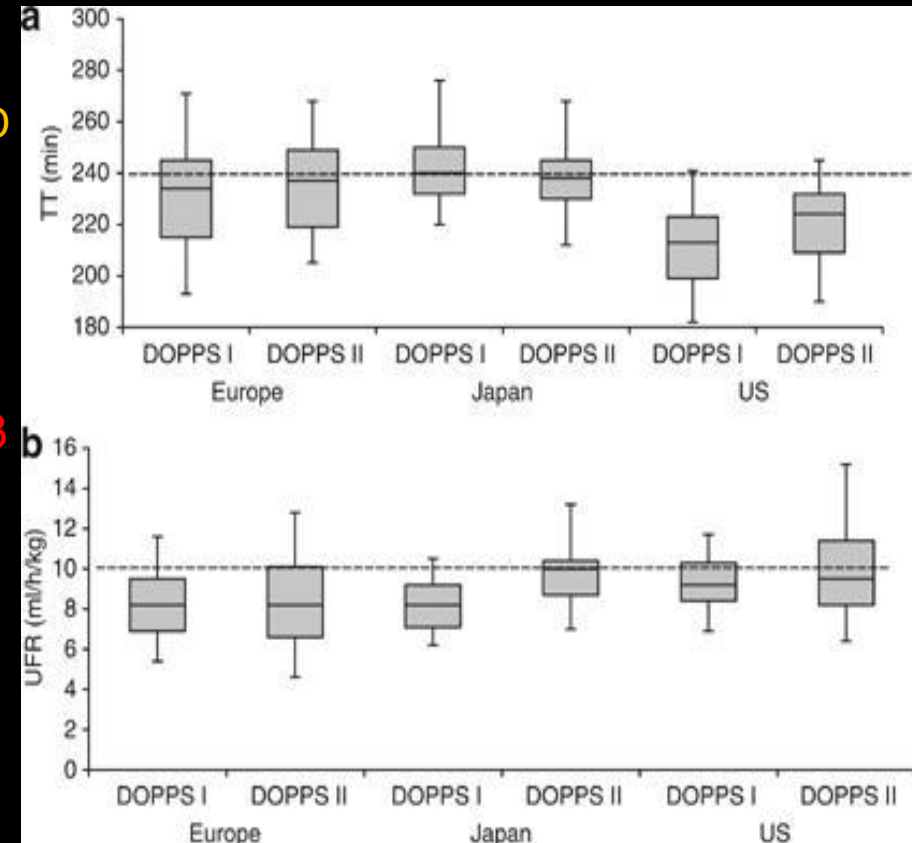
- ▣ Chronic hypervolemia and increased sympathetic outflow highly prevalent in hemodialysis patients
- ▣ LVH, high blood pressure and high cardiovascular mortality are commonly observed
- ▣ Only non-dialysis day blood pressures correlate with clinical outcome except....
- ▣ Low blood pressure episodes anytime are associated with poor outcome
- ▣ Hemodynamic stability should be an important goal in hemodialysis so.....
- ▣ Minimize UFR, get to dry weight-better survival versus control blood pressure by medications no benefit

# Hemodynamics-important to remember 2

- Dry weight: the lowest weight at which the patient is comfortable
- Symptoms of hypovolemia can be reproduced by too rapid fluid removal for a given patient (UFR tolerance may be different by: medications, underlying cardiovascular status)
- Greater precision can be achieved in the absence of large weight-gains
- Na modeling and UF profile-may lead to thirst and temporary high UFR

# Hemodynamics-treatment time and UFR in different continents

	DOPPS I		DOPPS II	
Régió	<i>n</i>	Mean±SD	<i>n</i>	Mean±SD
<i>Treatment time (minutes)</i>				
Europe	2590	232 <sup>b</sup> ±41	2856	235 <sup>b</sup> ±38
Japan	2169	244 <sup>b</sup> ±32	1805	240 <sup>b</sup> ±33
USA	3856	211±32	2260	221 <sup>c</sup> ±33
<i>UFR (ml/h/kg)</i>				
Europe	2590	8.3 <sup>b</sup> ±3.6	2856	8.4 <sup>b</sup> ±3.5
Japan	2169	8.2 <sup>b</sup> ±3.5	1805	9.9 <sup>c</sup> ±3.6
USA	3856	9.2±3.9	2260	9.8±3.7

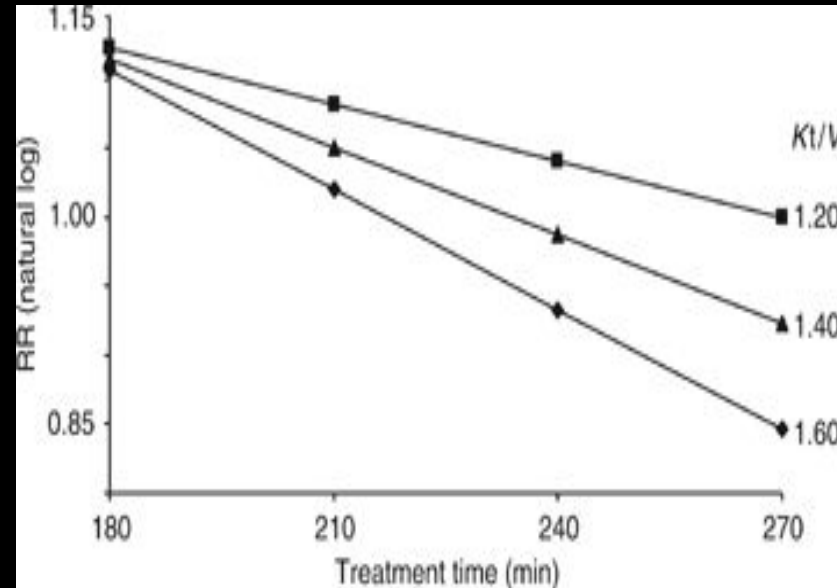


<sup>a</sup> Accounts for facility clustering.  
<sup>b</sup>  $P < 0.05$  vs US within phase.  
<sup>c</sup>  $P < 0.05$  comparing DOPPS II to DOPPS I within each country.

**\*Longer treatment time and slower ultrafiltration in hemodialysis: Associations with reduced mortality in the DOPPS**  
 R Saran, J L Bragg-Gresham, N W Levin, Z J Twardowski, V Wizemann, A Saito, N Kimata, B W Gillespie, C Combe, J Bommer, T Akiba, D L Mapes, E W Young and F K Port

# Treatment time and UFR-independent effects

	UFR>10 ml/h/kg		TT>240 min	
	RR	P-value	RR	P-value
RR of death				
Crude	1.01	0.75	0.68	<0.0001
Corrected*	1.09	0.02	0.81	0.0005



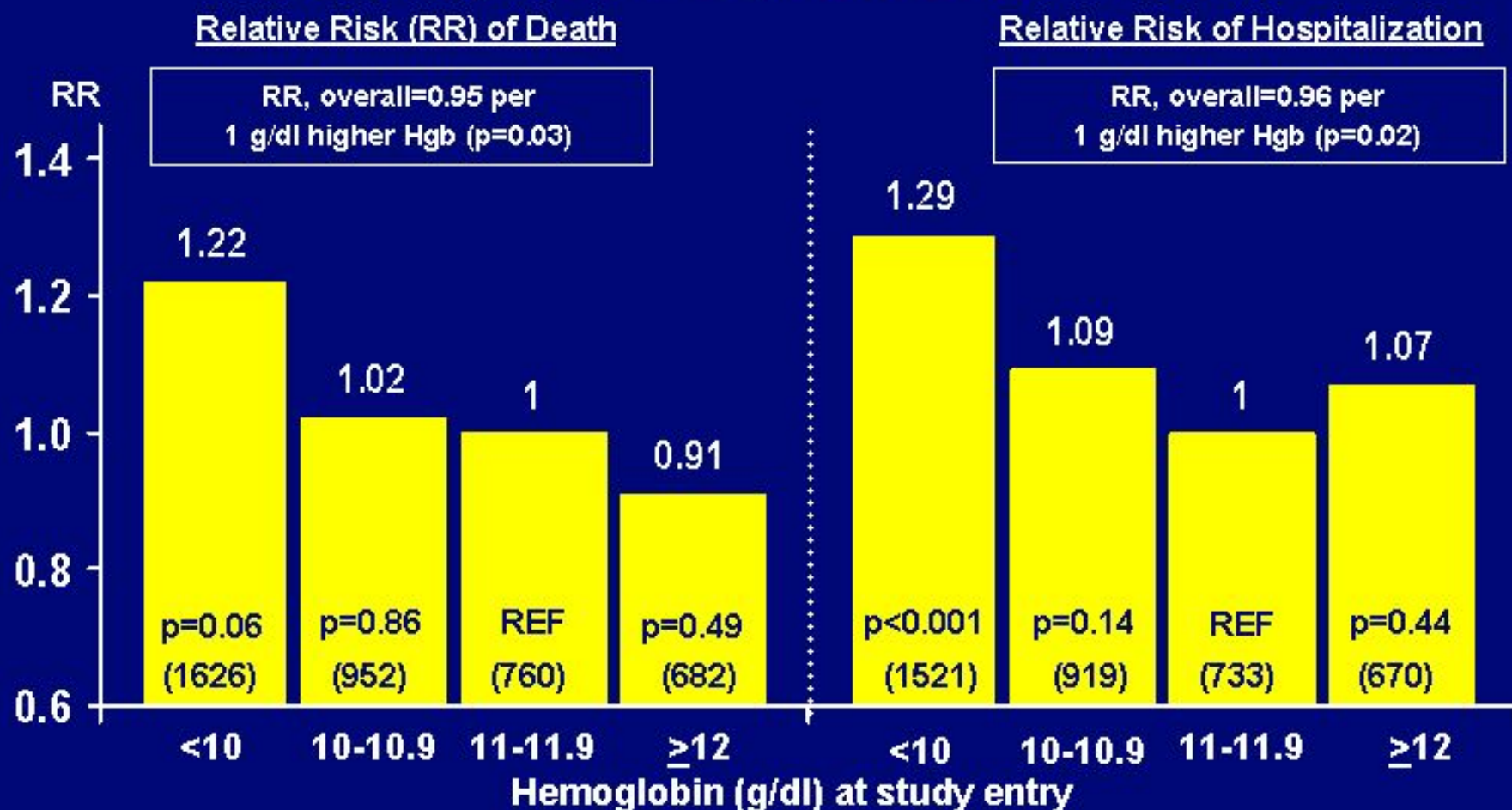
**Interaction between  $Kt/V$  and treatment time.** RR of death on a logarhythmic scale (y axis) by treatment time (x-axis) at 3 different  $Kt/V$  values (interaction  $P=0.007$ ). The effect is strongest at high  $Kt/V$  values.

\* Cox regression model by age, sex, ethnicity, vintage, 14 different comorbidities, living status, height, dry weight,  $Kt/V$ , BFR, residual function, catheter use, treatment time (UFR model) and UFR (treatment time model).

# Anemia-introduction

- Erythropoietin  $\alpha$  is given IV 3x/week: inefficient, may lead to headache, high blood pressure and increased graft clotting ( $\uparrow$ endothelin release) but used because of fear of increased immunogenicity of sq and: **convenience**
- Erythropoietin  $\beta^*$  can be safely given sq; anything given sq is more efficient with less side effects but may burn and may lead to antibody formation-medication warning
- EPO is very expensive but readily available; note therapeutic effect usually lags 4-6 weeks
- EPO resistance-main factors: iron deficiency, ACEI, **inflammation/malnutrition**, hyperparathyroidism and **poor dialysis**
- Target Hgb: 11-12; evidence from  $\approx$ 10 (better survival and hospitalization, less LVH); full correction in cardiac patients: bad outcome
- Iron therapy: lots of controversy, chronic HD and GI loss; current parameters are non-specific some are promising (reticulocyte Hgb content); give as slow as you staff can tolerate, true anaphylactoid reactions now rare

# EuroDOPPS: Higher Hemoglobin Concentrations are Associated with Lower Mortality and Hospitalization Rates



Analyses were adjusted for age, gender, 14 comorbidity classes, ability to walk without assistance, malnourishment, ability to eat independently, years with ESRD, first 180 days of ESRD, country of residence, and facility clustering effects

# Anticoagulation-introduction

- Anticoagulation is necessary to keep tubing/dialyzer from clotting and to prevent decrease in effective dialyzer surface area-should be clear after dialysis
- In US, usually unfractionated heparin with or without a pump, given in 1-2 boluses dosed by kg or by aPTT, in Europe LMW heparin commonly used
- Catheters are locked with heparin to fill volume (if too much is given PTT can be extremely high)

# Ca, P, PTH-introduction

- ▣ This is a highly controversial area: “calcification”; cardiovascular mortality
- ▣ Problem: high P-dialysis does not remove sufficient P necessitating oral P binders; residual renal function may help, long and frequent treatment the real solution
- ▣ Dialysis solution low in P, relatively high in Ca; high Ca bath used historically, now only rarely when low Ca with low intake
- ▣ IV calcitriol or analogue is often used to keep PTH low-given each dialysis unless Ca or Ca $\times$ P “high” when they are held; may be combined with calcimimetics (oral)
- ▣ Calcimimetics or parathyroidectomy often necessary

# Ca, P, PTH- outcome data

**% of patients**

Serum value	Recommended range <sup>a</sup>	Mean (SD)	Median	Below lower range limit	Above upper range limit
Phosphorus ( <i>N</i> = 8265)	3.5–5.5 mg/dL	5.8 (1.8)	5.6	7.6	51.6
Japan ( <i>N</i> = 2132)		5.8 (1.6)	5.7	5.8	53.6
Europe ( <i>N</i> = 2525)		5.7 (1.9)	5.5	10.1	49.4
U.S. ( <i>N</i> = 3608)		5.9 (1.9)	5.6	6.8	51.9
Albumin-corrected calcium ( <i>N</i> = 6898)	8.4–9.5 mg/dL	9.6 (1.0)	9.5	9.3	50.2
Japan ( <i>N</i> = 1617)		9.4 (1.0)	9.4	12.2	45.2
Europe ( <i>N</i> = 1720)		9.7 (0.9)	9.6	7.2	55.6
U.S. ( <i>N</i> = 3561)		9.6 (1.0)	9.5	9.1	49.9
Ca-P product ( <i>N</i> = 8070)	<55 mg <sup>2</sup> /dL <sup>2</sup>	54 (17)	53	NA	43.5
Japan ( <i>N</i> = 2131)		54 (16)	52	NA	43.2
Europe ( <i>N</i> = 2337)		54 (19)	53	NA	43.2
U.S. ( <i>N</i> = 3602)		54 (17)	53	NA	43.8
PTH ( <i>N</i> = 5240)	150–300 pg/mL	274 (400)	144	51.1	26.7
Japan ( <i>N</i> = 1142)		196 (241)	111	58.6	19.0
Europe ( <i>N</i> = 1716)		269 (365)	149	50.1	26.9
U.S. ( <i>N</i> = 2382)		316 (473)	158	48.2	30.3

# Nutrition/inflammation-introduction

- ▣ Nutrition is a **critically important** topic in hemodialysis patients
- ▣ Worst prognosis on hemodialysis=catabolic/malnourished patients with chronic inflammation
- ▣ Dietary assessment (*Subjective Global Assessment, SGA*)
- ▣ **Laboratory parameters:**
  - low** albumin, Fe sat, NPCR, P, BUN, creat, BMI, weight gain, cholesterol, fetuin A (some may be pseudo-normal)
  - high** ferritin, CRP, IL6, EPO dose

# CANUSA: Relative Risk of Mortality

- ▣ \*SGA      0.740      0.647-0.842
- ▣ Kd creatinine      1.000      0.898-1.105  
(each 5 L/wk per 1.73 m<sup>2</sup> greater)
- ▣ RRF      0.88      0.829-0.943  
(each 5 L/wk per 1.73 m<sup>2</sup> greater)

**\*Subjective global assessment by a dietician**

# NECOSAD : Relative Risk of Mortality

- Large multi-center prospective observational study in incident HD patients who survived the first 3 months (n=740)
- Follow-up to 36 months, Cox proportional-hazard model used for patient survival
- SGA is again a *strong independent predictor of mortality* (RR=0.89)
- RRF good predictor, dKt/V only a predictor in anuric patients

# Nutrition/inflammation-being consistent

- ▣ Nutritional status should be closely followed in hemodialysis patients
- ▣ Malnutrition is more dangerous than obesity
- ▣ Anemia, infections (catheter biofilm, leg ulcers, periodontitis) and poor dialysis are potential risk factors (but the latter can cause both former)
- ▣ Constipation (BP meds) needs to be treated
- ▣ Exercise/rehab may be important- early mobilization in hospital
- ▣ Minimize hemodynamic stress on dialysis (UFR)
- ▣ Consider increasing treatment time irrespective of urea-based clearance especially in smaller patients

# Nutrition/inflammation-albumin

- ▣ Low albumin as marker of poor nutrition:  
ROC curve is poor, worse than CRP
- ▣ Low albumin correlates with mortality, less  
with protein-energy malnutrition
- ▣ Proper way to follow PEM is SGA
- ▣ SGA validated as a clinical tool in at least 2  
large dialysis trials

# Summary-main parameters at the dialysis chair: “clearance”

Dialysis dose/adequacy: subjective assessment with special attention to

1. loss of appetite
2. not feeling well
3. fatigue
4. consistent weight loss
5. low albumin
6. epo resistance
7. high inflammatory markers
8. access dysfunction
9. urea-based parameters -special attention to small or anuric patients and short treatment times

# Clearance: what to do

- ▣ Maximize treatment time
- ▣ Avoid hemodynamic instabilities
- ▣ Optimize dialysis access flow rate, needle size and position (distance) so that effective BFR can be maximized
- ▣ May need to increase DFR if BFR is reasonable
- ▣ Use high-flux high-efficiency dialyzers when BFR permits to take advantage of their effective use
- ▣ Adequately anticoagulate
- ▣ Maximize patient compliance by *consistent follow up and team work*

# Summary-main parameters at the dialysis chair:hemodynamics

- ▣ *Avoid hypotensive episodes*
- ▣ Minimize *UFR*: depends on *interdialytic weight gain* (Na, sugar intake) and *treatment time*
- ▣ Correct anemia
- ▣ Obtain *non-dialysis day blood pressure* readings when possible- dose BP meds by that
- ▣ *Avoid Na profiling*
- ▣ Carefully assess *dry weight* -the lowest at which the patient feels well, especially if blood pressure is high
- ▣ *Avoid high blood flows* in hemodynamically unstable patients

# Summary-main parameters at the dialysis chair: anemia

- ▣ *Target Hgb 11-12 but try to minimize Epo dose*
  - avoid *infections* (diabetic ulcer, periodontitis)
  - maintain good *iron stores*
  - avoid *bleeding* episodes: adequate *anticoagulation*, use good access *stickers*, *GI* studies when indicated (PUD, AVM etc)
  - avoid malnutrition/inflammation by *individualizing dialysis “dose”*

# Summary-main parameters at the dialysis chair: Ca, P, PTH

- ▣ Keep *P levels* low while maintaining adequate *protein intake*
- ▣ Keep *Ca level* around 8.5 by balancing Ca intake, vitamin D and calcimimetics
- ▣ Keep *PTH level* around 150-300 by balancing P intake, vitamin D and calcimimetics
- ▣ Given limits maximize treatment time and frequency

# Summary-main parameters at the dialysis chair: nutrition/inflammation

- ▣ Avoid *infections* (catheters!)
- ▣ Treat *comorbidities*
- ▣ Give *protein supplements* when indicated
- ▣ Maximize *treatment time*
- ▣ Maintain *residual function*
- ▣ Stress *exercise*
- ▣ Treat *depression*

# Hemodialysis patient in the hospital: infections

- ▣ *Access* (catheters!)-usually staphylococcus vancomycin or cefazolin; change, remove catheter ASAP, may need to remove graft, change antibiotics as needed by blood cultures, follow up drug levels (vanc 10-15)-if persists suspect endocarditis (gentamycin plus TEE)
- ▣ *Infections: pneumonia*-often gram negative, special attention to nutritional status
- ▣ Discharge patient on hemo dosing of IV or PO antibiotics as soon as functional
- ▣ Avoid femoral catheters: infection, poor functional status, bad dialysis

# Hemodialysis patient in the hospital: GI bleed

- ▣ PUD, diverticulosis common: endoscopy often necessary; hold heparin on dialysis
- ▣ Always try to dialyze a patient while giving blood (K, volume)
- ▣ Close attention of volume status is necessary
- ▣ Most patients already on PPI for GERD and IV iron on dialysis for anemia
- ▣ AV malformation if endoscopy negative-sometimes may respond to estrogen or possibly to better dialysis

# Hemodialysis patient in the hospital: cardiac problems

- ▣ Cardiovascular mortality (especially sudden cardiac death in especially diabetics) is most common
- ▣ Avoid infections, treat phosphorus, remove fluid gently to avoid hypotension and control BP; statins are of unclear benefit, BB for secondary prevention, ASA in all diabetics, ACEI in most also to maintain RRF, diuretics if RRF present-avoid Minoxidil, hydralazine, oral clonidine (good for short term or cocaine abusers) when you can-IV labetalol good, nitroglycerine good, nicardipine good, nitroprusside <48h
- ▣ Aggressive revascularization often necessary especially in diabetics-renal patients are substantially higher risk

# Hemodialysis patient in the hospital: blood sugar issues

- NPO: very high risk for hypoglycemia
- Insulin resistance yes, but half life much increased
- Sulfonylureas: Glucotrol, Amaryl acceptable but not preferred
- Ketoacidosis: dialyze do not overhydrate, insulin drip is great but lower dosages
- High index of suspicion for infections and silent ischemic episodes

# Peritoneal dialysis patient in the hospital-special problems

- High variability of prescription due to lifestyle issues and membrane characteristics (cycler at night, manual exchanges during the day, 2-3 l exchanges, 1.5D, 2.5D, 4.25D, number of exchanges)
- Better preservation of RRF, slower ultrafiltration, sugar load, more protein losses
- Constipation to be avoided
- Peritonitis: cell count  $>100$ , cloudy bag, abdominal pain: rapid exchanges, cultures, IV antibiotics, look for exit site or tunnel infection
- Catheter removal: relapsing (biofilm), exit site or tunnel infection, fungal or therapy resistant peritonitis

# Conclusions

- Hemodialysis patients have numerous comorbidities and are prone to have cardiovascular, GI and infectious problems
- Hemodialysis can be done well: maximize treatment time, slow ultrafiltration and get as close to euvolemia as possible
- Special attention to nutrition then mobilize and discharge
- Rehabilitation, exercise, functional capacity are key on long term