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ANNA National President-Elect

Objectives:

- Review the pathophysiology of cardiac stunning in the ESRD patient

- Compare and contrast in-center hemodialysis (ICHD) and home therapy patients regarding incidence and outcomes of cardiac stunning

- Discuss key clinical strategies to prevent and/or mitigate cardiac stunning in the ESRD patient
- Integrate appropriate nursing responsibilities into prevention strategies for cardiac stunning in the ESRD patient

Dialysis: A Stunning Event

- “Stunned myocardium” was the term initially used to describe a condition demonstrated in the laboratory in which total coronary artery occlusion lasting only 5-15 minutes (a period not associated with cell death) produced an abnormality in regional LV wall motion that persisted for hours or days following reperfusion
  - Short-term, total, or near total reduction of coronary blood flow/volume
  - Persistent abnormality of regional wall motions (RWMAs)

Dialysis: A Stunning Event

The heart muscle is “stunned” by lack of oxygen each time there is a drop in blood pressure

The muscle may or may not return to normal following a return to normal blood pressure

Cardiac Stunning

- Dr. McIntyre and his colleagues used a PET scanner DURING dialysis to evaluate cardiac output
- Seven patients without significant cardiac histories or diabetes were scanned prior to HD, after 30 minutes and again at 220 minutes.
- All seven had reduced blood flow to the heart
- At 30 minutes it fell 13.5+11.5% (without ultrafiltration)
- 220 minutes it fell 26.6+13.9%

Myocardial perfusion during HD via pet scan

McIntyre CW. Acute cardiac effects of haemodialysis. Kidney Int 2009

Cardiac Issues

- Findings:
  - “The reduced blood flow was comparable to a heart attack.”
  - “Hemodialysis–induced stunning lead to myocardial hibernation and decreased systolic function. After stunning, patients’ blood pressure becomes less responsive. After 6 months, only a tiny fraction have normal hearts.”

Stunning Effect on Other Organs

- Brain
- Kidney
- Muscle
- Gut

Recurrent Circulatory Stress: "The Dark Side of Dialysis"

"

McIntyre CW, Sem Dial 23:449, 2010

- Myocardial stunning
- Leukoaraiosis (ischemic injury to brain white matter)
- Endotoxin release from gut ischemia
- Kidney damage (loss of autoregulation)

Who gets Stunned?

Patients with:

- Known coronary artery disease
- Severe *symptomatic* hypotension
- Systolic BP drop of 30 mmHg or greater
- Normal Coronary arteries
- Valvular heart disease
- Patients who are volume overloaded and present with pulmonary edema

Your Stunned Patient…

- Is more likely to have symptomatic hypotension
- May be more prone to having a myocardial infarction
- Arrhythmia's
- Fibrotic heart muscle
- Possible resistant to ESA
- Lack of oxygen and blood flow may lead to cognitive impairment

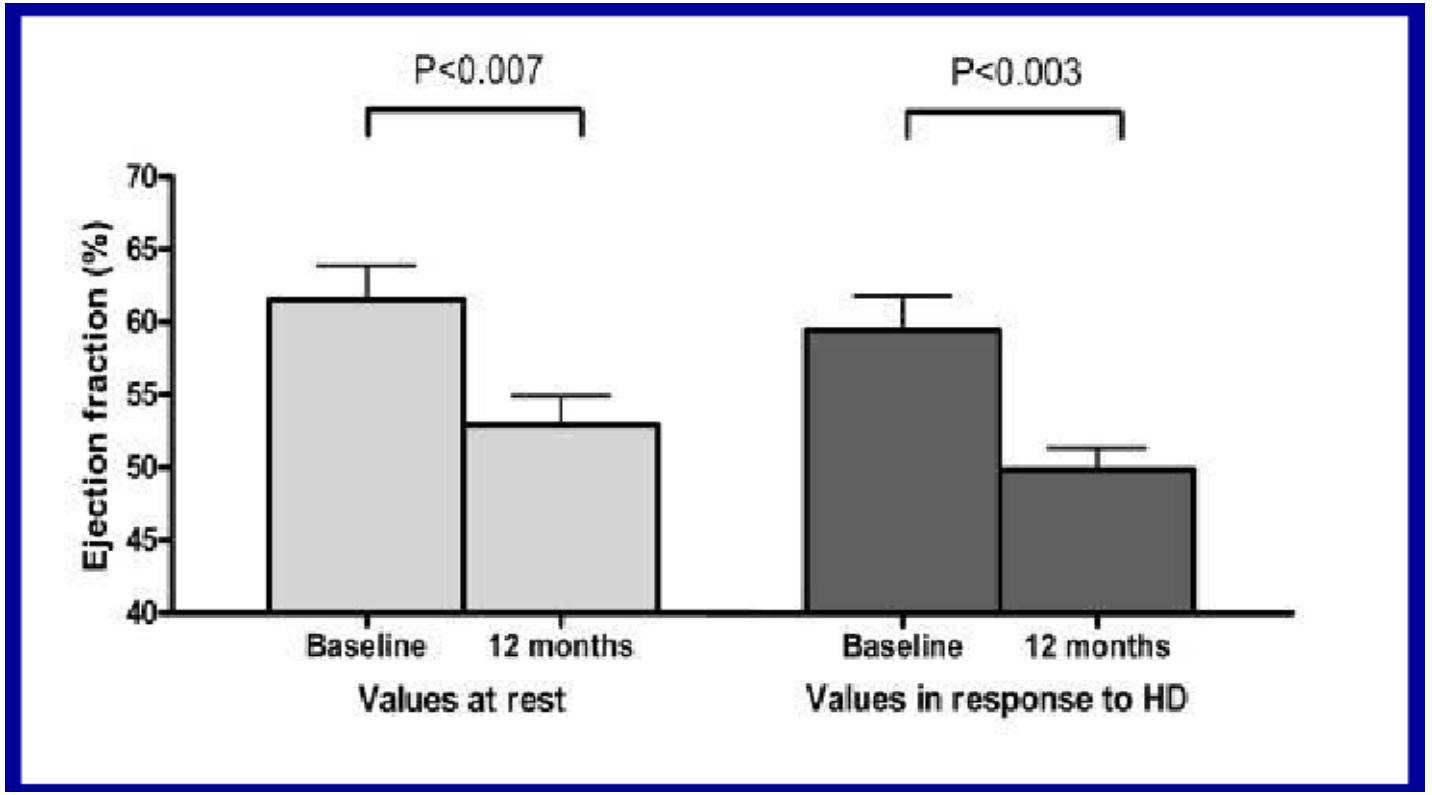
Measurement of cardiac stunning could occur if we evaluated Troponin levels, however keep in mind accurate results would need to be obtained 6-8 hours following the insult

Cardiovascular Issues

In a study of 30 patients who experienced hemodialysis induced cardiac damage, just one year of dialysis resulted in decreased left ventricular ejection fraction

LVEF in Patients who stun

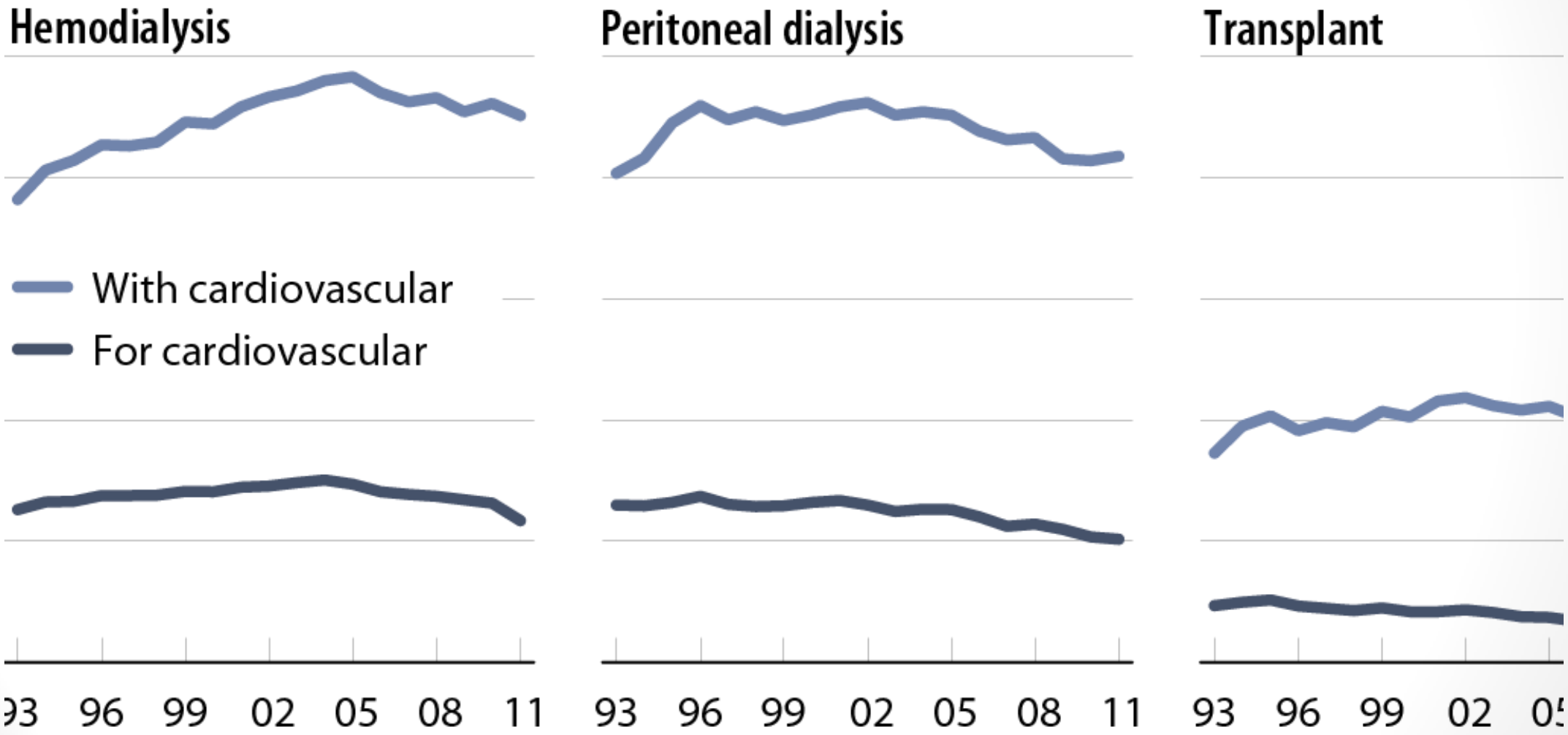
(at 1 year)



Cardiovascular Issues

Nearly 40% of dialysis patient deaths are cardiovascular-related

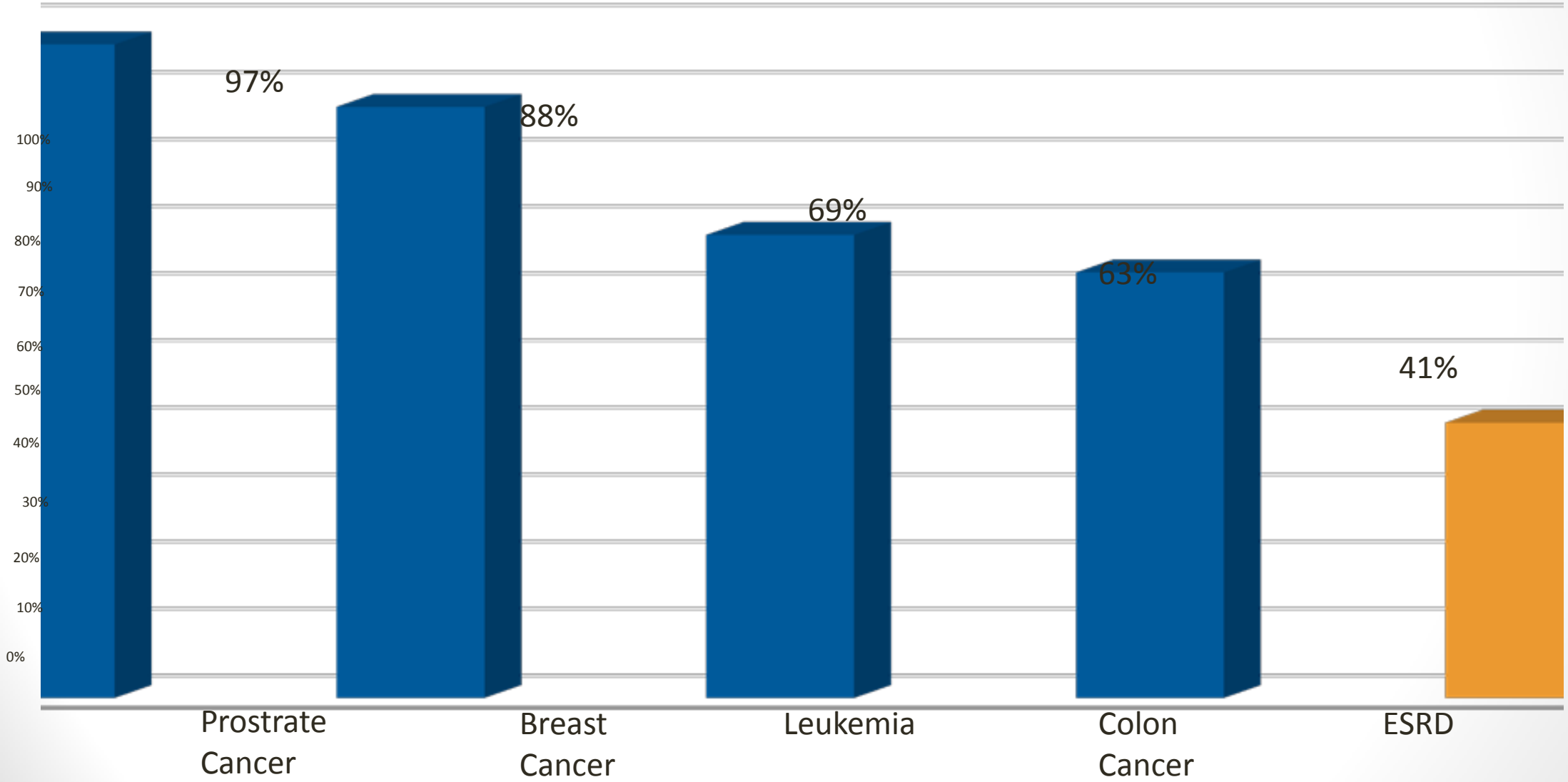
Cardiovascular Hospitalizations



Necessary Improvements

- Do you believe we've improved mortality rates for the ESRD population?
  - Yes
  - No

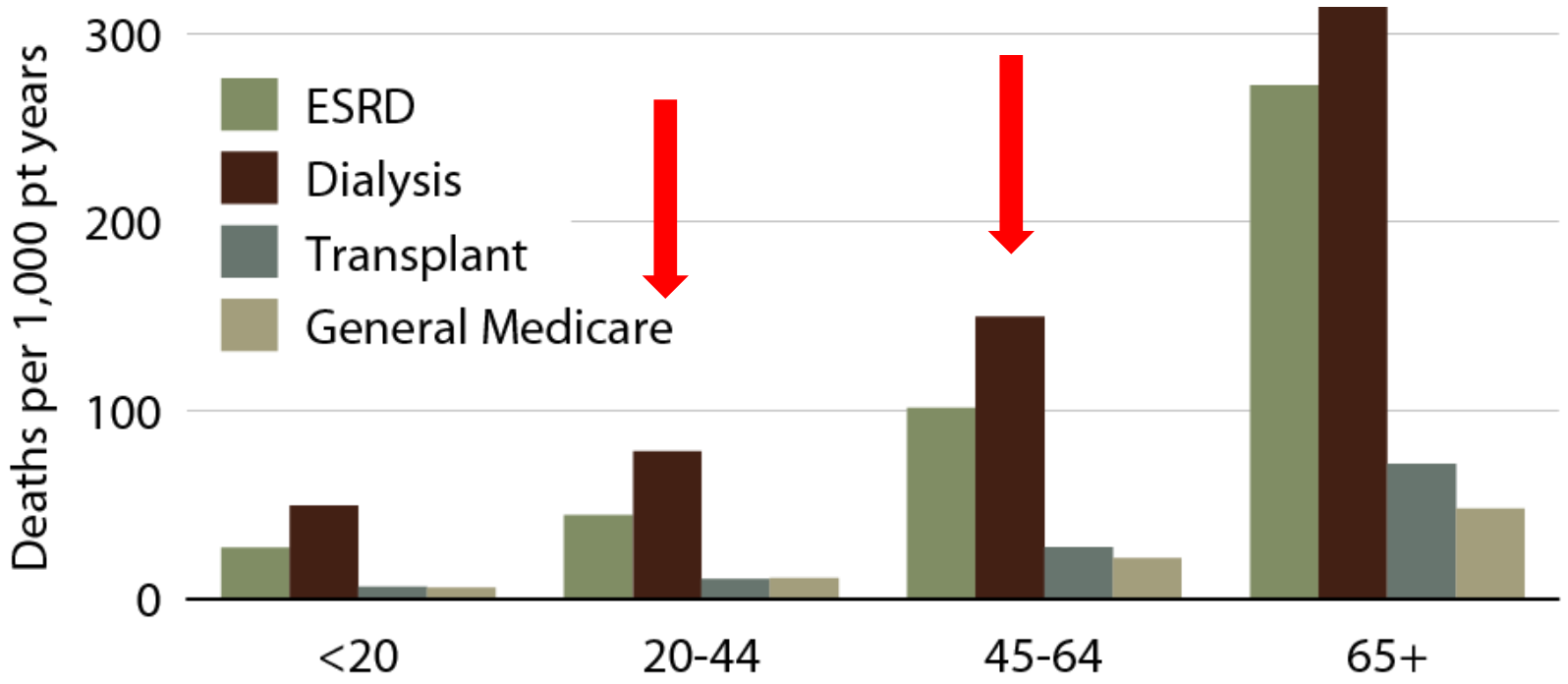
5 Year Relative Survival Rate



ADJUSTED ALL-CAUSE MORTALITY RATES

in the ESRD & general populations, by age, 2011

Figure 5.2 (Volume 2)

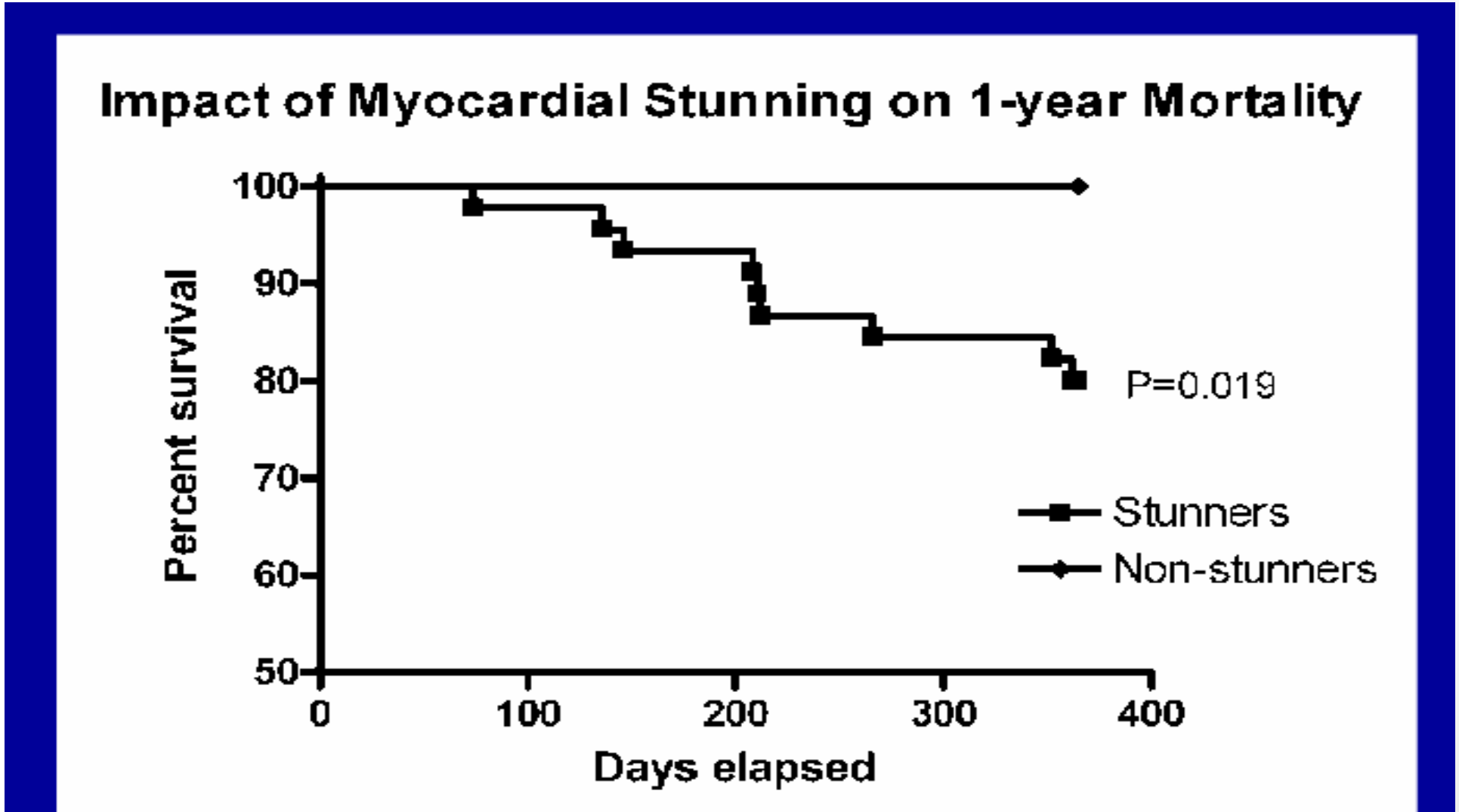


Prevalent ESRD patients from day one, 2011, & general Medicare (non-ESRD) patients with at least one month of Medicare eligibility in 2011. Adj: gender/race; ref: Medicare patients, 2011.

USRDS 2013 report. Vol 2, Fig 5.2

Survival in Patients who stun

(At one year)



Prevalence of Inter Dialytic Hypotension

- jeff sands

1. IDH complicates 5-30% of HD treatments
2. 75% of patients had at least one IDH event
3. 16% had IDH>35% of treatments
4. In Some, IDH complicates >50% of HD treatments

Sands et al, Hemodial Int 2014

TRENDS IN MORTALITY

- Overall mortality improving
- Very high early mortality rate with minimal improvement
- Outcomes on PD and CHD similar
- Little data on relative risk of death for HHD vs CHD vs PD in large observational data sets

- It terms of MYOCARDIAL STUNNING, patients on PD or frequent HD therapies less likely to have stunning.

Inter-Dialytic Hypotension

- Cramping, headaches and that washed out feeling following dialysis increases with episodes of IDH and may increase due cardiac stunning

Recovery Time

Patients on Frequent Dialysis and Peritoneal Dialysis typically do not complain of feeling washed out after their treatments

TIME TO RECOVERY POST DIALYSIS

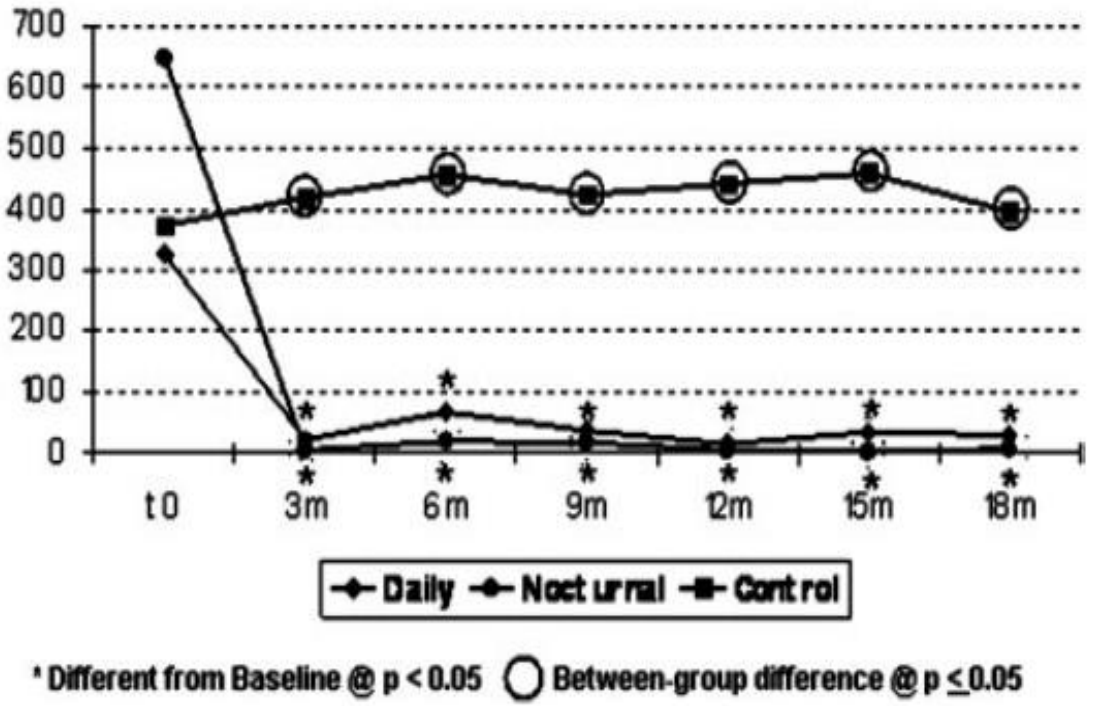
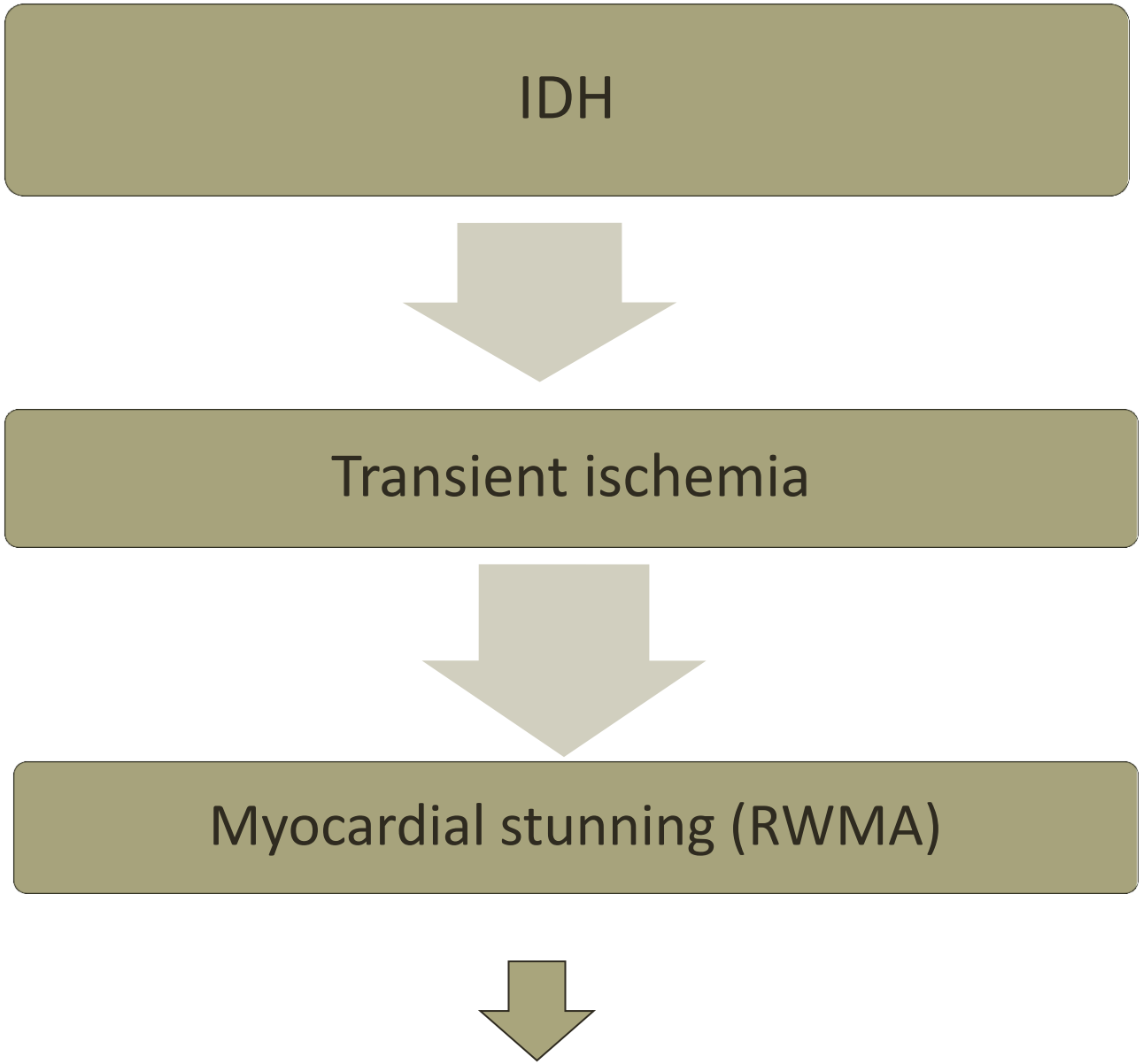
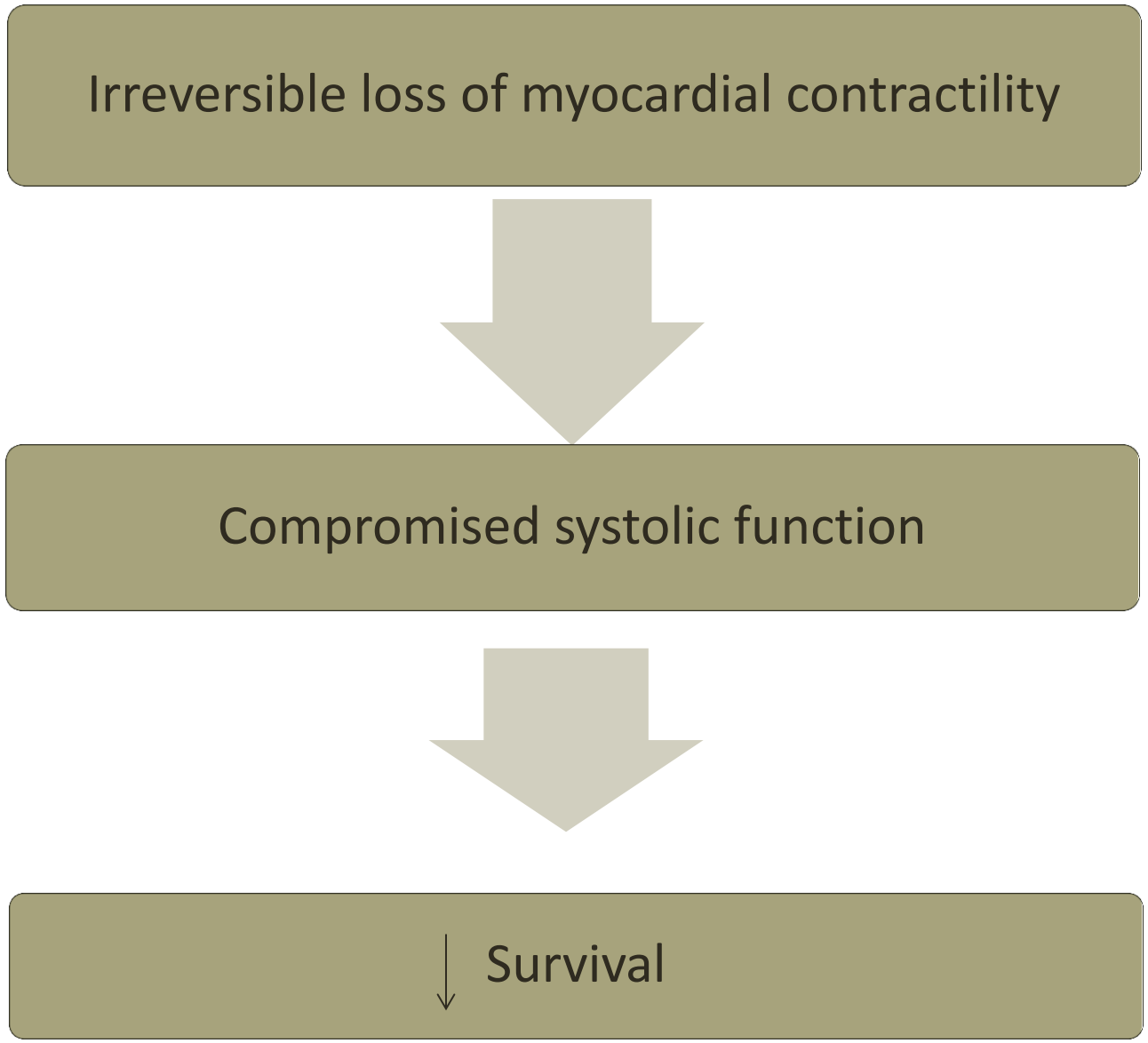


Figure 1. Time to recover (minutes) shown at time zero and at 3-mo intervals for the daily/nocturnal and control hemodialysis HD patients. Statistical significance shown both within group (*) and between groups (○).

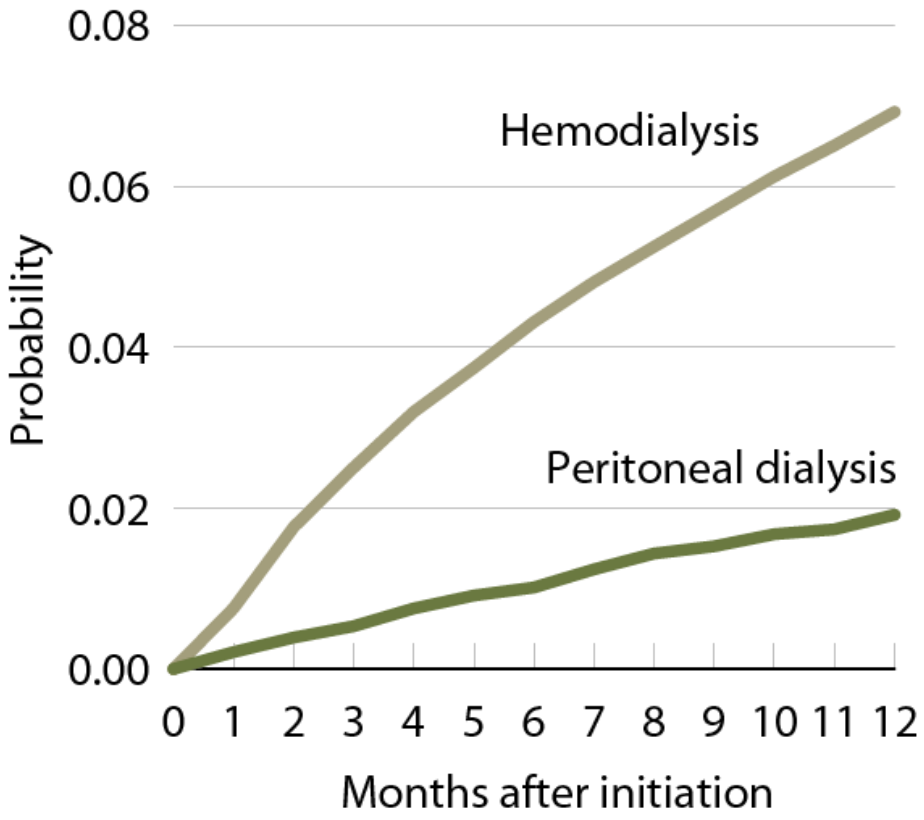
Lindsay et al, CJASN 1:952-959; 2008


IDH
Transient ischemia
Myocardial stunning (RWMA)


Irreversible loss of myocardial contractility
Compromised systolic function
↓ Survival

Probability of sudden cardiac death in 2010 incident dialysis patients by modality

Figure 4.11 (Volume 2)

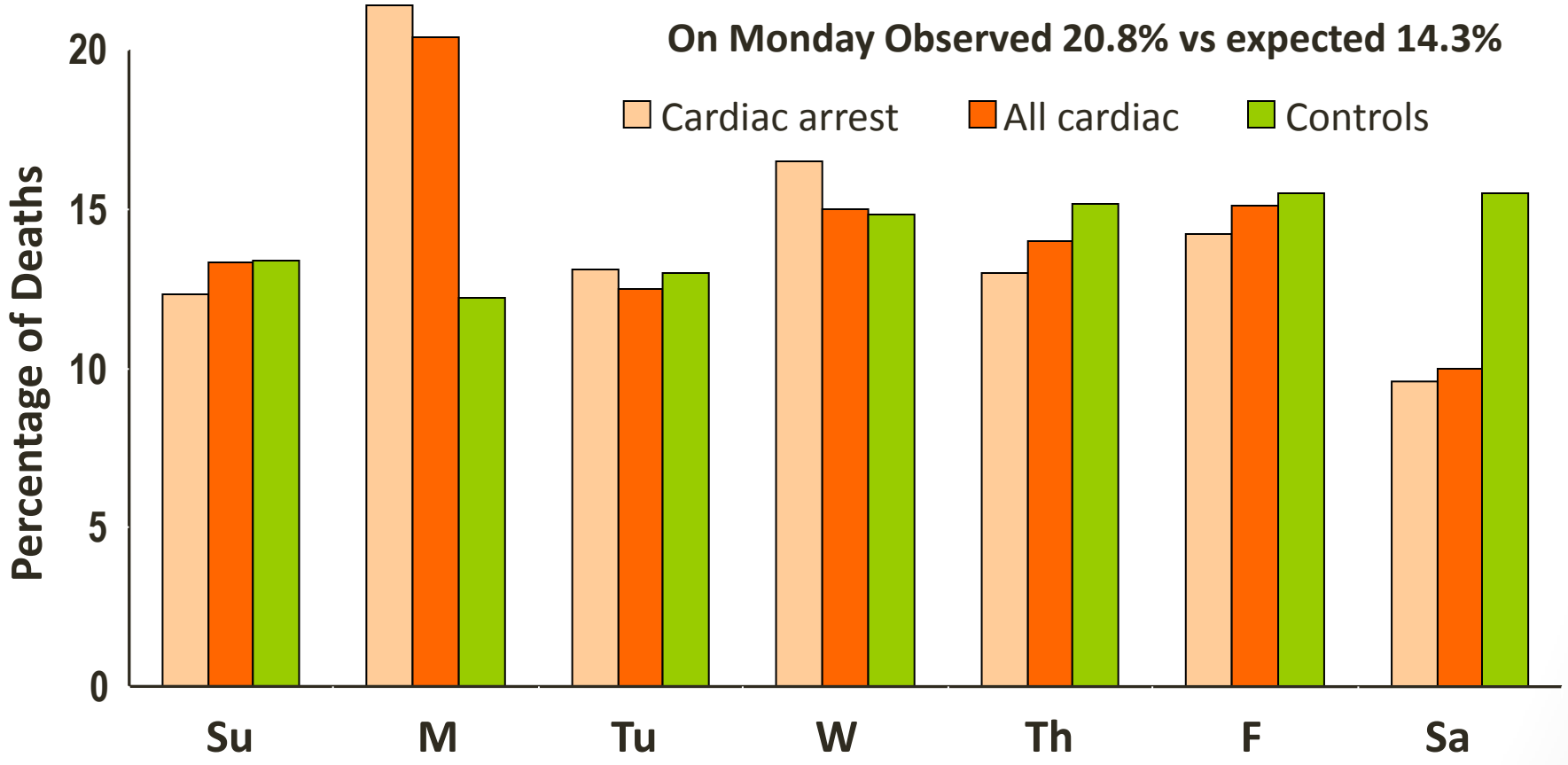


USRDS 2013 Annual Report: Vol 2, Fig. 4.11

Frequent Dialysis

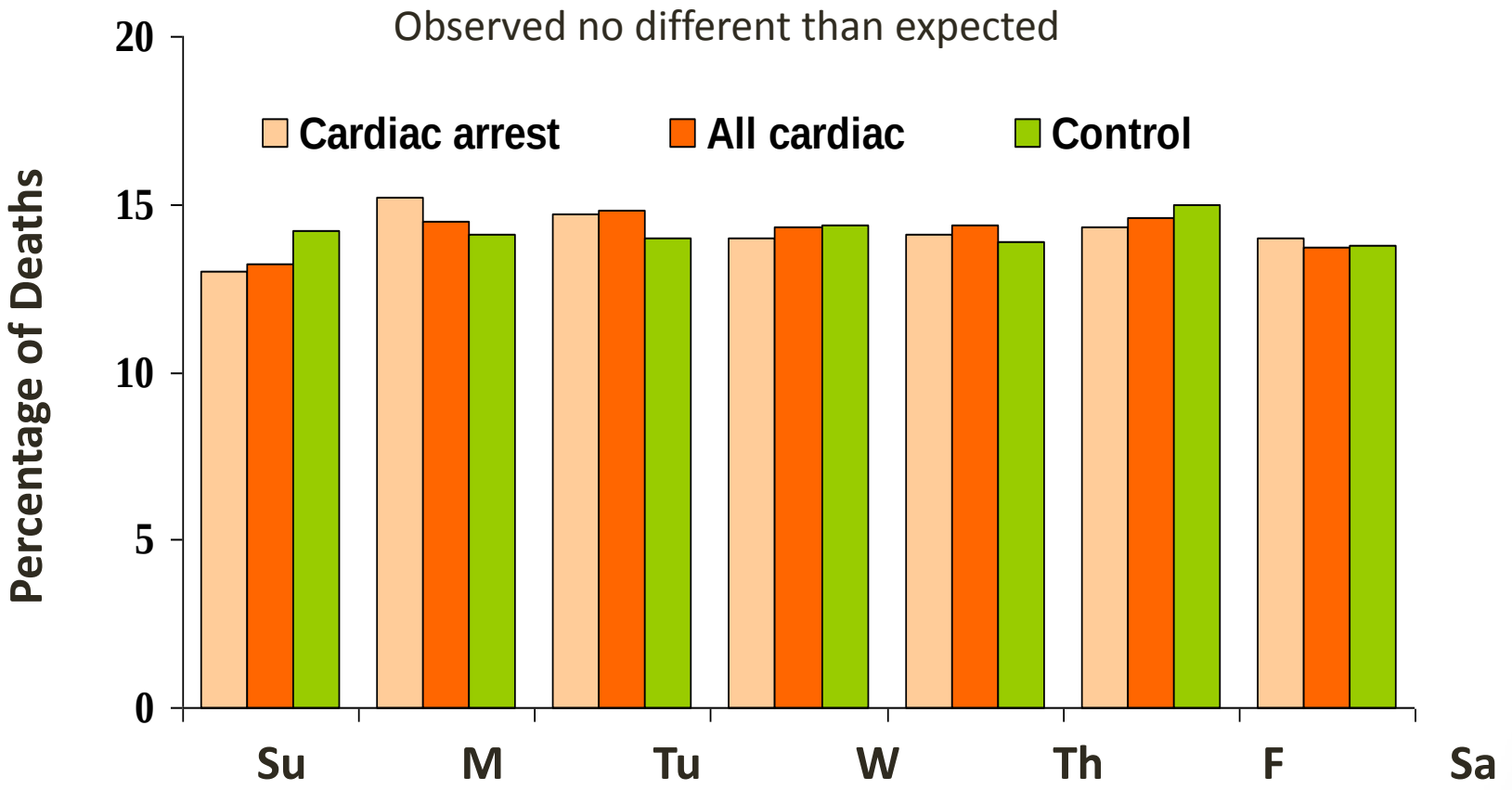
Your thoughts?

Distribution of Deaths According to Day of the Week for M/W/F: HD Patients



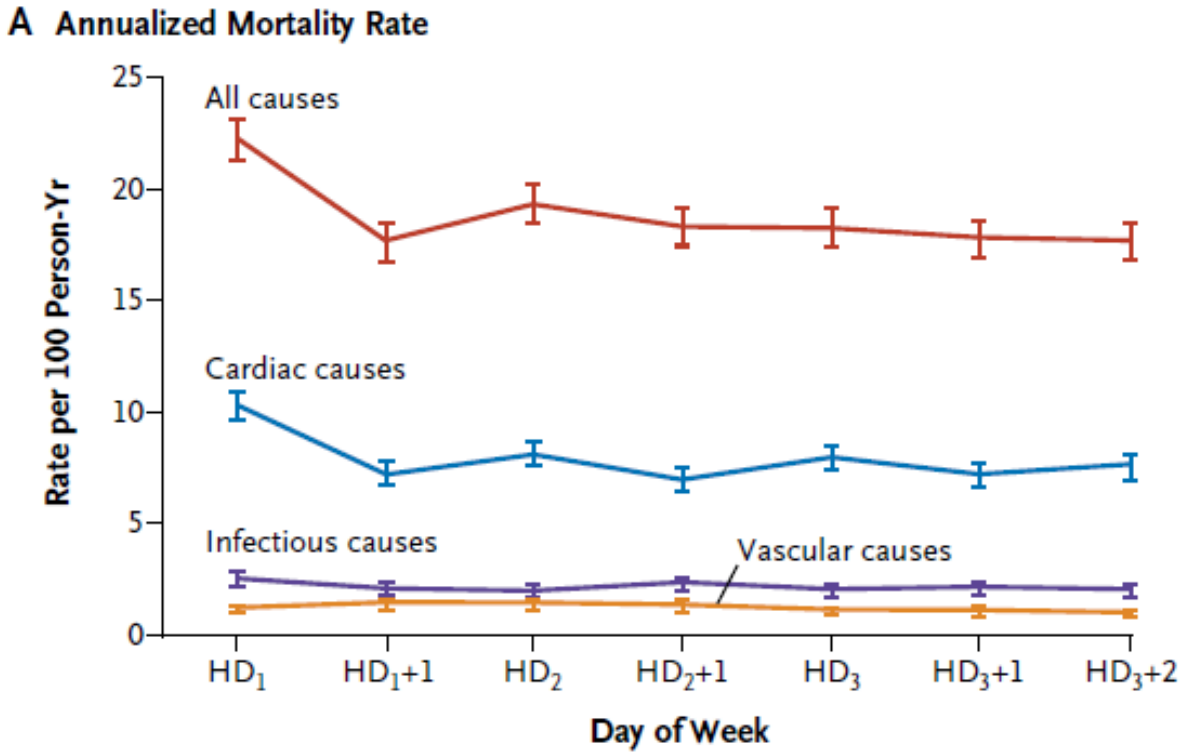
Bleyer AJ, et al, Kidney Int, 1999; 55:1553

Distribution of Deaths According to Day of the Week for PD Patients



Bleyer AJ, et al, Kidney Int, 1999; 55:1553

INCREASED RISK OF DEATH AFTER LONG INTERDIALYTIC INTERVAL



Foley et al, N Engl J Med 2011; 365: 1099-107

RISK OF SUDDEN DEATH IS RELATED TO INTRADIALYTIC TIME INTERVAL

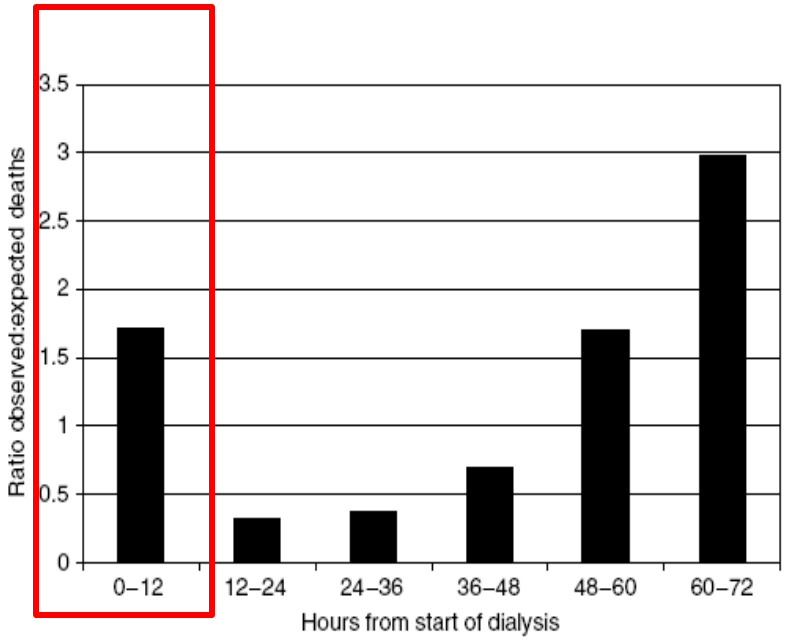


Figure 2 | Ratio of actual to expected number of occurrences of sudden death for each 12 h interval beginning with the start of HD.

For thrice a week CHD:
Threefold increase in RRD
During 12 hr *prior* to 1st Rx/week
And,
1.7 fold increase during 12 hours *starting* with 1st Rx of week
Why?

Bleyer et al KI 69:2268-2273, 2006

SUDDEN DEATH IN DIALYSIS

- Multifactorial:
  - Some related to Hyperkalemia
  - Some related to change in K and Ca during dialysis treatment?
    - Made worse by overtreatment with buffer?
    - Calcium fluxes?
    - Electrolyte fluxes and baseline pH?
  - Baseline predisposition for arrhythmias from prior aggressive UF rates with resultant cardiac stunning and intra-myocardial fibrosis

Myocardial stunning may be due to the treatment itself

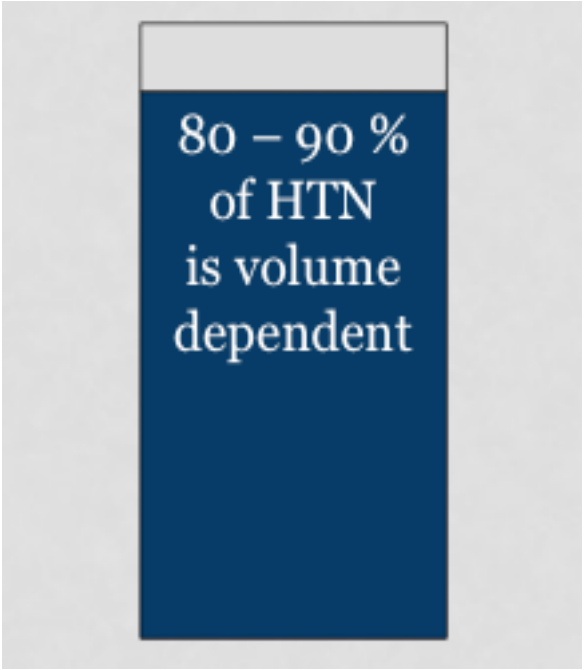
- **Facts**
- Not observed in PD patients
- Much less prevalent in more frequent HHD patients than IHD patients and correlated with ultrafiltration rates **Conclusion**
- High ultrafiltration rates were associated with increased all-cause and cardiovascular mortality
- Rates greater than 10 - 13 mL/kg/hr were associated with congestive heart failure **Noteworthy**
- Wall-motion abnormalities were noted even in the absence of ultrafiltration

Joel D. Glickman. Stunning Consequences of Thrice-Weekly In-center Dialysis. *Medscape*. Apr 27, 2012

Stun Guns

- Decrease Ultrafiltration Rates
- Sodium Modeling
- Sodium Variation
- More frequent dialysis
- Longer duration of dialysis
- Cold Dialysate

Blood pressure control = volume control



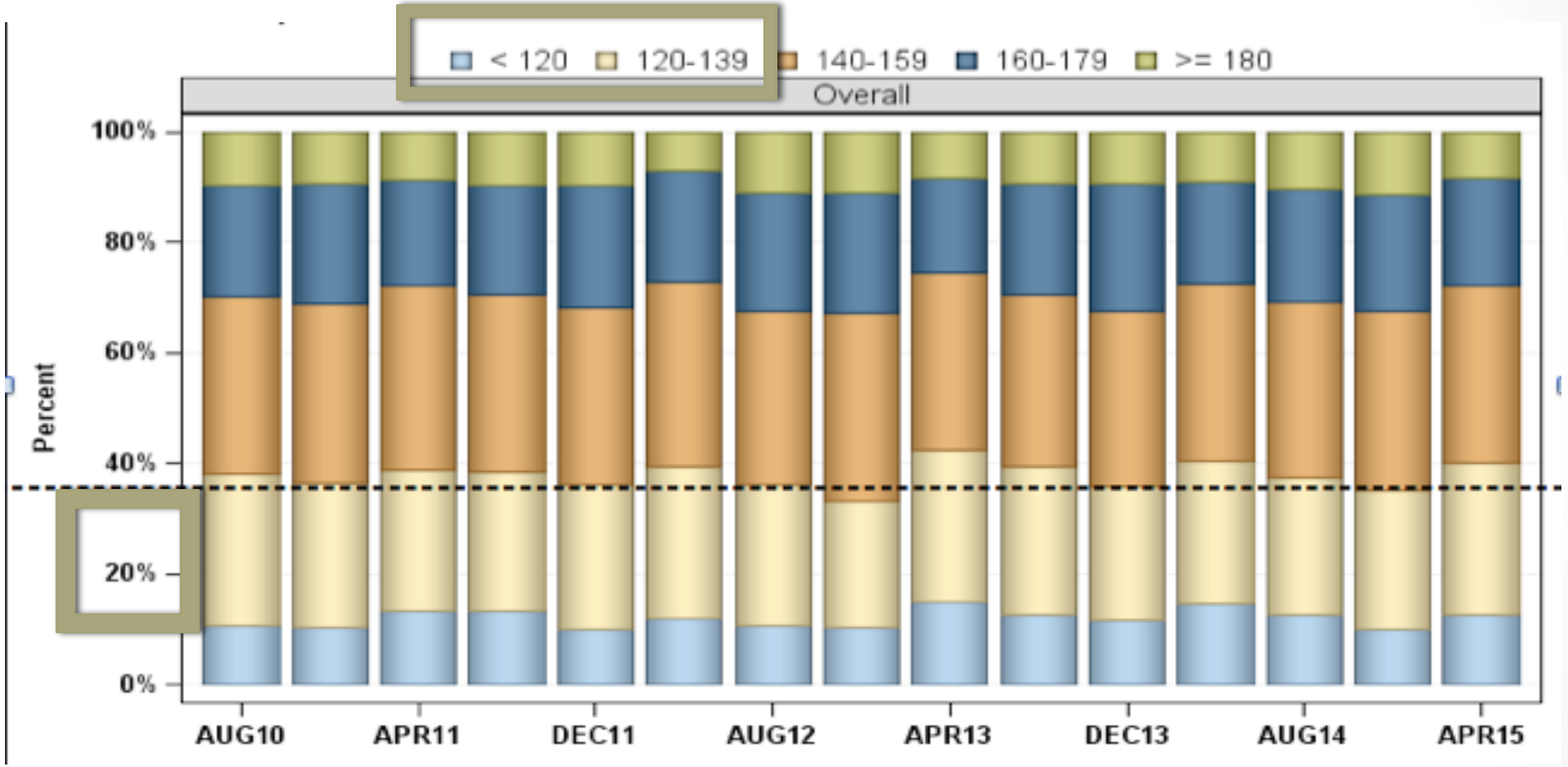
EGE University (Turkey) & tassin (france)

EGE university & tassin

HD time (13-24 hrs/week) &
Dialysate Na ~138 mEq/L

Mean BP ~ 120’s/70’s with
zero BP medications (>90%)

Systolic BP (pre HD) – 2010-2015



DOPPS – Dialysis Outcomes and Practice Patterns Study (Arbor Research Collaborative for Health)

Does your facility have a significant number (4 or more) of patients who have high interdialytic weight gains between treatments (3 Kg or higher)?

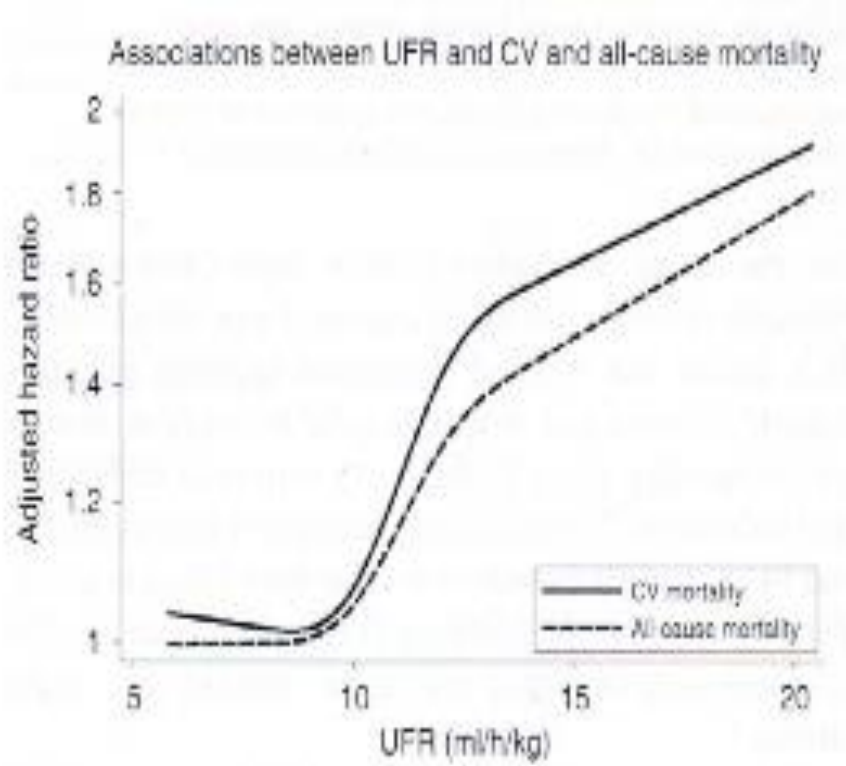
a. Yes
b. No

Uf ratE (UFR) & Mortality

HEMO study subjects

1846 patients

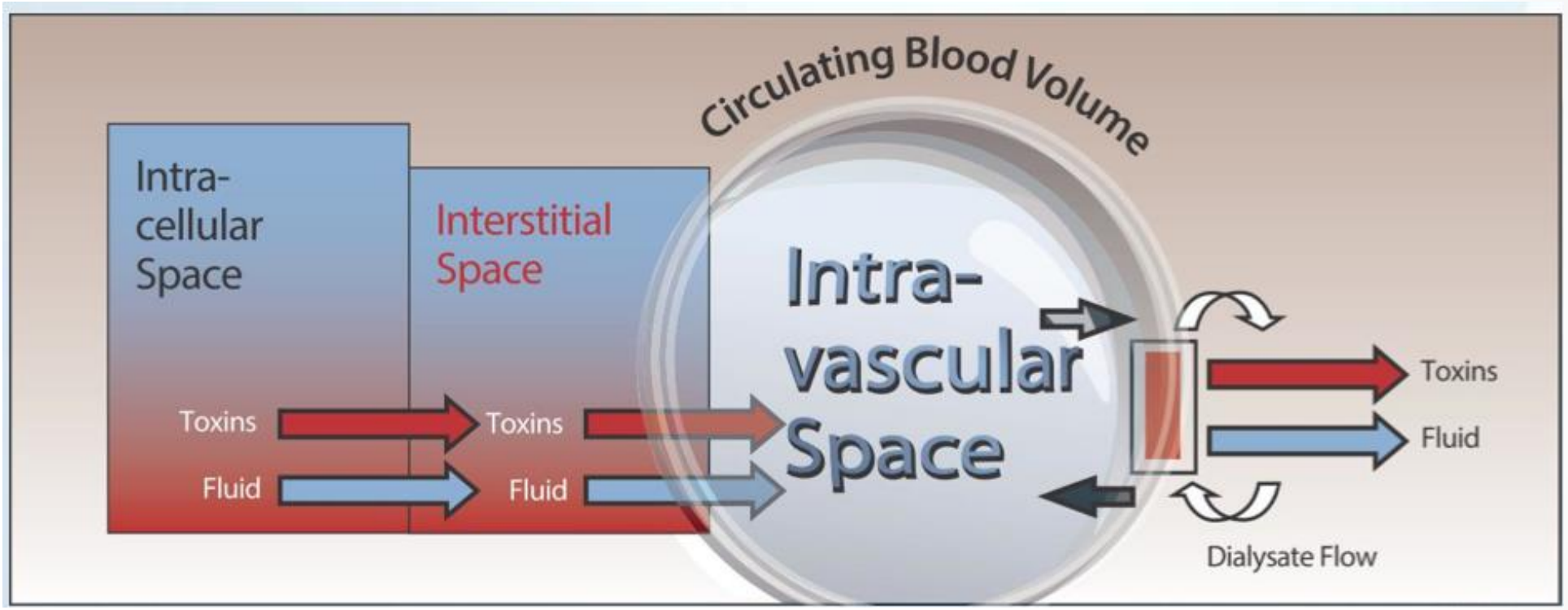
7 year randomized trial



Decreasing Ultrafiltration Rates

- Fluid Management!!!
- Diet Management

Plasma refilling



myocardial stunning, fluid removal (UF) & IDH

Factor associated with presence of myocardial stunning	Odds Ratio	*P* value
UF volume during HD of 1L	5.1	0.007
UF volume during HD of 1.5L	11.6	
UF volume during HD of 2L	26.2	
Maximum SBP reduction during HD of 10 mmHg	1.8	0.002
Maximum SBP reduction during HD of 20 mmHg	3.3	
Maximum SBP reduction during HD of 30 mmHg	6.0	

FLUID management goals

1. Systolic BP 120-130 mmHg pre HD without BP medication
2. Avoid fluid overload
3. Avoid Intra-Dialytic Hypotension (IDH)

- Overall, ultrafiltration rates between 10–13 ml/h/kg were not associated with all-cause or cardiovascular mortality; however, they were significantly associated among participants with congestive heart failure. The risk of all-cause and cardiovascular mortality began to increase at ultrafiltration rates over 10 ml/h/kg regardless of the status of congestive heart failure. Hence, higher ultrafiltration rates in hemodialysis patients are associated with a greater risk of all-cause and cardiovascular death.

- Kidney Int. 2011 Jan; 79(2): 250–257.
- Published online 2010 Oct 6. doi: 10.1038/ki.2010.383
- **ng dialysis is associated with cardiovascular morbidity and mortality**

- Jennifer E. Flythe,[1] Stephen E. Kimmel,[2] and Steven M. Brunelli[1]

Sodium Modeling

Does altering the sodium during hemodialysis effect fluid removal?

- Yes
- No

Sodium Variations

- Na 140?
- Na145?
- Na138?

HD Patents residing in Fla nursing homes – Sna mEq/L

<132	133	134	135	136	137	138	139	140	141	>142
39%	**6%**	**8%**	9%	14%	10%	5%	3%	3%	0%	3%

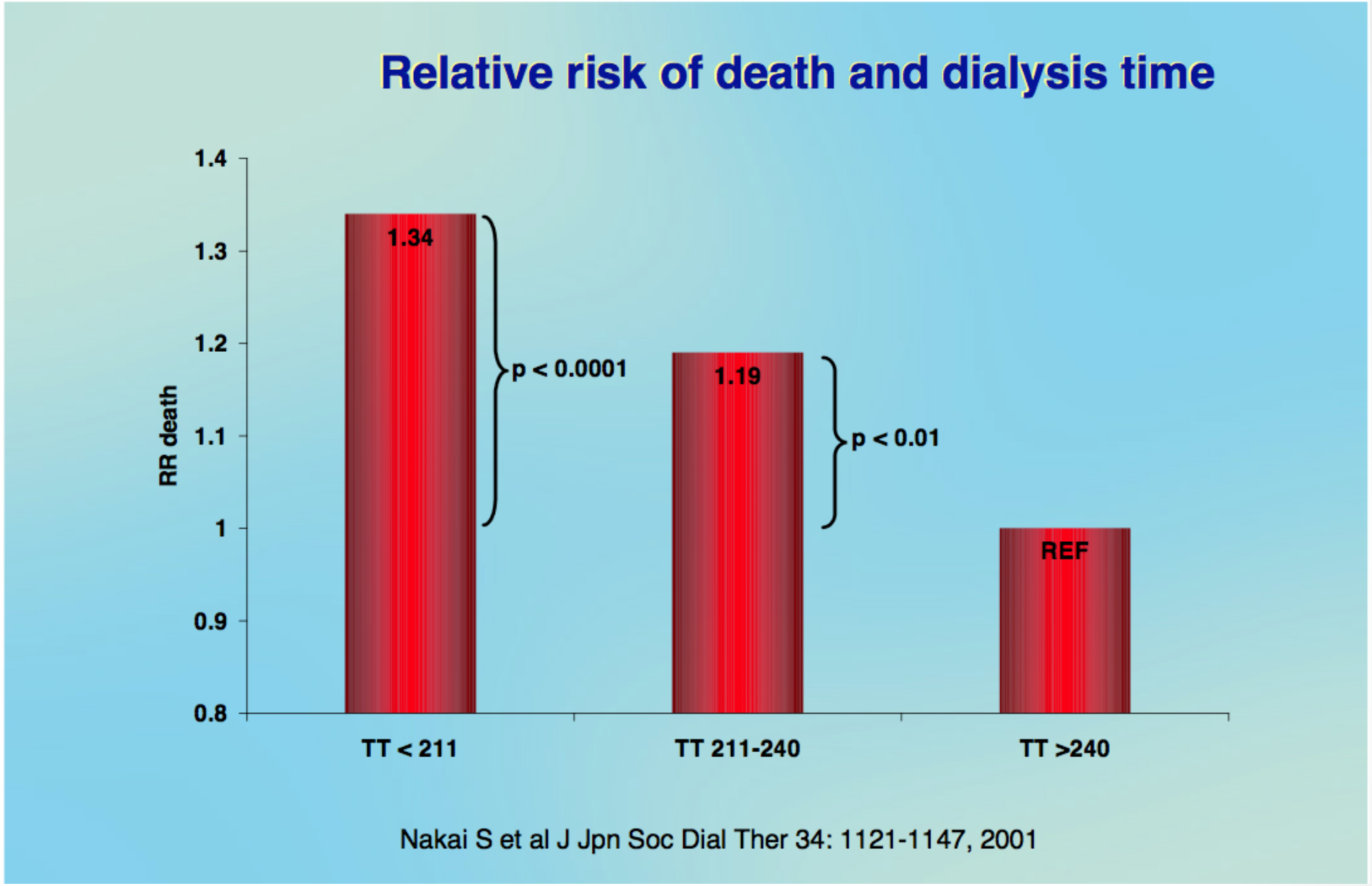
Sodium Gradient of 5 @ HD = 5 Big macs each HD


McDonald's Big Mac

- How much sodium in a Big Mac?
- **> 1 gram**
- McDonald's Big Mac 7.6 oz (219 g)

Longer Duration Dialysis

Does it help???

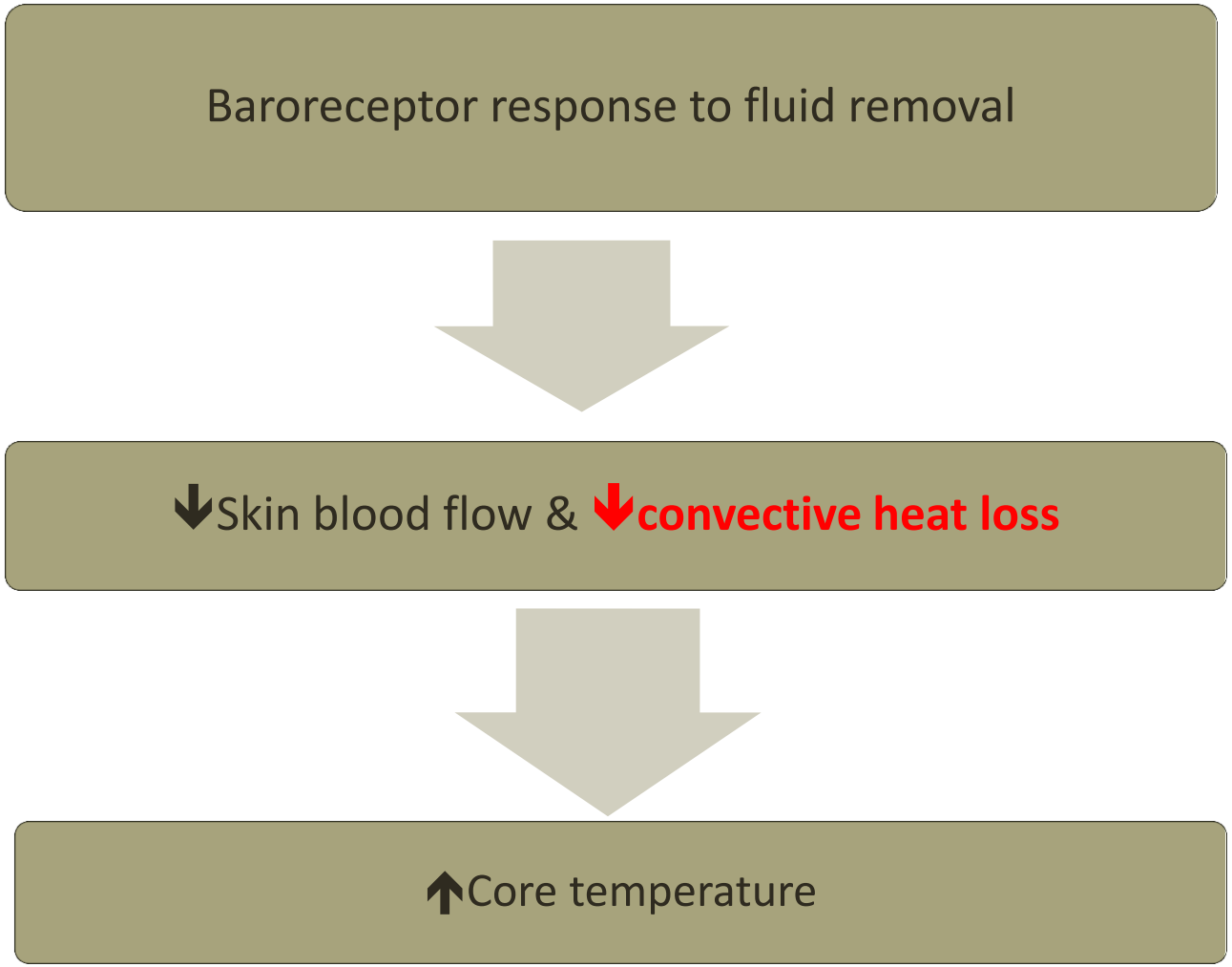


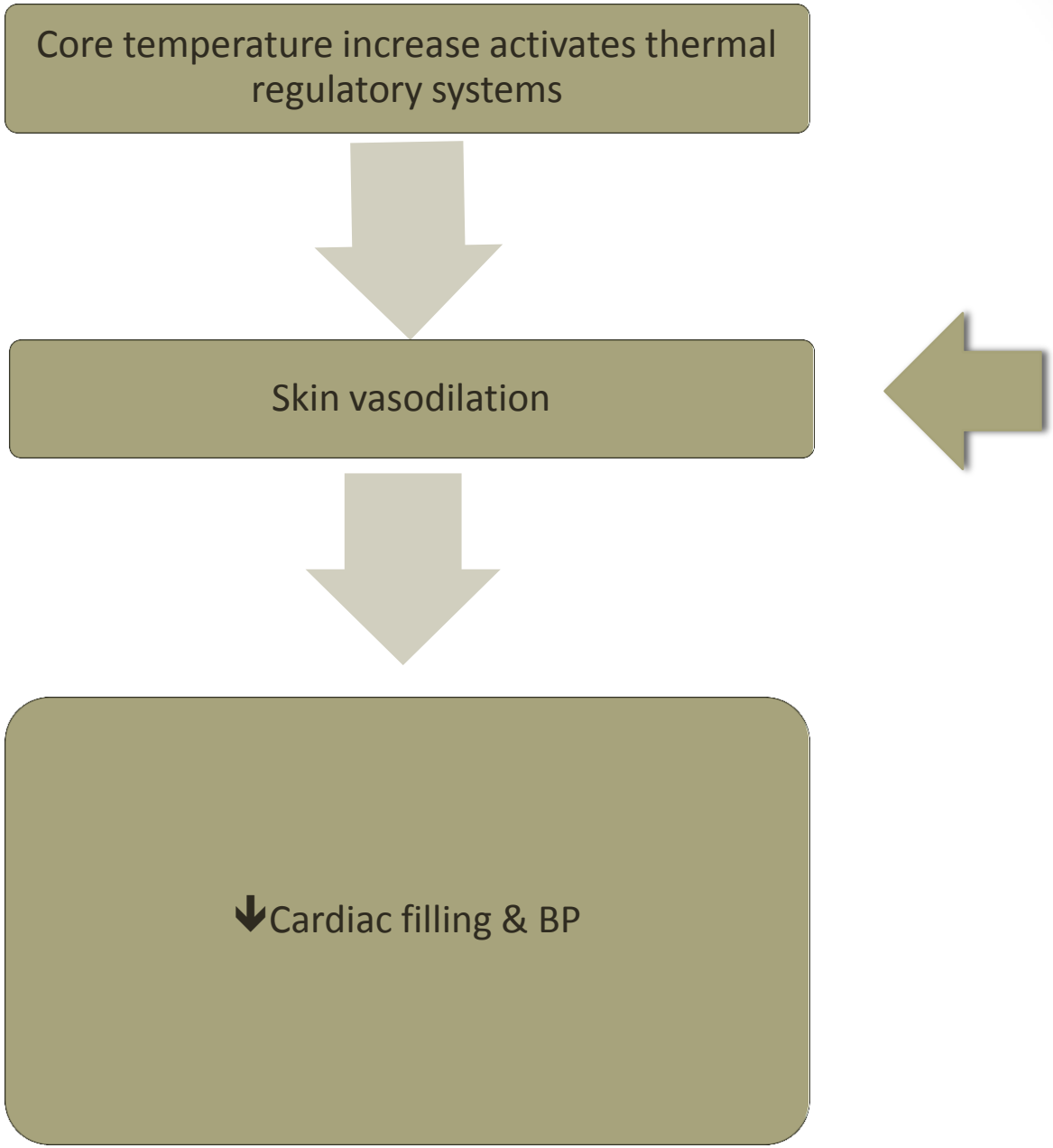
Independent of Kt/V

Cold Dialysate

- Dialysate temperature of 37F
- Dialysate temperature 36.5
- Dialysate temperature 36.0

Eldehni Mt, Odudu A et al. Randomized clinical trial of dialysate cooling and effects on brain white matter. J Am Soc Nephrol. 2015 Apr; 26(4):957-65


Baroreceptor response to fluid removal
↓Skin blood flow & ↓convective heat loss
↑Core temperature


Core temperature increase activates thermal regulatory systems
Skin vasodilation
↓Cardiac filling & BP

More Frequent Dialysis

- Does MFD Decrease IDH?

MFD & Intradialytic hypotension

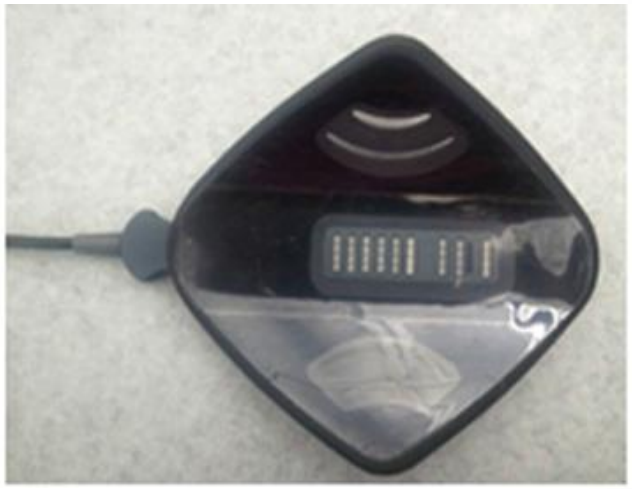
Frequent hemodialysis network trial 2010

	3 PER WEEK HD	6 PER WEEK HD
IDH (% treatments)	13.6%	10.9%
RR IDH	1.53	1.00

FLUID management goals

1. Systolic BP 120-130 mmHg pre HD without BP medication
2. Avoid fluid overload
3. Avoid Intra-Dialytic Hypotension (IDH)

Near infrared spectroscopy Tissue oxygenation



CareGuide, Sotera Wireless, San Diego, CA

Photoplethysmography

puLse pressure

CVInsight Monitoring System, Intelomed, Pittsburgh, PA

continuous BP

ViSi Mobile Monitor, Sotera Wireless, San Diego, CA

Plan A : Roadmap for right now

1. Avoid Na loading - dialysate Na ~137 mEq/L
2. Stabilize BP w cooled dialysate (T ~36°C)
3. Stabilize BP by limiting UFR (13ml/kg/hr (CMS QIP) or, even better, 10ml/kg/hr

AND SERIOUSLY CONSIDER

① Longer conventional HD (4+ hrs, 3 per week)

② More Frequent HD (5-6 per week)

③ Nocturnal HD (3-6 per week)

Plan B : SMART Hemodialysis

1. **Individual Customization**
2. Real time adjustments of dialysate Na
3. Real time adjustments of dialysate temperature
4. Real-time analysis of physiological responses

Let’s collaborate!!