

Sudden Death in Hemodialysis and Peritoneal Dialysis Patients

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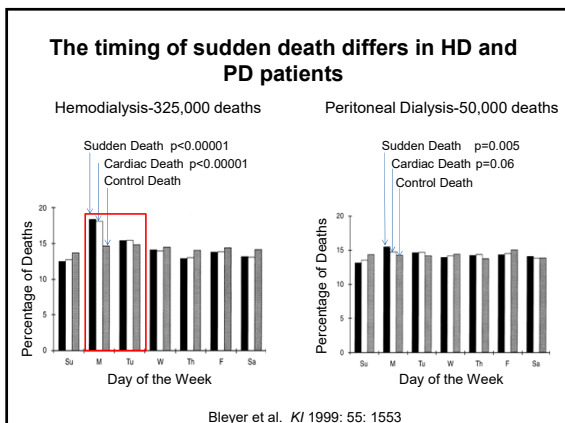
- ### Overview
- Timing of Sudden Death
 - Associated Rhythms
 - Associated Characteristics
 - Patient Comorbidities
 - Dialysis Prescriptions
 - Potential Preventative Strategies

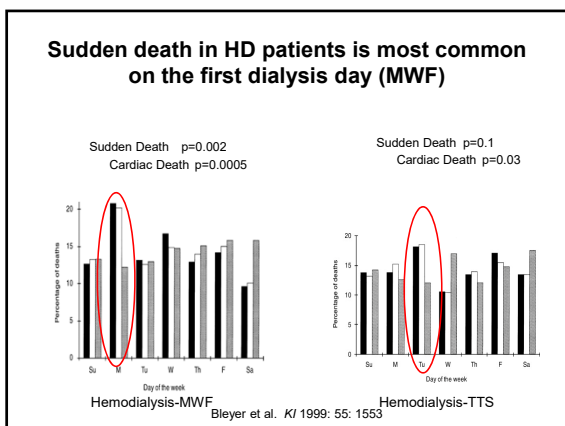
Life Expectancy Is Significantly Decreased in Dialysis Patients

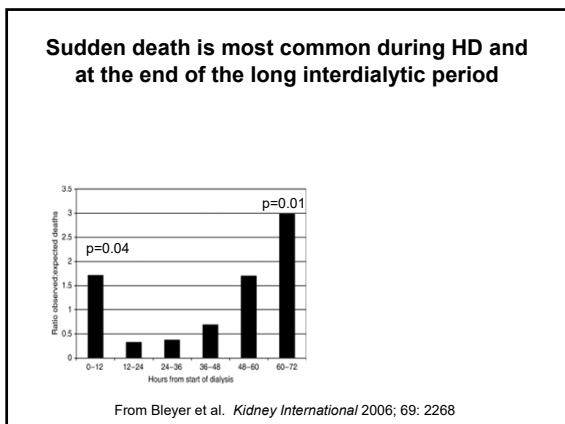
EXPECTED REMAINING LIFE

AGE	MEN	WOMEN	General Population
0-14	70.6	75.4	
15-19	59.6	64.3	
20-24	54.9	59.4	
25-29	50.2	54.6	
30-34	45.6	49.8	
35-39	41.0	45.0	
40-44	36.5	40.3	
45-49	32.0	35.7	
50-54	27.7	31.2	
55-59	23.7	26.8	
60-64	19.9	22.7	
65-69	16.3	18.6	
70-74	12.9	14.8	
75-79	9.8	11.4	
80-84	7.2	8.4	
85+	3.8	4.4	

United States Renal Data System. 2018 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2018.







Arrhythmias are most common during HD and the end of the long interdialytic period

- 66 HD patients with Implanted Reveal monitors
 - Pacemaker or ICD patients excluded
 - 50% with CAD, 26% CHF, 3% EF <35
- Clinically Significant Arrhythmia
 - Vtach > 150 bpm for 30 seconds
 - Bradycardia <40 bpm
 - Asystole
 - Symptomatic event confirmed by adjudicator
 - Monitors interrogated every treatment
- Bradycardia was single most common
- CSA most common during first HD treatment
- Bradycardia most common at end of long interdialytic interval
- Afib common during HD

Roy-Chaudhury et al. *Kidney Int* 2018; 93: 941

The preceding rhythm varies with time of arrest

Study	N	Follow Up (months)	SCD bradyarrhythmia	SCD tachyarrhythmia	SCD unknown
Wong et al	50	18	8	0	0
Silva et al	100	14	3	1	2
Sacher et al	71	21	4	0	0
Roberts	30	18	0	1	1
Roy-Chaudrey	66	6	0	0	0

Adapted from Kalra et al. *Kidney Int*; 2018; 93: 781

110 in center cardiac arrests attended to by EMS
 72 Vtach or Vfib
 38 PEA or asystole
 Vtach/Vfib
 5 x more likely if arrest occurred during HD
 14 x more likely if arrest occurred after HD
 Davis et al. *KI* 2008; 73: 933

What are the characteristics of patients who experience sudden death?

Comorbidity	%
Diabetes	58
CAD	56
CHF	55
Prolonged QT	54
Non Compliance	21
EF<35%	25

From Bleyer et al. *Kidney International* 2006; 69: 2268

What are the characteristics of patients who experience sudden death?

- Case Control Study of sudden death *within* HD unit
- 784 cases of sudden death of which 502 were matched to 1600 controls (18 million treatments)
- Cases more frequently had
 - Ischemic heart disease and congestive heart failure
 - More likely to be prescribed ACEI/ARB, beta blocker, ASA, statin
 - Lower Cr, albumin, hemoglobin
 - Higher serum bicarbonate
 - Lower dry weight but greater time averaged ultrafiltration
 - Nonsignificant trend for lower K (4.6 vs. 4.7) and higher Ca (9.3 vs. 9.2)

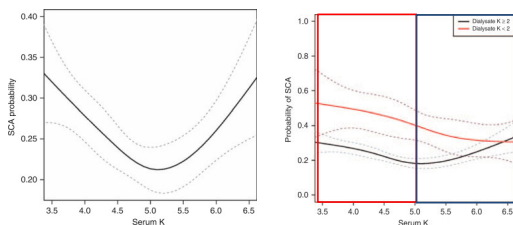
Pun et al. *Kidney Int* 2011; 79: 218

What are the *modifiable* risk factors of patients who experience sudden death?

- Low Dialysate K (<2) in the last treatment
 - 18% vs 9% (p<0.0001)
 - Also more common in cases when averaged over 3 months
 - Pre dialysis K among those with low K bath lower in cases (5 vs 5.3)
- Low Dialysate Ca (<2.5)
 - 12% vs 6% (p<0.00001)
- Multivariate modeling
 - Low Dialysate K
 - Low Dialysate Ca
 - Hgb, Cr, bicarb
 - Prescription of antiarrhythmic meds, ACE/ARB, or active Vit D
 - NOT
 - CHF, CAD, beta blocker, statin, ASA

Pun et al. *Kidney Int* 2011; 79: 218

The risk of very low K dialysate varies with serum K



Pun et al. *Kidney Int* 2011; 79: 218

Additional modifiable risk factors for sudden death-DOPPS

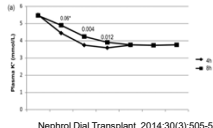
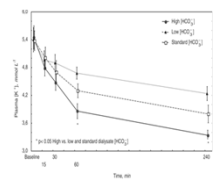
Variable	HR	CI	P-value		
Treatment Time <210 min	1.13	1.00-1.27	0.04		
Kt/V < 1.2	1.10	.97-1.24	0.15		
UF >5.7%	1.15	1.00-1.32	0.04		
Dialysate K <1.5 (vs 3)	1.39	1.12-1.74	0.004	Serum K>5, 1.21 (p=0.2)	Serum K<5 1.53 (p=0.01)
Dialysate K 2-2.5 (vs 3)	1.17	1.01-1.37	0.04	Serum K>5, 1.11 (p=0.3)	Serum K<5, 1.18 (p=0.08)

Data from the Patient Level Model approach

Adapted from Jadoul et al. CJASN 2012; 7: 765

Prescription Recs

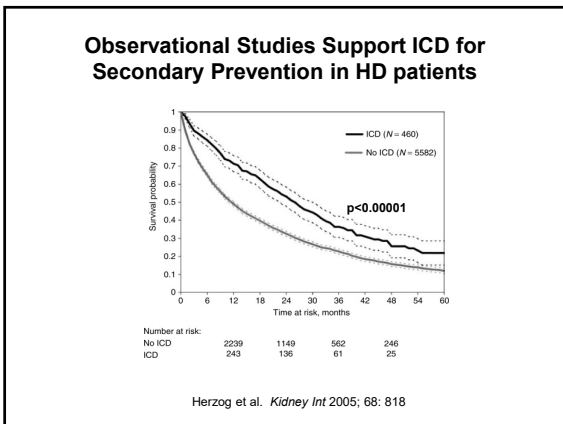
- Potassium
 - Frequent Monitoring
 - Use dialysate K <2 with caution
 - Data supports harm when serum K <5
 - Consider other prescription modifications
 - Bicarbonate
 - Time
 - Consider other factors
 - Access function
 - Diet...Binders?
- Calcium
 - Consider risks and benefits of higher calcium dialysate in the long term
- Fluid Removal/HD Time
 - Further evidence supporting gently ultrafiltration

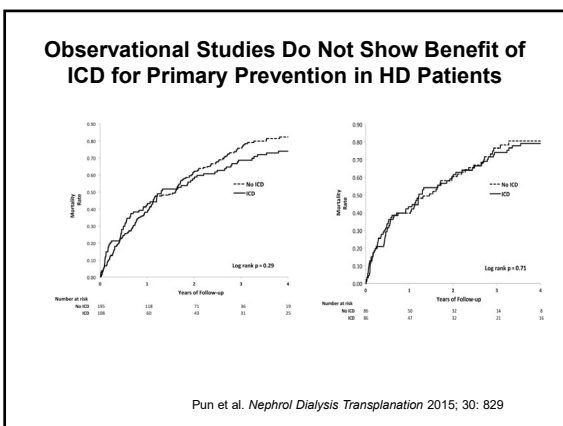


Nephrol Dial Transplant. 2014;30(3):505-513.

What about ICDs?

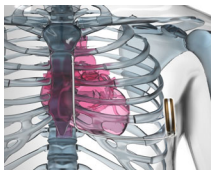
- Potential complications include infections and vascular stenosis
 - 60% can develop central stenosis
 - Future access complications
 - Tricuspid regurgitation
 - Increased risk of right heart failure
- Remember ICD does not respond to bradycardia or asystole

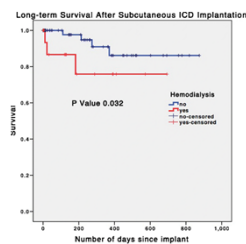




Subcutaneous Defibrillators

- Similar number of inappropriate shocks
- No device or blood stream infections in HD patients
- BUT as expected overall greater mortality





Long-term Survival After Subcutaneous ICD Implantation

P Value 0.032

Koman et al. *J Interventional Cardiology and Electrophysiology* 2016; 45: 219-223

Final Thoughts

- No silver bullet for hyperkalemia
 - Bimodal temporal pattern likely due to both hyper and relative hypokalemia
 - Dialysate potassium concern can be reduced if potassium is checked more frequently
- Dialysate calcium prescription will always have to take into consideration long term risks of excessive calcium exposure
- Rapid fluid shifts (short time, large volume) continue to surface as a problem in HD patients in general
- Wait for further data on subcutaneous defibrillators

Thank you
