



NxSTAGE[®]
Home Therapies



Home Hemodialysis Clinical Evidence

PART 1: CARDIAC INJURY AND DIALYSIS

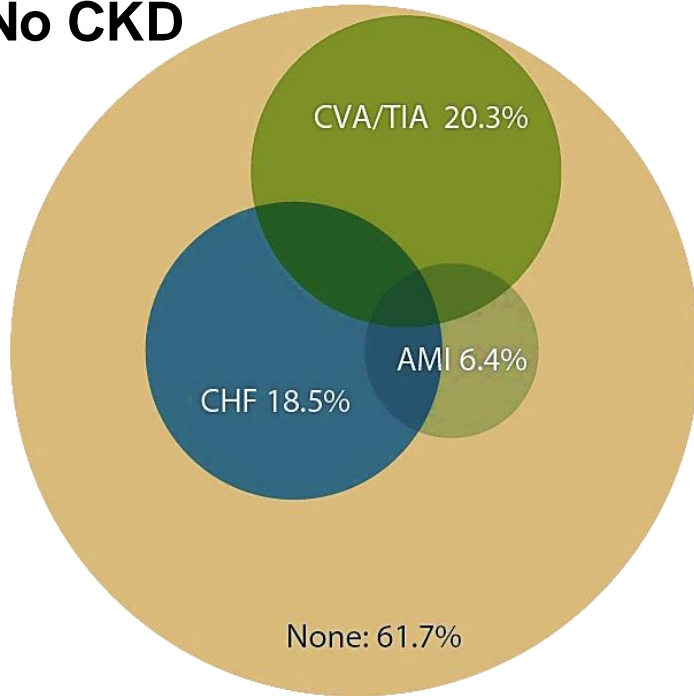
Presented by: <name>

Agenda

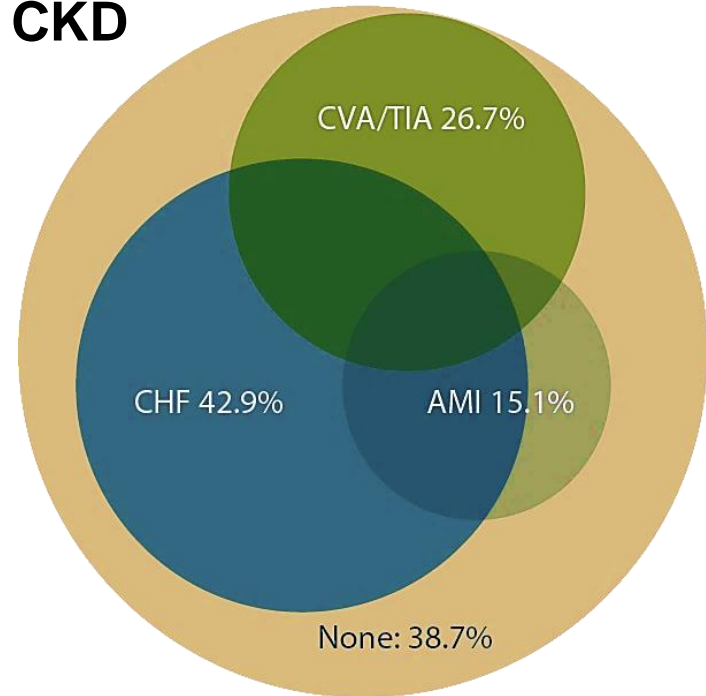
- The Association Between Cardiac Injury and Dialysis
- Current Dialysis Situation by Modality in the US
- Dialysis Induced Stress on the Heart by Modality
 - Blood Pressure Control
 - Left Ventricular Hypertrophy
 - Myocardial Stunning
- Frequency and Duration Matter

Cardiovascular Disease is More Prevalent in Chronic Kidney Disease Patients¹

No CKD

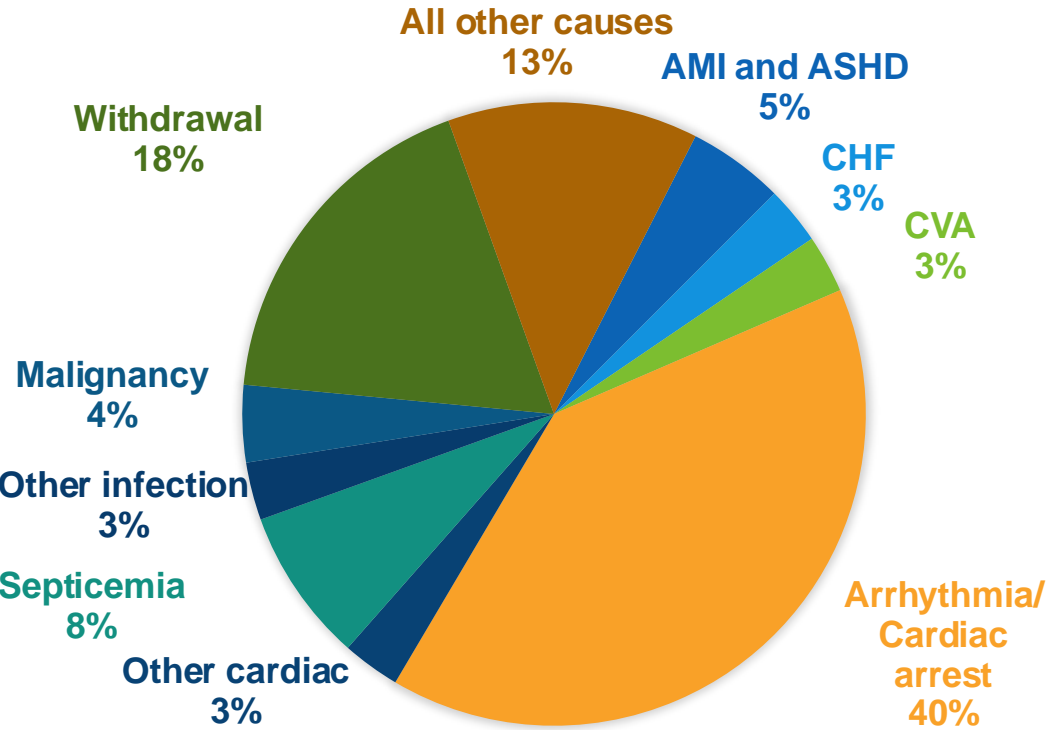


CKD



¹USRDS 2013 ADR: Figure 4.1 (Volume 1). December 31, 2011 point prevalent Medicare enrollees with CVD, age 66 & older, with fee-for-service coverage for the entire calendar year.

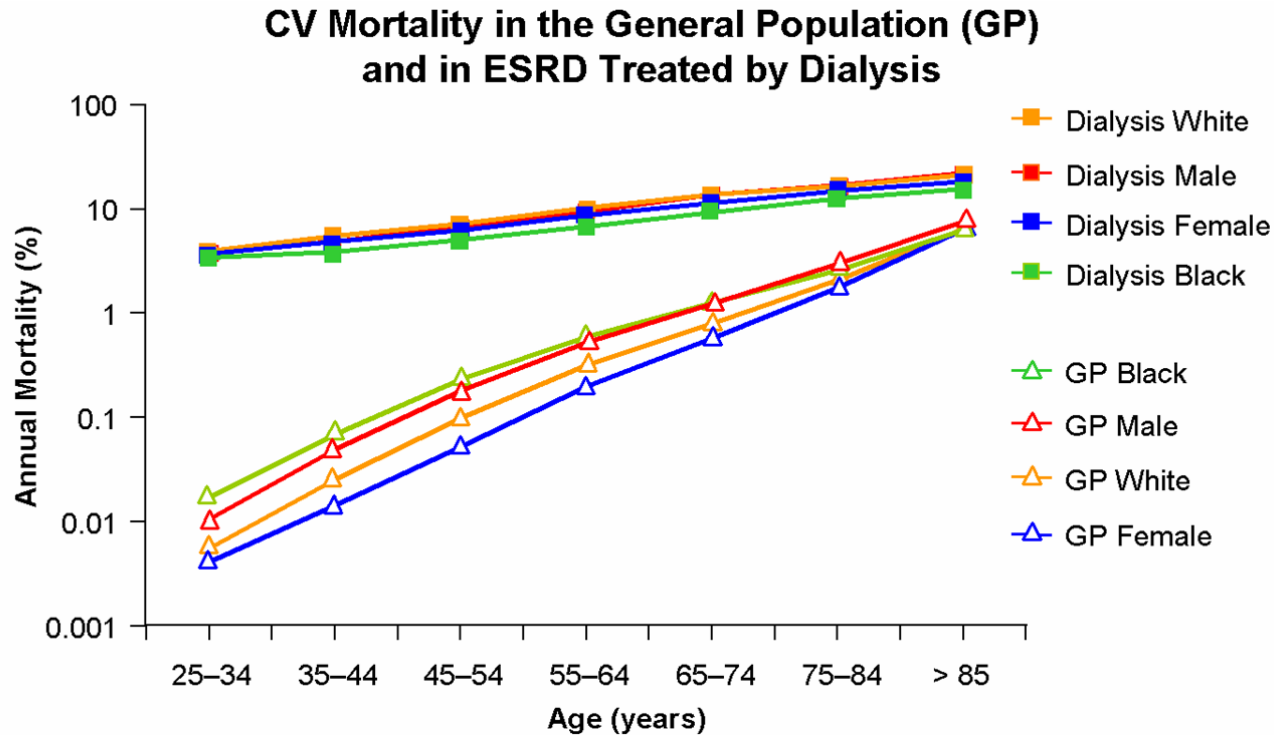
Cardiovascular-Related Deaths are Common



**OVER 40%
OF DIALYSIS PATIENT
DEATHS ARE
CARDIOVASCULAR-
RELATED¹**

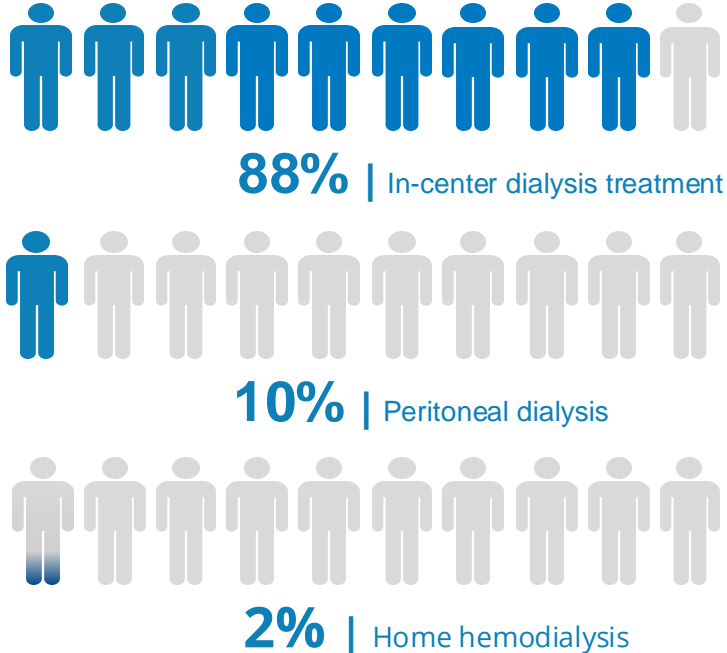
¹USRDS 2018 Annual Data Report, Figure 5.4.a Volume 2, Dialysis patients, denominator excludes missing/unknown causes of death

Cardiovascular Mortality Significantly Higher in Dialysis Patients¹

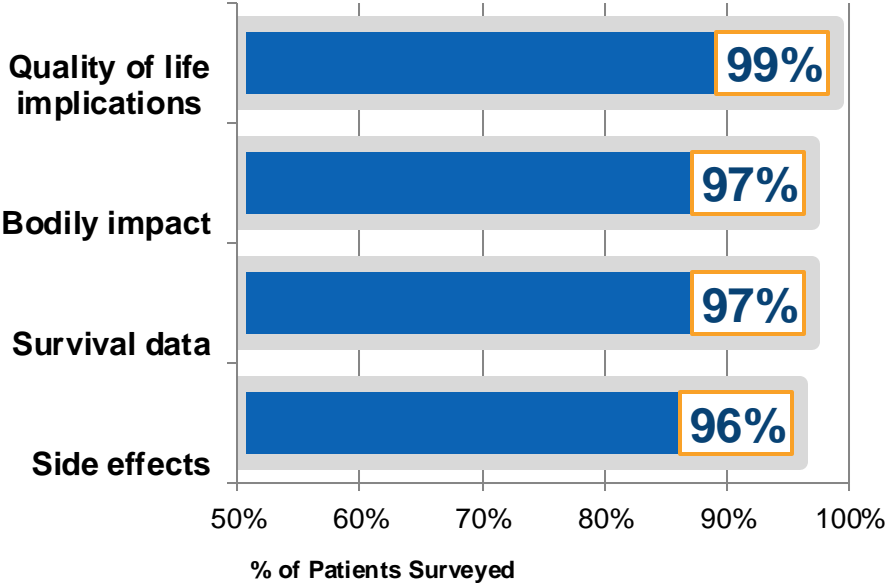


¹Sarnak MJ, et al, Am J Kidney Dis, 2000;35(4 Suppl 1) S:117-131.

Current Dialysis Situation by Modality¹



Most surveyed patients want to know...²



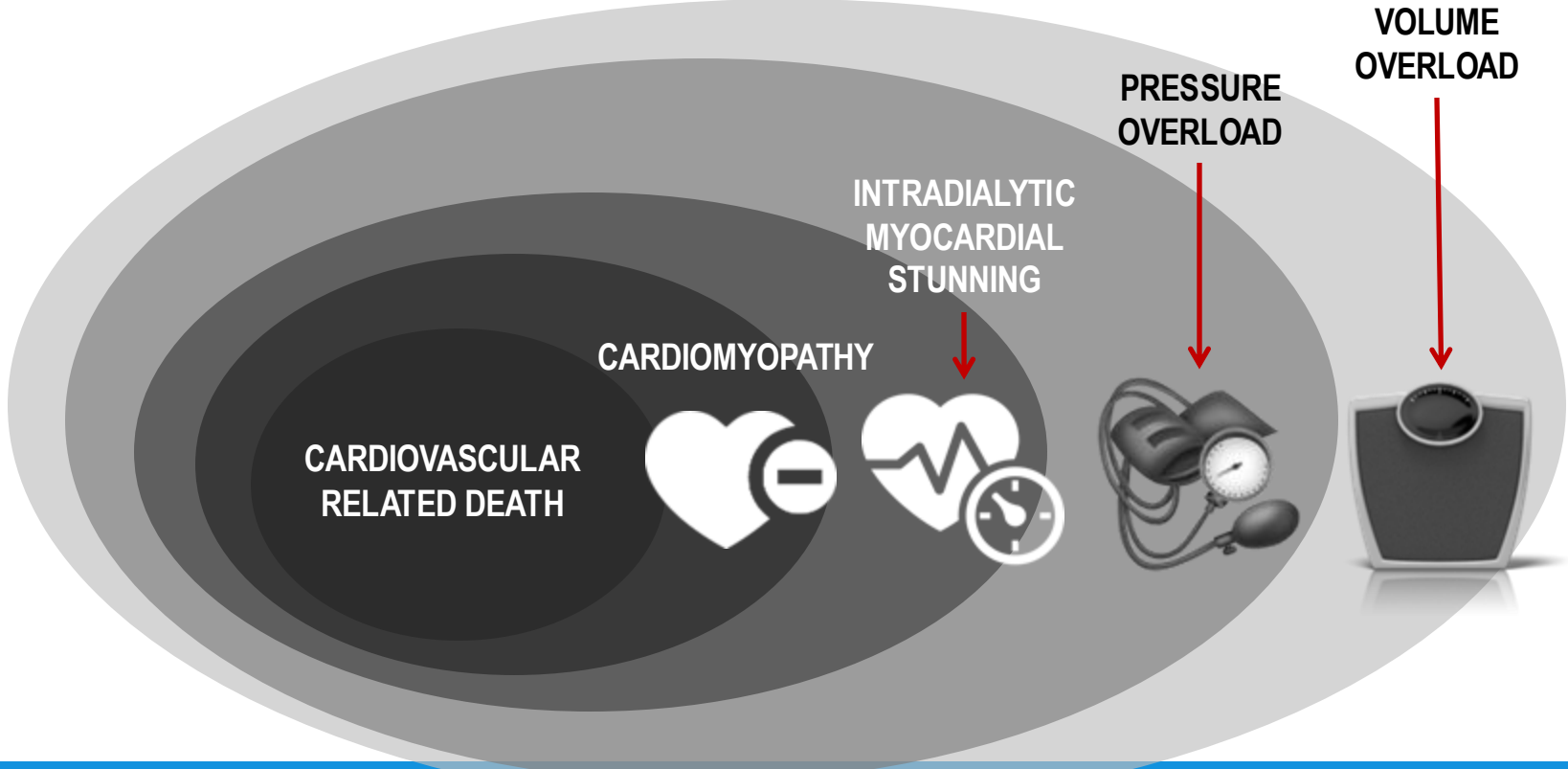
¹Data source: 2013 Census Data by MAC and State, 2013 ESRD Network Annual Report ²Fine A, et al. Nephrologists should voluntarily divulge survival data to potential dialysis patients: a questionnaire study. Perit Dial Int. 2005;25:269-273



The Heart of the Matter



Dialysis Induced Stress on the Heart Varies by Modality



Cardiovascular Improvement is a Hallmark Benefit of More Frequent Therapy

		Frequent Nocturnal	Frequent Hemodialysis	Peritoneal Dialysis	In-center Hemodialysis
Hypertensive / Blood Pressure Control	♥	5% ▼ Systolic BP ¹	7% ▼ Systolic BP ²	3% ▲ Systolic BP ³	≤1% ▼ Systolic BP ^{1,2}
Occurrence of Myocardial Stunning	♥	50% Patients ⁴	75% Patients ⁴	- Not studied	100% Patients ⁴
Regional Wall Motion Abnormalities	♥	38% ▼ RWMAs ⁴	31% ▼ RWMAs ⁴	- Not studied	Index RWMAs
Left Ventricular Mass Index	♥	8% ▼ LV Mass ⁵	11% ▼ LV Mass ²	14% ▲ LV Mass ³	2% ▼ LV Mass ²

Frequent Nocturnal Hemodialysis (5+x/week), Frequent Hemodialysis (5-6x/week), In-Center Hemodialysis (3x/week)

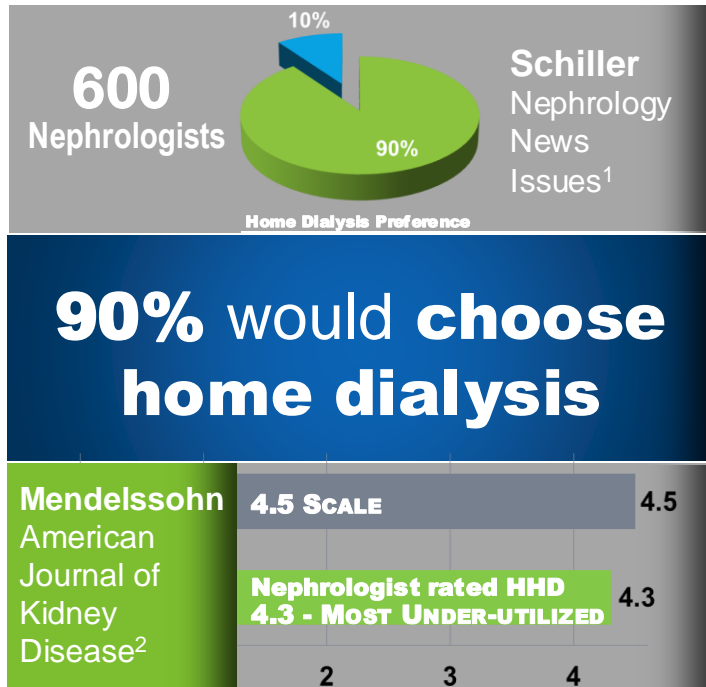
¹Rocco, et al., The effects of frequent nocturnal home hemodialysis: the Frequent Hemodialysis Network Nocturnal Trial. International Society of Nephrology, 2011. ²FHN Trial Group. In-center hemodialysis six times per week versus three times per week. N Engl J Med. 2010;363(24):2287-2300. ³Foley, et al., Long-term evolution of cardio myopathy in dialysis patients. Kidney International, Vol. 54 (1998), pp. 1720-1725. ⁴Jefferies et al. Frequent hemodialysis schedules are associated with reduced levels of dialysis-induced cardiac injury (Myocardial stunning). Clin J Am Soc Nephrol 2011 June, 6(6); 1326-1332. ⁵Culleton BF, et al., Effect of frequent nocturnal hemodialysis vs conventional hemodialysis on left ventricular mass and quality of life. JAMA. September 2007; Vol 298, No. 11, 1291 – 1299.



Frequency and Duration Matter



What Nephrologists Would Choose for Themselves Should be Considered



- A significant majority of nephrologists agree...
 - Home dialysis therapies are an effective alternative to in-center treatments¹
 - Home hemodialysis is the most under-utilized modality²
- Broader access to home therapies is essential
 - 26% of ESRD providers offer home hemodialysis³
 - 49% are certified to offer PD³

¹Schiller B, Neitzer A, Doss S. Perceptions about renal replacement therapy among nephrology professionals. Nephrol News Issues. 2010; 24(10):36-44.

²Mendelssohn DC, et al. What do American Nephrologists think about dialysis modality selection? Am J Kidney Dis. 2001;37(1):22-29.

³Dialysis Facility Compare Website provided by the Centers for Medicare & Medicaid Services. Updated July 14, 2014.

Frequency and Duration Matters

Duration matters, even with more frequent therapy

SHORTER



LONGER

Lower Risk of Death

Performing more frequent nocturnal hemodialysis has shown similar 5-year survivability as deceased donor transplantation.¹

Better Cardiovascular Outcomes

Patients performing more frequent hemodialysis with lower UF volumes resulted in a mean reduction of Regional Wall Motion Abnormalities (RWMAs), which are associated with elevated mortality risk, per patient as compared to conventional, thrice-weekly therapy with higher UF volumes.²

Improved Phosphorus Control and Middle Molecule Clearance

Compared to conventional thrice weekly in-center hemodialysis, more frequent hemodialysis is associated with improved control of hyperphosphatemia.³ Nocturnal therapy is associated with greater clinical benefits with significantly higher total cleared volume both of Phosphorus and β 2-microglobulin.⁴

More Energy and Vitality

More frequent dialysis, during the day or overnight, provides significant and wide-reaching therapeutic benefits. Quicker time to recovery.⁵ Less dietary restriction.⁶⁻⁷ Better blood pressure control with fewer medications.⁸⁻⁹

References: slide 15

A Question of Balance

Improved BP control & survival¹⁻⁶

Reduced LVH & cardiovascular hospitalizations^{2,5-7}

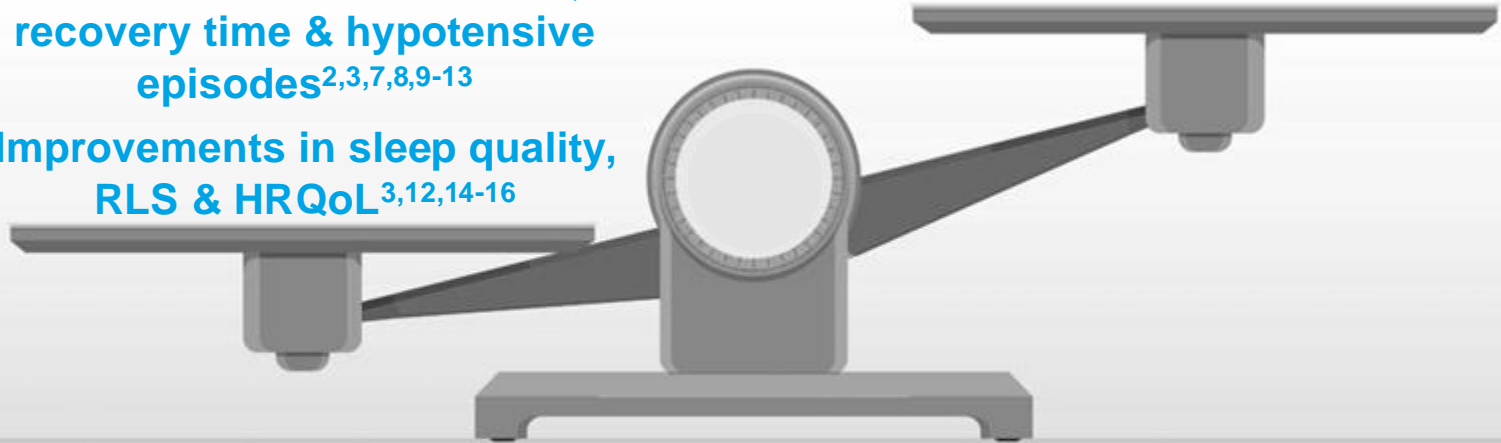
Reduced ultrafiltration rate, recovery time & hypotensive episodes^{2,3,7,8,9-13}

Improvements in sleep quality, RLS & HRQoL^{3,12,14-16}

Vascular access complications¹⁷

Technique survival⁵

Infection risk^{18,19}



Risks and Responsibilities

The reported benefits of home hemodialysis (HHD) may not be experienced by all patients.

The NxStage System is a prescription device and, like all medical devices, involves some risks. The risks associated with hemodialysis treatments in any environment include, but are not limited to, high blood pressure, fluid overload, low blood pressure, heart-related issues, and vascular access complications. When vascular access is exposed to more frequent use, infection of the site, and other access related complications may also be potential risks. The medical devices used in hemodialysis therapies may add additional risks including air entering the bloodstream, and blood loss due to clotting or accidental disconnection of the blood tubing set.

Home hemodialysis with the NxStage System during waking hours may not require a care partner, provided a physician and a qualified patient agree that solo home hemodialysis is appropriate. Patients performing nocturnal treatments are required to have a care partner. Care partners are trained on proper operation and how to get medical or technical help if needed.

Certain risks associated with hemodialysis treatment are increased when performing solo HHD because no one is present to help the patient respond to health emergencies. If patients experience needles coming out, blood loss, or very low blood pressure during solo HHD, they may lose consciousness or become physically unable to correct the health emergency. Losing consciousness or otherwise becoming impaired during any health emergency while alone could result in significant injury or death. Additional ancillary devices and training are required when performing solo HHD.

Certain risks associated with hemodialysis treatment are increased when performing nocturnal therapy due to the length of treatment time and because therapy is performed while the patient and care partner are sleeping. These risks include, but are not limited to, blood access disconnects and blood loss during sleep, blood clotting due to slower blood flow and/or increased treatment time, and delayed response to alarms when waking from sleep.

Patients should consult their doctor to understand the risks and responsibilities of performing these therapies using the NxStage System.

Frequency and Duration Matter

References

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- ²Jefferies et.al. Frequent hemodialysis schedules are associated with reduced levels of dialysis-induced cardiac injury (Myocardial stunning). *Clin J Am Soc Nephrol* 2011 June, 6(6); 1326-1332.
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- ⁴Elloot S, Van Biesen W, Dhondt A, Van de Wynkele H, Glorieux G, Verdonck P, Vanholder R. Impact of hemodialysis duration on the removal of uremic retention solutes. *Kidney International*. 2008, 73, 765-770.
- ⁵Heidenheim PA, Muirhead N, Moist L, Lindsay RM. Patient quality of life on quotidian hemodialysis. *Am J Kidney Dis*. 2003;42(S1)(S1):S36-S41.
- ⁶Charra B, Charzot C. The neglect of sodium restriction in dialysis patients: a short review. *Hemodial Int* 2003;7(4):342-347.
- ⁷Pierratos A. Daily nocturnal home hemodialysis. *Kidney Int* 2004;65(5)1975-1986.
- ⁸Culleton BF, Walsh M, Klarenbach SW, Mortis G, Scott-Douglas N, Quinn RR, Tonelli M, Donnelly S, Friedrich MG, Kumar A, Mahallati H, Hemmelgarn BR, Manns BJ. Effect of frequent nocturnal hemodialysis vs conventional hemodialysis on left ventricular mass and quality of life. *JAMA*. September 2007; Vol 298, No. 11, 1291 – 1299.
- ⁹Chan C, et al. Regression of left ventricular hypertrophy after conversion to nocturnal hemodialysis. *Kidney International*, 2002;61:2235-2239.

A Question of Balance

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- 5Weinhandl ED, Gilbertson DT, Collins AJ. Mortality, Hospitalization, and Technique Failure in Daily Home Hemodialysis and Matched Peritoneal Dialysis Patients: A Matched Cohort Study. *Am J Kidney Dis.* 2016;67(1):98-110.
- 6Weinhandl, E.D., Liu, J., Gilbertson, D.T., Arneson, T.J., Collins, A.J. Survival in daily home hemodialysis and matched thrice-weekly in-center hemodialysis patients. *J Am Soc Nephrol.* 2012;23:895–904.
- 7McCullough, P.A., Chan, C.T., Weinhandl, E.D., Burkart, J.M., and Bakris, G.L. Intensive hemodialysis, left ventricular hypertrophy, and cardiovascular disease. *Am J Kidney Dis.* 2016; 68: S5–S14.
- 8Raimann, J.G., et al. The Effect of Increased Frequency of Hemodialysis on Volume-Related Outcomes: A Secondary Analysis of the Frequent Hemodialysis Network Trials. *Blood Purif* 2016;41:277–286.
- 9Weinhandl, Collins, Kraus. Ultrafiltration Rates with More Frequent Home Hemodialysis. Oral Presentation. 2017 ADC.
- 10Stefánsson, B.V., Brunelli, S.M., Cabrera, C. et al. Intradialytic hypotension and risk of cardiovascular disease. *Clin J Am Soc Nephrol.* 2014; 9: 2124–2132.

A Question of Balance

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- ¹¹Jefferies, H.J., et al. Frequent Hemodialysis Schedules Are Associated with Reduced Levels of Dialysis-induced Cardiac Injury (Myocardial Stunning). *Clin J Am Soc Nephrol*. 2011 June; 6(6): 1326–1332.
- ¹²Jaber BL, Lee Y, Collins AJ, et al. Effect of daily hemodialysis on depressive symptoms and postdialysis recovery time: interim report from the FREEDOM (Following Rehabilitation, Economics and Everyday-Dialysis Outcome Measurements) Study. *Am J Kidney Dis*. 2010;56(3):531-539.
- ¹³Lindsay RM, Heidenheim PA, Nesrallah G, Garg AX, Suri R, Daily Hemodialysis Study Group London Health Sciences Centre. Minutes to recovery after a hemodialysis session: a simple health-related quality of life question that is reliable, valid, and sensitive to change. *CJASN*. 2006;1(5):952-959.
- ¹⁴Finkelstien FO, et al. At-home short daily hemodialysis improves the long-term health-related quality of life. *Kidney International* (2012) 82, 561–569.
- ¹⁵Jaber BL, et al. Impact of Short Daily Hemodialysis on Restless Legs Symptoms and Sleep Disturbances. *CJASN* May 2011 vol. 6 no. 5 1049-1056.
- ¹⁶Kraus, Michael A. et al. Intensive Hemodialysis and Health-Related Quality of Life. *Am J of Kidney Dis*. 2016;68:S33-S42.
- ¹⁷Suri RS, et al. Risk of Vascular Access Complications with Frequent Hemodialysis. *J Am Soc Nephrol* 24: 498–505, 2013.
- ¹⁸Spry LA, Burkart JM, Holcroft C, Mortier L, and Glickman JD. Survey of home hemodialysis patients and nursing staff regarding vascular access use and care. *Hemodialysis International*. 2015 April;19(2), 225-234.
- ¹⁹Weinhandl EW, et al. Hospitalization in Daily Home Hemodialysis and Matched Thrice-Weekly In-Center Hemodialysis Patients. *Am J Kidney Dis*. 65(1):98-108.



Appendix: Cardiovascular Outcomes





Blood Pressure Control



More Frequent Hemodialysis Associated with Better Blood Pressure Control

Outcome	No. with Data [†]	Baseline	12 Months	Change from Baseline to 12 Months	Adjusted Mean (±SE) Change from Baseline [‡]	Difference in Change (Frequent-Conventional) (95% CI)	P Value
Erythropoiesis-stimulating agents — EPO equivalent units ^{††}							
Conventional hemodialysis	90	57,070±65,456	53,093±63,552	-3,976±69,525	-5%±10%		0.24
Frequent hemodialysis	103	56,176±102,288	41,877±44,636	-14,299±76,191	-18%±8%		
Weekly average predialysis systolic blood pressure — mm Hg							
Conventional hemodialysis	93	146±18	147±18	0.9±16.2	0.9±1.6	-10.1 (-14.3 to -6.0)	<0.001
Frequent hemodialysis	104	147±19	137±19	-9.7±18.2	-9.2±1.5		
Antihypertensive agents consumed — no.							
Conventional hemodialysis	92	2.80±1.69	2.58±1.68	-0.23±1.35		—	<0.001 ^{††}
Frequent hemodialysis	103	2.69±1.80	1.82±1.73	-0.87±1.85			

MORE FREQUENT HEMODIALYSIS ASSOCIATED WITH A 7% DECREASE IN SYSTOLIC BLOOD PRESSURE

The FHN Trial Group. In-Center Hemodialysis Six Times per Week versus Three Times per Week. *N Engl J Med.* 2010 December 9; 363(24): 2287–2300



More Frequent Nocturnal Hemodialysis Associated with Better Blood Pressure Control

Table 2. Outcomes for LV Mass, Blood Pressure, Anemia, and Mineral Metabolism^a

Characteristic	Nocturnal Hemodialysis ^b (n = 26)	Conventional Hemodialysis ^b (n = 25)	Between-Group Comparison (95% CI) ^c
Blood pressure, mean (SD), mm Hg			
Systolic			
Baseline	129 (23)	135 (19)	-6 (-17 to 6)
Exit	122 (23)	139 (20)	-17 (-28 to -4)
Change	-7 (29)	4 (17)	-11 (-24 to 2)
Diastolic			
Baseline	75 (14)	77 (16)	-2 (-10 to 7)
Exit	68 (16)	75 (12)	-7 (-15 to 1)
Change	-7 (16)	-2 (12)	-5 (-13 to 2)

MORE FREQUENT HEMODIALYSIS ASSOCIATED WITH A 7% DECREASE IN SYSTOLIC BLOOD PRESSURE

Culleton BF, Walsh M, Klarenbach SW, Mortis G, Scott-Douglas N, Quinn RR, Tonelli M, Donnelly S, Friedrich MG, Kumar A, Mahallati H, Hemmelgarn BR, Manns BJ. Effect of frequent nocturnal hemodialysis vs conventional hemodialysis on left ventricular mass and quality of life. JAMA. September 2007; Vol 298, No. 11, 1291 – 1299.



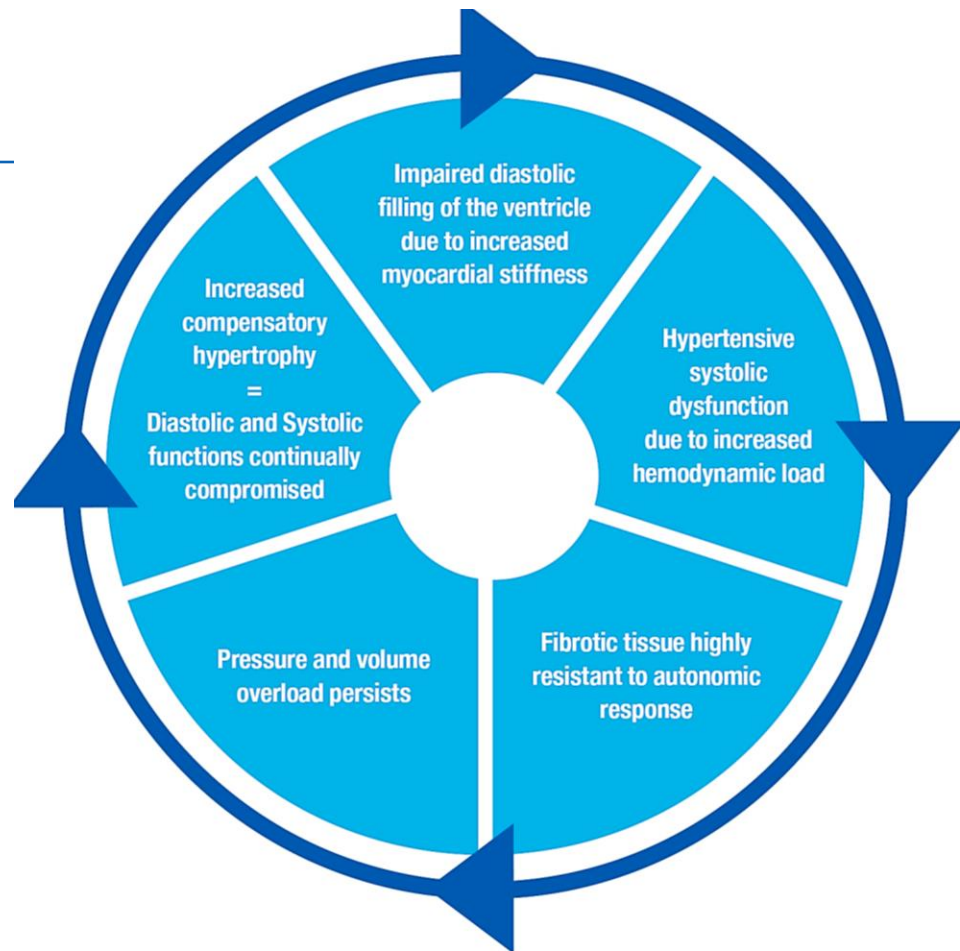


Left Ventricular Hypertrophy



Clinical Consequences of Increased Left Ventricular Mass

- The impaired ventricular function present in Left Ventricular Hypertrophy can actually simulate a vicious cycle
- May cause LVH progression
- Complicated by ESRD uremic risk factors.



More Frequent Hemodialysis Reduced Left Ventricular Mass^{1,2}

- Left Ventricular Hypertrophy (LVH) represents a major predictor of the development of cardiovascular complications
- 70-90% of patients exhibit LVH of varying degrees of severity prior to the initiation of renal replacement therapy^{3,4}
- Many patients continue to exhibit LVH despite initiating dialysis⁵
- Persistence of vascular volume increase due to inadequate ultrafiltration has been reported as a major factor in the failure of LVH to regress⁵

¹Culleton BF, Walsh M, Klarenbach SW, Mortis G, Scott-Douglas N, Quinn RR, Tonelli M, Donnelly S, Friedrich MG, Kumar A, Mahallati H, Hemmelgarn BR, Manns BJ. Effect of frequent nocturnal hemodialysis vs conventional hemodialysis on left ventricular mass and quality of life. JAMA. September 2007; Vol 298, No. 11, 1291 – 1299.

²Ayus JC, Mizani MR, Achinger SG, et al. Effects of short daily versus conventional hemodialysis on left ventricular hypertrophy and inflammatory markers: a prospective, controlled study. J Am Soc Nephrol. 2005;16(9):2778-2388.

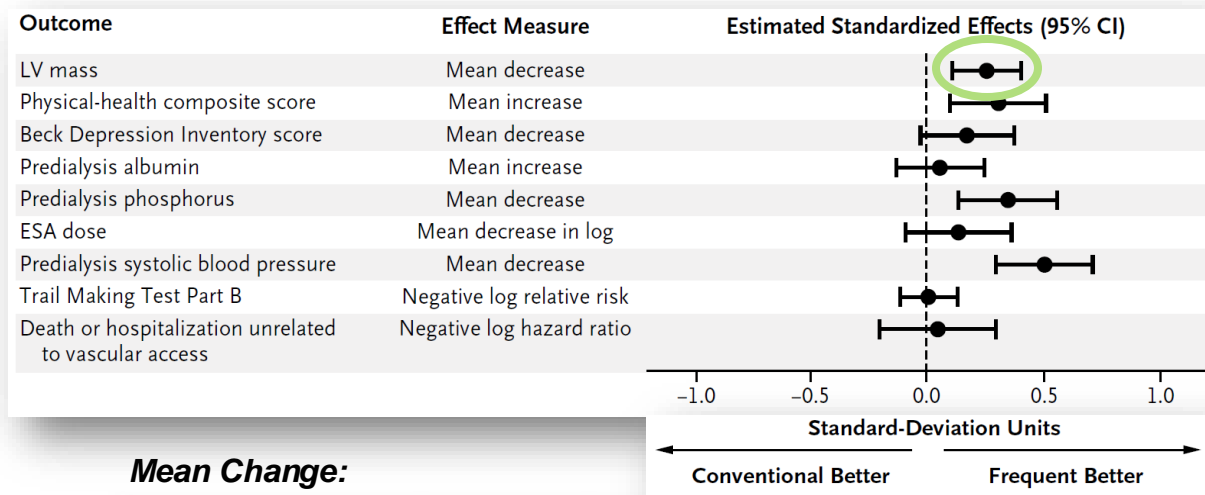
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⁴McMahon LP, Roger SD, Levin A. Development, prevention, and potential reversal of left ventricular hypertrophy in chronic kidney disease. J Am Soc Nephrol. 2004;15:1640-1647.

⁵Richard J. Glascock, Roberto Pecoits-Filho, Silvio Barbareto, Increased Left Ventricular Mass in Chronic Kidney Disease and End-Stage Renal Disease: What Are the Implications? Dialysis & Transplantation . January 2010: 1-4.



FHN Daily Trial: Significant Reduction in Left Ventricular Mass



Mean Change:

Left Ventricular Mass (g)	Baseline	Month 12	Change	P Value ^a
Conventional	141 ± 49	138 ± 52	-2.6	< 0.001
Frequent	142 ± 59	125 ± 46	-16.4	

**11% DECREASE
IN LV MASS
During study period**

The FHN Trial Group. In-Center Hemodialysis Six Times per Week versus Three Times per Week. The New England Journal of Medicine. 010:363:2287-2300.



Canadian Nocturnal Hemodialysis Trial: Significant Reduction in Left Ventricular Mass

Characteristic	Nocturnal Hemodialysis ^b (n = 26)	Conventional Hemodialysis ^b (n = 25)	Between-Group Comparison (95% CI) ^c
LV mass, mean (SD), g			
Baseline	177.4 (51.1)	181.5 (92.3)	-4.1 (-49.5 to 41.3)
Exit	163.6 (45.2)	183.0 (84.2)	-19.4 (-60.5 to 21.7)
Change	-13.8 (23.0)	1.5 (24.0)	-15.3 (-29.6 to -1.0) ^d
LV mass, mean (SD), g/m ²			
Baseline	92.4 (26.6)	101.8 (50.6)	-9.4 (-34.0 to 15.2)
Exit	85.3 (23.2)	102.8 (46.1)	-17.5 (-39.8 to 4.6)
Change	-7.1 (12.4)	1.0 (14.1)	-8.1 (-16.2 to -0.1) ^d

MORE FREQUENT HOME NOCTURNAL HD ASSOCIATED WITH AN 8% DECREASE IN LV MASS
Similar LV mass regression observed in HHD patients with benefits attributable to better fluid management

CONVENTIONAL HD SHOWED INSIGNIFICANT LEFT VENTRICULAR MASS REGRESSION
Although the short daily FHN trial showed a 2% improvement in LV mass, the Canadian nocturnal trial reported no significant improvement

Culleton BF, et al. Effect of frequent nocturnal hemodialysis vs conventional hemodialysis on left ventricular mass and quality of life. JAMA. September 2007; Vol 298, No. 11, 1291 – 1299.



Stunning Consequences of Thrice-Weekly Hemodialysis

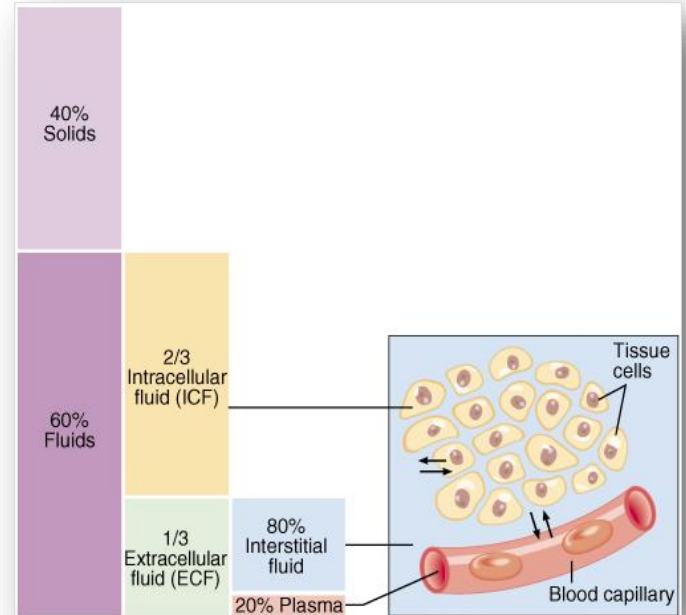


Fluid Dynamics in the Body

- **Compartments**
 - Intracellular: 2/3
 - Extracellular: 1/3
 - Plasma: 20%
 - Interstitial: 80%
- Hemodialysis only directly cleans the blood
- Blood is only about 15% of total body mass
- The majority of the excess fluid must shift from the other compartments into the blood to be removed

TOTAL BODY MASS:

Medical Education Institute, Inc. in cooperation with the National Association of Nephrology Technicians/Technologists (NANT) with review and approval by Jim Curtis, CHT, CCHT, nationally recognized dialysis technician trainer and consultant.



Frequent Hemodialysis are Associated with Reduced Levels of Dialysis-Induced Cardiac Injury (Myocardial Stunning)¹

- Study Design
 - Cross-sectional, observation study
- Patient Population
 - 18+ years of age, on current therapy for 3 months
 - Patients with severe LV or heart transplant were excluded
- Location:
 - Satellite Dialysis and WellBound, Mountain View, CA
- Enrollment Size
 - 46 well-matched hemodialysis (HD) patients
 - 12 Conventional HD (not studied on the day after 2 day intradialytic interval)
 - 12 More frequent in-center HD (5+/week)
 - 12 More frequent home HD (5+/week)
 - 10 More frequent home nocturnal HD (5+/week)

¹Jefferies HJ, Virk B, Schiller B, Moran J, McIntyre CW. Frequent Hemodialysis Schedules Are Associated with Reduced Levels of Dialysis-induced Cardiac Injury (Myocardial Stunning). CJASN. 2011 June; 6(6): 1326–1332.



Intradialytic Hypotension: Increased with Conventional Hemodialysis¹

Methods

- Pre-dialysis BP measurements after 5 minutes of rest
- Subsequent BP measurement taken 15 minutes before the end of treatment (“peak stress”)

Results

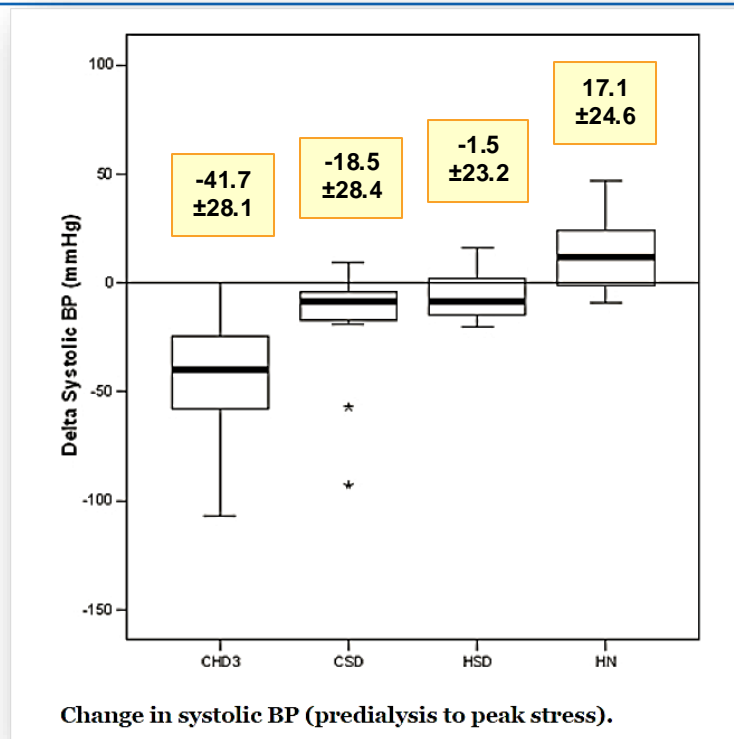
- Strong correlation between ultrafiltration volume and intradialytic hypotension

CHD3=Conventional In-Center HD (3x/week)

CSD=Center Short Daily (5+x/week)

HSD=Home Short Daily (5+x/week)

HN=Home Nocturnal (5+x/week)



¹Jefferies HJ, Virk B, Schiller B, Moran J, McIntyre CW. Frequent Hemodialysis Schedules Are Associated with Reduced Levels of Dialysis-induced Cardiac Injury (Myocardial Stunning). C.JASN. 2011 June; 6(6): 1326–1332



Regional Wall Motion Abnormalities: Increased with Higher Ultrafiltration Rate¹

- Regional Wall Motion Abnormalities (RWMA) have been associated with Myocardial Stunning or Cardiac Injury
- Repeated occurrences of myocardial stunning may result in permanent injury and lead to heart failure

CHD3=Conventional In-Center HD (3x/week)

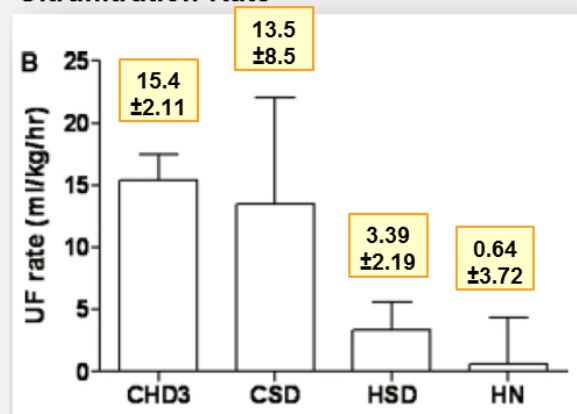
CSD=Center Short Daily (5+x/week)

HSD=Home Short Daily (5+x/week)

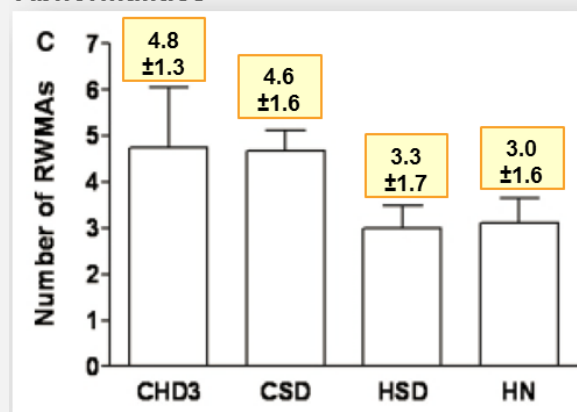
HN=Home Nocturnal (5+x/week)

¹Jefferies HJ, Virk B, Schiller B, Moran J, McIntyre CW. Frequent Hemodialysis Schedules Are Associated with Reduced Levels of Dialysis-induced Cardiac Injury (Myocardial Stunning). CJASN. 2011 June; 6(6): 1326–1332

Ultrafiltration Rate



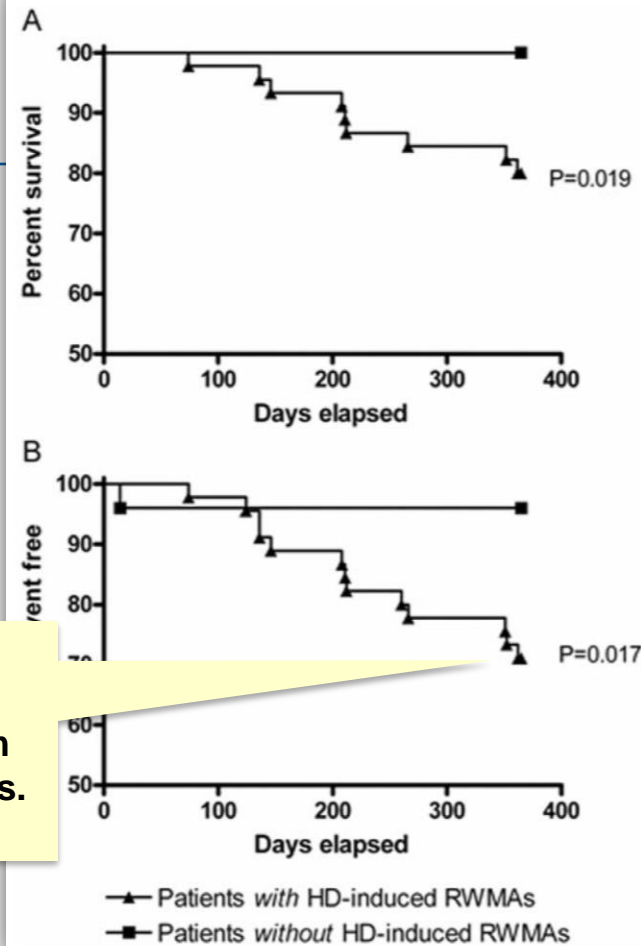
Number of Regional Wall Motion Abnormalities



Regional Wall Motion Abnormalities: Patient Survival After 12 Months¹

- LVEF at rest had significantly deteriorated in patients with RWMA but remained unchanged in those patients without
 - (62.1, 11.4% versus 54.7, 10.1%, P 0.0008)
- The presence of HD-induced RWMA was associated with increased relative mortality at 12 months (P 0.019)
- Patient Deaths
 - With HD-induced RWMA: 13
 - Without HD-induced RWMA: 1

Death resulted overwhelmingly from cardiovascular causes.



¹Burton, JO et al., Hemodialysis-Induced Cardiac Injury: Determinants and Associated Outcomes. Clin J Am Soc Nephrol 4: 914–920, 2009

Myocardial Stunning: May be Due to the Treatment Itself¹

- Intravascular volume contraction may begin to occur during HD if fluid is removed at a rate >5–6 mL/kg/hr
- Reduced organ perfusion is risked if fluid is removed during HD at a rate >10 mL/kg/hr
- Reduced organ perfusion will likely result if fluid is removed during HD at a rate >13 mL/kg/hr

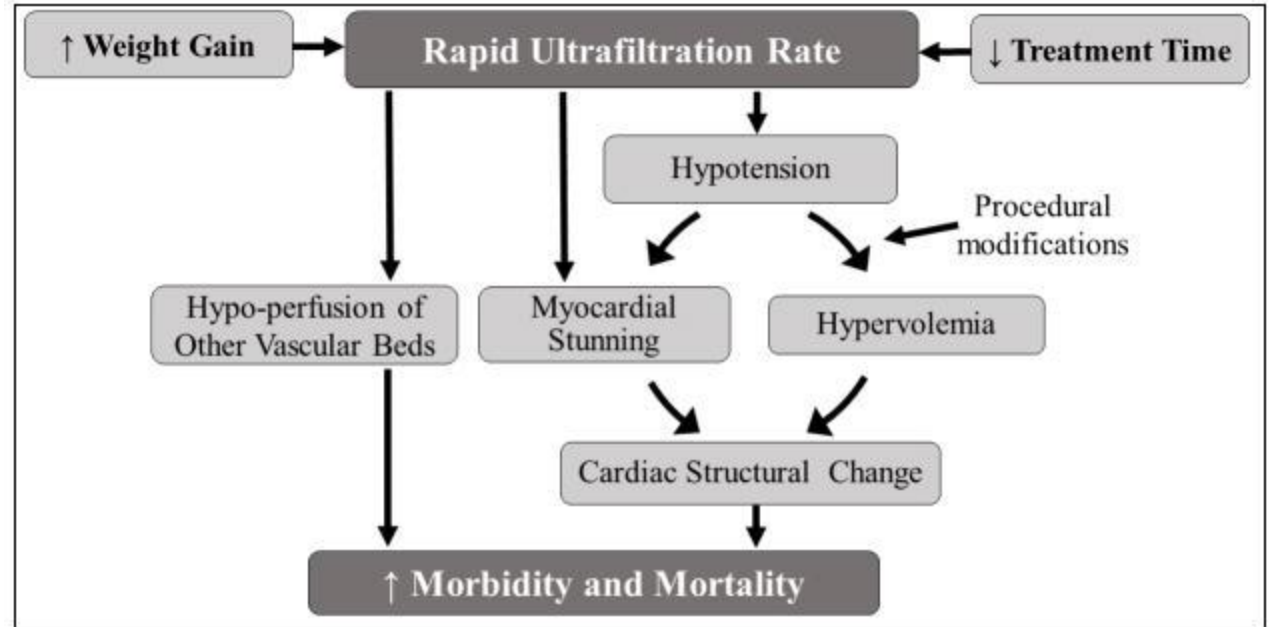
Factor associated with presence of myocardial stunning	Odds Ratio
UF volume during HD of 1L	5.1
UF volume during HD of 1.5L	11.6
UF volume during HD of 2L	26.2
Maximum SBP reduction during HD of 10 mmHg	1.8
Maximum SBP reduction during HD of 20 mmHg	3.3
Maximum SBP reduction during HD of 30 mmHg	6.0

¹Burton, JO et al., Hemodialysis-Induced Cardiac Injury: Determinants and Associated Outcomes. Clin J Am Soc Nephrol 4: 914–920, 2009



Ultrafiltration Rate Implications for Patient Care¹

- 2/3 of patients suffer from recurrent HD-induced ischemic injury
- The way that the heart moves changes as parts of the heart die



¹Assimon MM, Flythe JE. Rapid ultrafiltration rates and outcomes among hemodialysis patients: re-examining the evidence base. *Curr Opin Nephrol Hypertens*. 2015 November ; 24(6): 525–530.

Stunning Consequences of Thrice-Weekly In-Center Hemodialysis¹

“Although patients may look comfortable during hemodialysis, in reality this innocuous-appearing procedure has much more stunning effect than meets the eye.”

Dr. Joel Glickman

Facts

- Not studied 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

¹Joel D. Glickman. Stunning Consequences of Thrice-Weekly In-center Dialysis. Medscape. Apr 27, 2012





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