Present and Future in Home Dialysis – Global Perspective

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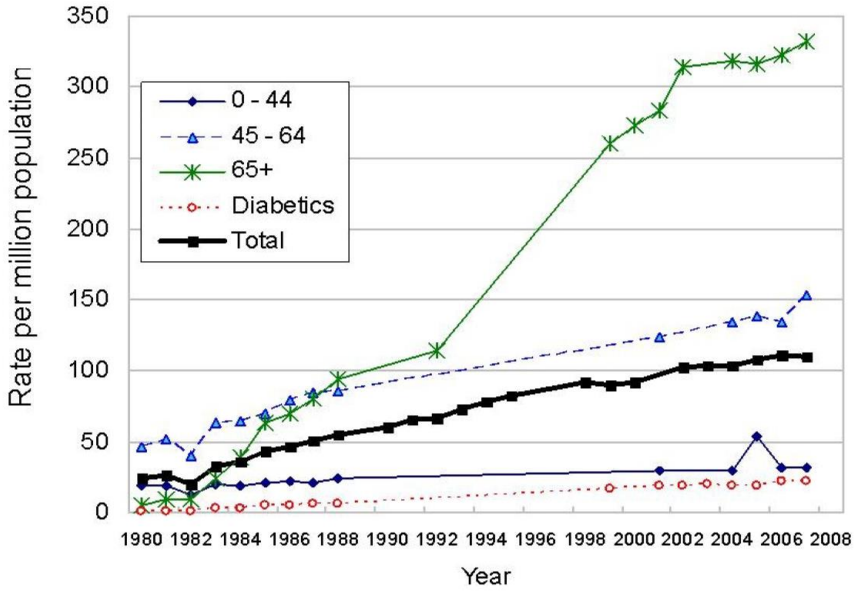
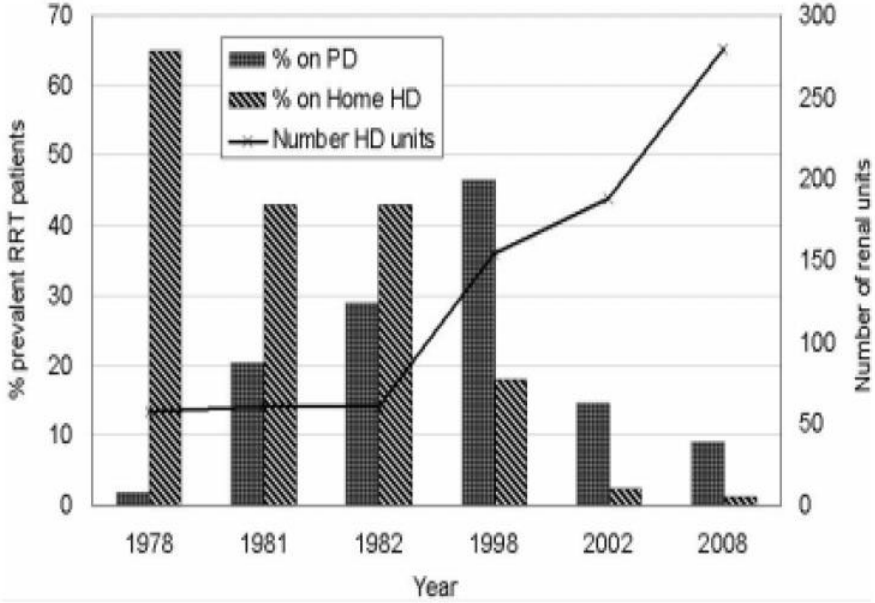
Objectives

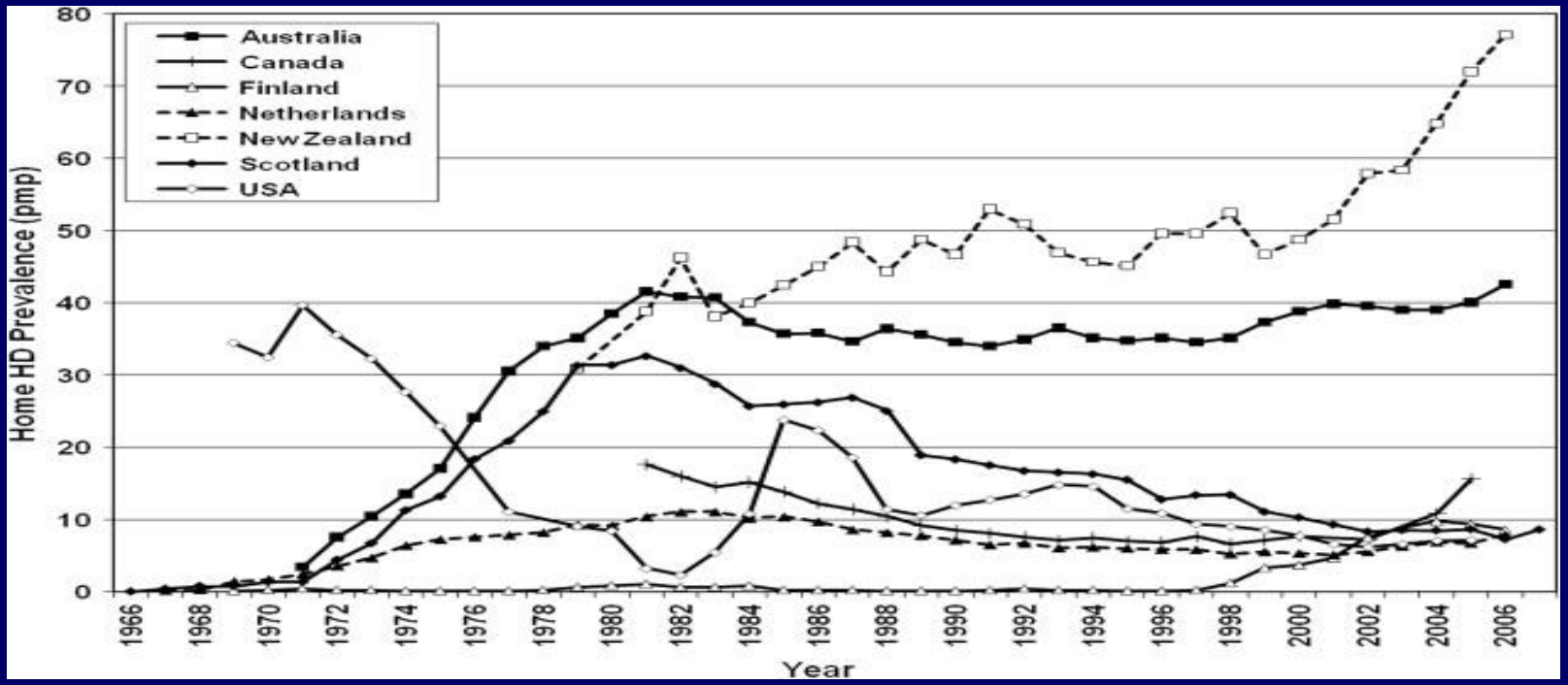
- To discuss and review the emerging trends in home dialysis
  - Practice
  - Research
  - Quality

The Change of Dialysis Practice





The prevalence of HHD in several countries from 1966 to 2006



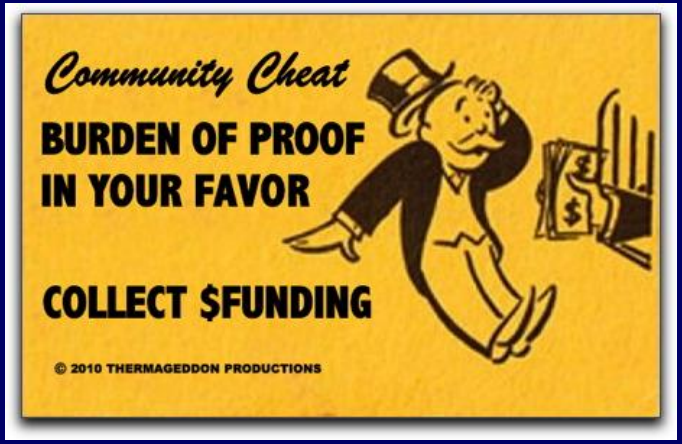
. Data are expressed as pmp.

International Variations and Trends in Home Hemodialysis
Advances in Chronic Kidney Disease Volume 16, Issue 3 2009 205 - 214

Hypothesis: The “unphysiology” of dialysis

Kjellstrand et al KI 1975

“…Approximation of normal physiology should reflect the best clinical outcome…”



Typical Treatment Parameters During Frequent Hemodialysis: Dose is Different!

	Conventional HD	Short Daily HD	Nocturnal HD	NxStage HD
Treatments/wk	3	5-6	5-6	6
Treatment time (hrs)	3-4	2-3	6-8	2.5-3.5
Blood Flow Rate (ml/min)	200-400	400	200-300	400
Dialysate Flow Rate (ml/min)	500-800	500-800	200-350	130

Frequent HD: mortality studies

Observations:

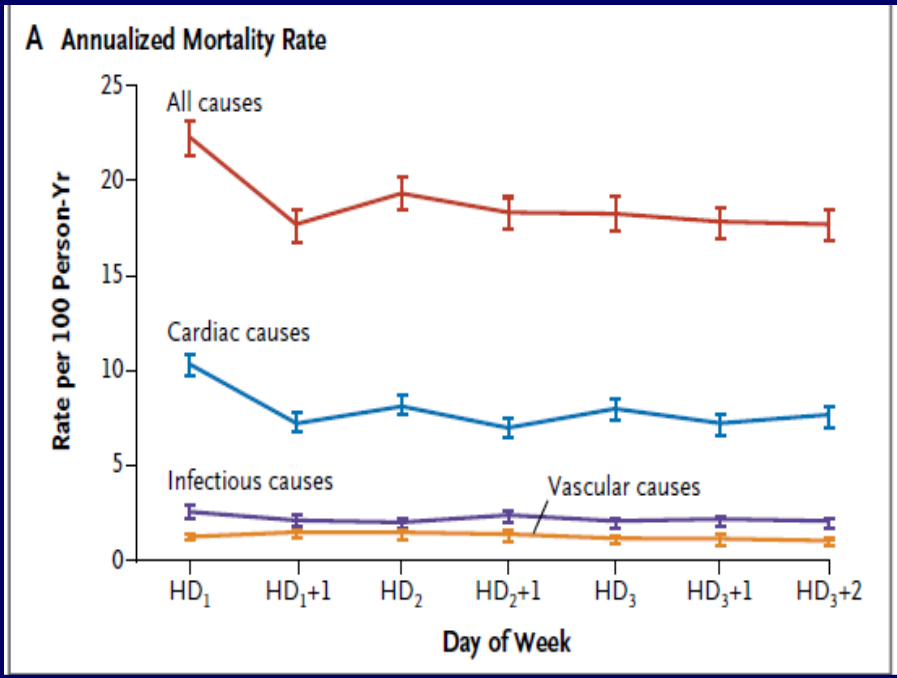
- Overall – suggests frequent HD better than incenter HD
- BUT estimate of clinical benefit varies
- Technique survival is different

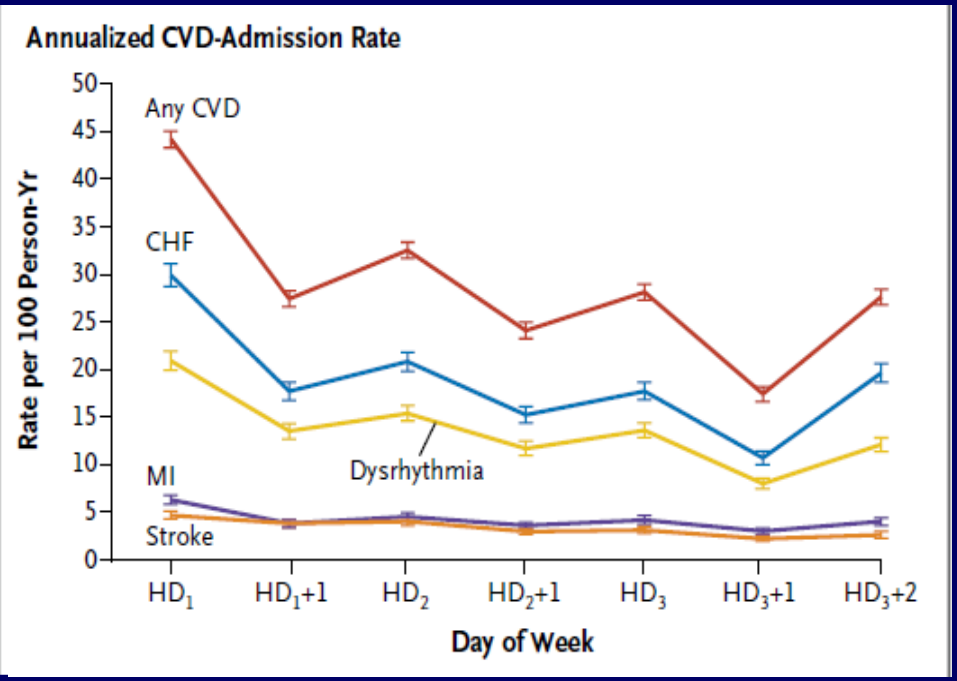
Study	Countries and duration of follow-up	Study population		Relative mortality in HHD population
		Intensive HHD	In-centre CHD	
Johansen *et al.* (2009)[16]	USA, 3 years	94 patients receiving home NHD (mean 5.7 days per week)	940 patients in USRDS	HR 0.36 (95% CI 0.22–0.61); $P<0.001$
Johansen *et al.* (2009)[16]	USA, 3 years	43 patients receiving SDHD (mean 5.4 days per week)	430 patients in USRDS	HR 0.64 (95% CI 0.31–1.31); $P=$NS
Marshall *et al.* (2011)[15]	Australia and New Zealand, 72,052 patient-years	Inception cohort of incident dialysis patients, of whom 865 were receiving frequent or extended HHD	21,184 patients included in Australian and New Zealand registry	HR 0.53 (95% CI 0.41–0.68); $P<0.05$ Per protocol
Lockridge & Kjellstrand (2011)[17]	USA, 287 patient-years	87 patients receiving home NHD (mean 40 ± 6 h per week)	87,121 incident dialysis patients from the 1998 USRDS cohort	SMR 0.53 (95% CI 0.34–0.79); $P=0.005$ Intention to treat
Nesrallah *et al.* (2012)[18]	France, USA, Canada, 3,008 patient-years (median 1.8 years)	338 patients receiving intensive HHD (4.8 sessions per week, of 7.4 h each)	1,388 patients from DOPPS	HR 0.55 (95% CI 0.34–0.87); $P=0.01$ Intention to treat
Weinhandl *et al.* (2012)[19]	USA, mean 1.8 years	1,873 patients receiving daily HHD (5–6 sessions per week)	9,365 patients from USRDS	HR 0.87 (95% CI 0.78–0.97); $P<0.01$ Intention to treat

Adapted from
Tennankore et al: Nature Neph Reviews 2012

Long Interdialytic Interval and Mortality among Patients Receiving Hemodialysis

Robert N. Foley, M.B., David T. Gilbertson, Ph.D., Thomas Murray, M.S., and Allan J. Collins, M.D.

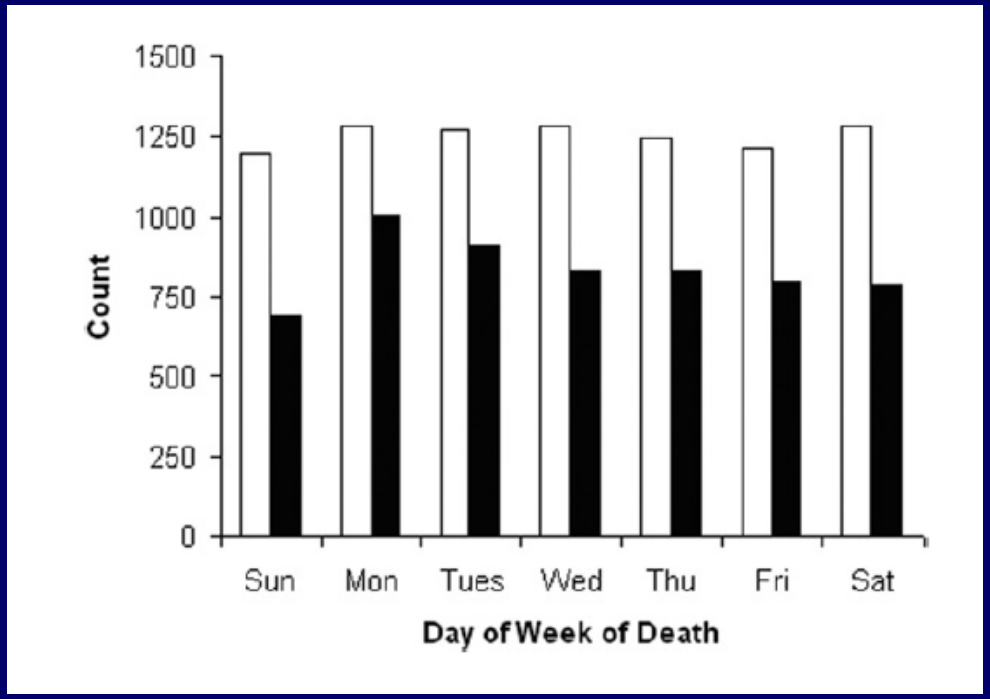




Foley et al – NEJM 2011

Daily Variation in Death in Patients Treated by Long-term Dialysis: Comparison of In-Center Hemodialysis to Peritoneal and Home Hemodialysis

Rathika Krishnasamy, MD,[1,2] Sunil V. Badve, MD,[1,2] Carmel M. Hawley, M Med Sci,[1,2] Stephen P. McDonald, PhD,[1,3] Neil Boudville, M Med Sci,[1,4] Fiona G. Brown, PhD,[1,5] Kevan R. Polkinghorne, PhD,[1,5] Kym M. Bannister, MD,[1,3] Kathryn J. Wiggins, PhD,[1,6] Philip Clayton, MM Clin Epi,[1,7,8] and David W. Johnson, PhD[1,2]



Conclusions: Daily variation in the pattern of cardiac deaths was observed in HD patients receiving 3 or fewer dialysis sessions per week, but not in PD, home HD, and HD patients receiving more than 3 sessions per week.

Survival among nocturnal home haemodialysis patients compared to kidney transplant recipients

Robert P. Pauly[1], John S. Gill[2], Caren L. Rose[2], Reem A. Asad[3], Anne Chery[4], Andreas Pierratos[5] and Christopher T. Chan[3]

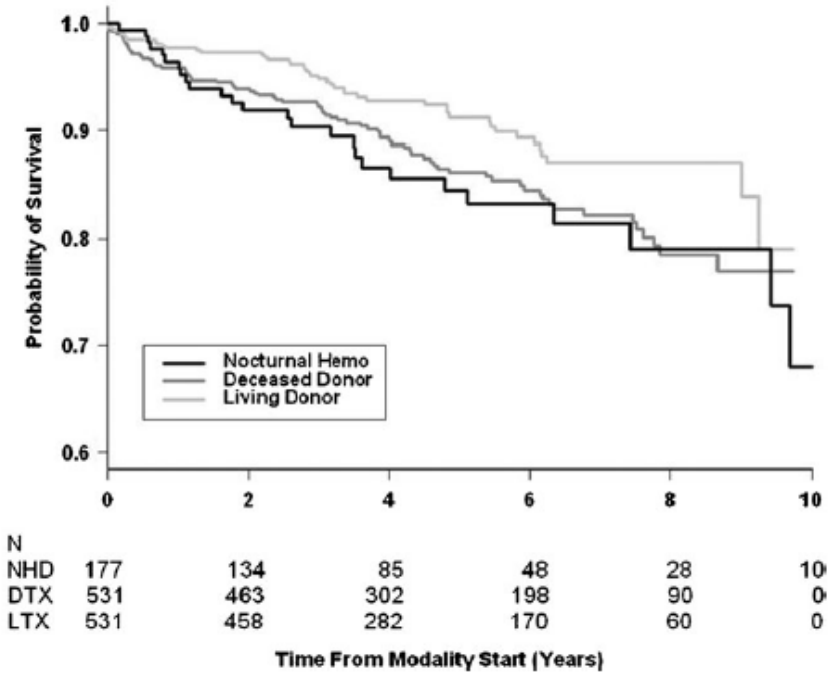


Fig. 1. Time to death in patients treated with nocturnal haemodialysis, deceased and living donor kidney transplantation (log-rank test, $P = 0.03$).

Table 3. Association of treatment modality with death

	HR[a]	95% confidence interval	*P*-value
NHD (Reference group)	1		
DTX	0.87	0.50, 1.51	0.61
LTX	0.51	0.28, 0.91	0.02

Pauly et al. NDT 2009

Survival data suggest:

- Frequent HD is better than in-center HD
- BUT:
  - Not all frequent HD is equal
  - Intermittency of HD OR Frequency of HD?
  - Renal Tx versus Intensive HD
    - Better inform patient → choice

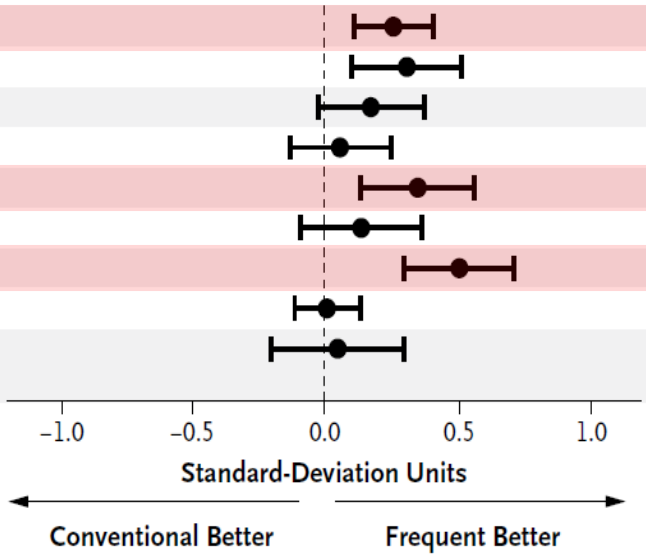
The NEW ENGLAND JOURNAL of MEDICINE

In-Center Hemodialysis Six Times per Week versus Three Times per Week

The FHN Trial Group*

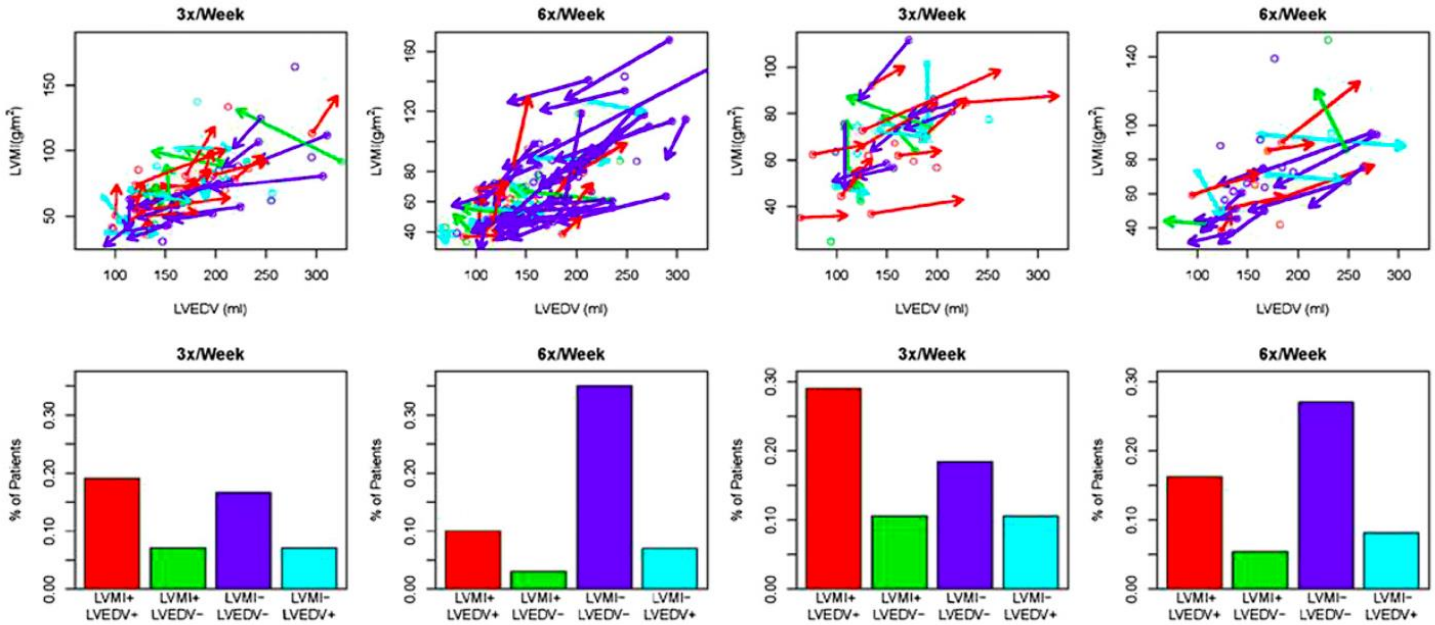
C Main Secondary Outcomes

Outcome	Effect Measure
LV mass	Mean decrease
Physical-health composite score	Mean increase
Beck Depression Inventory score	Mean decrease
Predialysis albumin	Mean increase
Predialysis phosphorus	Mean decrease
ESA dose	Mean decrease in log
Predialysis systolic blood pressure	Mean decrease
Trail Making Test Part B	Negative log relative risk
Death or hospitalization unrelated to vascular access	Negative log hazard ratio



Effects of Frequent Hemodialysis on Ventricular Volumes and Left Ventricular Remodeling

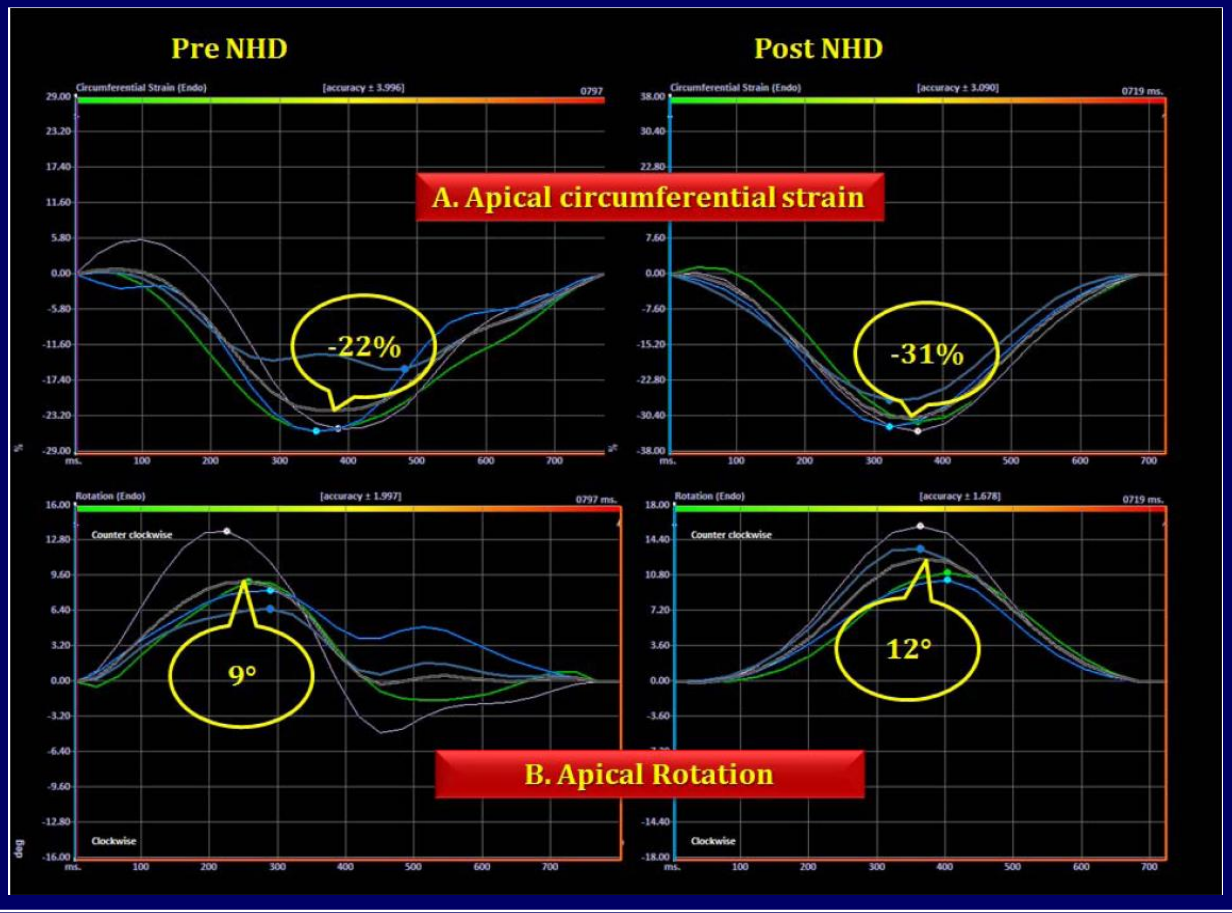
Christopher T. Chan, Tom Greene,† Glenn M. Chertow,‡ Alan S. Kliger,§ John B. Stokes,‖ Gerald J. Beck,¶ John T. Daugirdas,** Peter Kotanko,†† Brett Larive,¶ Nathan W. Levin,†† Ravindra L. Mehta,‡‡ Michael Rocco,§§ Javier Sanz,‖‖ Phillip C. Yang,‡ Sanjay Rajagopalan,¶¶ and the Frequent Hemodialysis Network Trial Group*



Chan et al CJASN 2013

Impact of Frequent Nocturnal Hemodialysis on Myocardial Mechanics and Cardiomyocyte Gene Expression

Christopher T. Chan, MD; Sara Arab, PhD; Shemy Carasso, MD; Gil Moravsky, MD; Guo Hua Li, PhD; Peter P. Liu, MD*; Harry Rakowski, MD*



Chan et al – Circ (CVS Imaging) 2012

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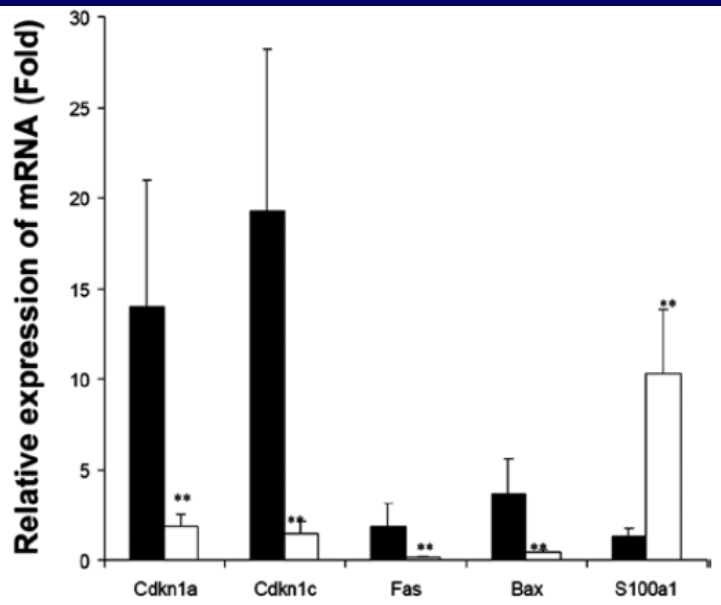


Figure 2. Real-time quantitative polymerase chain reaction confirmation of cardiomyocyte gene signature before and after conversion from conventional to nocturnal hemodialysis. Black bar indicates conventional hemodialysis. White bar indicates nocturnal hemodialysis. $^{**}P<0.05$ between conventional hemodialysis and nocturnal hemodialysis. *Cdkn1a* indicates cyclin-dependent kinase inhibitor 1A; *Cdkn1c*, cyclin-dependent kinase inhibitor 1C; *Bax*, Bcl2-associated X protein; *S100a1*, S 100 calcium binding protein A1.

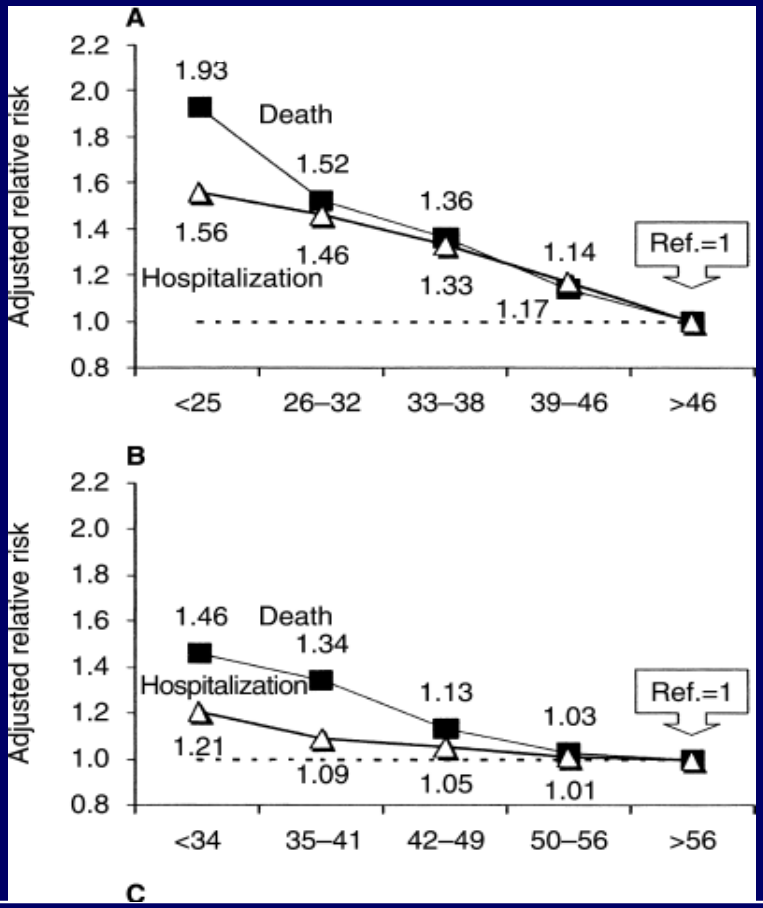
CVS data

- Frequent HD
  - BP control
  - LV mass decreases
- ALSO: STRUCTURE AND FUNCTION
- FHN Biomarker Study:

  Surrogate Marker

  Biology → ? Uremia → Accelerated Ageing

Why Do We Care About Quality of Life (Q of L)?

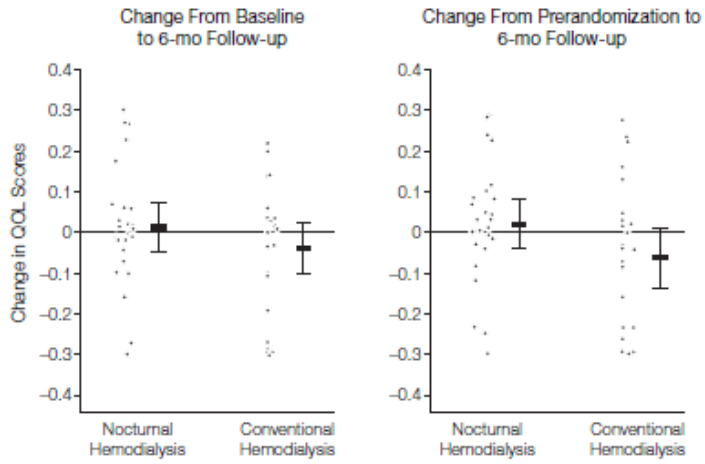


- DOPPS data base
- lower Q of L values associated with more hospitalization and death
- applies to both physical and mental components
- “adjusted” for co-morbidities

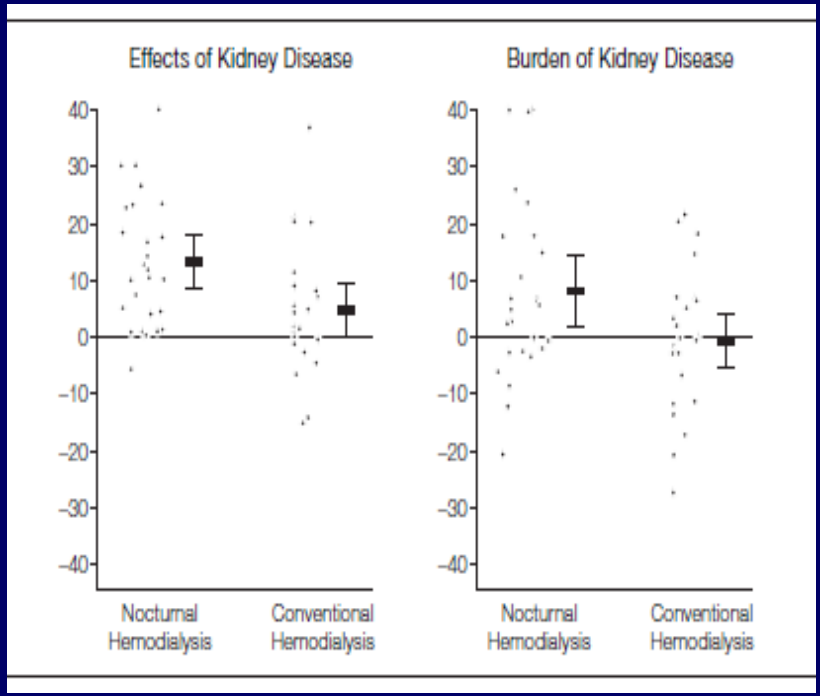
Mapes et al Kidney Int 2003

QOL Changes: Results From AKDN

Figure 2. Change in Quality-of-Life Scores (EuroQol-5D Index) by Intent-to-Treat Analysis



The horizontal bars indicate mean change and error bars indicate 95% confidence intervals (CIs). Quality-of-life (QoL) scores at baseline were −0.003 (−0.10 to 0.096) for nocturnal hemodialysis patients and −0.05 (−0.12 to 0.02) for conventional hemodialysis patients. Values at prerandomization were 0.683 (95% CI, 0.579-0.786) for nocturnal hemodialysis patients and 0.705 (95% CI, 0.611-0.800) for conventional hemodialysis patients.



JAMA. 2007;298(11):1291-1299

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In-Center Hemodialysis Six Times per Week versus Three Times per Week

The FHN Trial Group*

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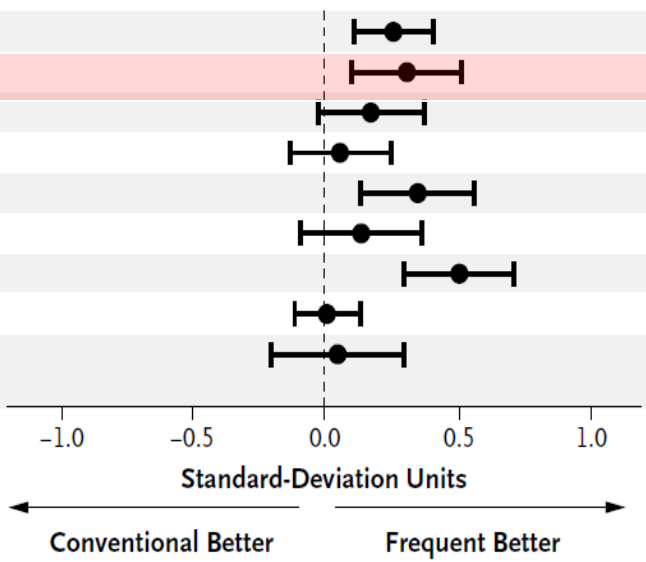
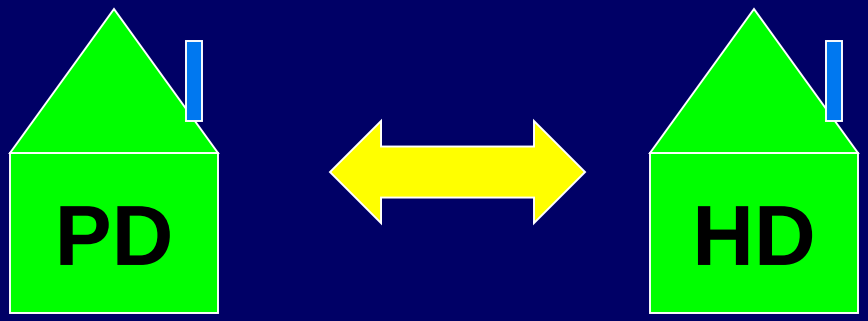


An Unanswered Question… Home vs Home

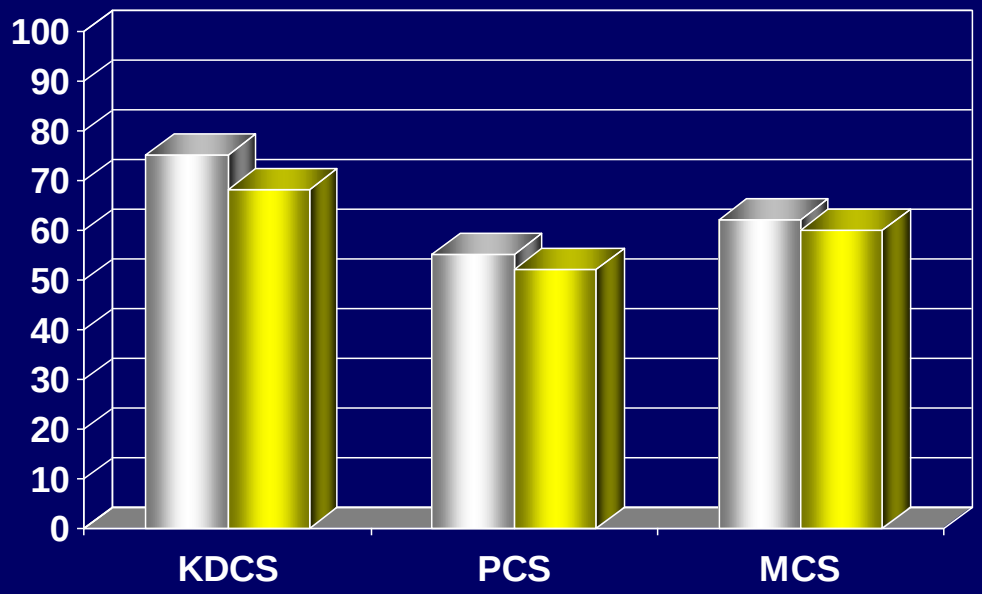
- Are there differences in Quality of Life between Home PD and Home Hemodialysis?



Quality of Life: The Toronto Study NHD vs PD

- patients on NHD or PD a minimum of 3 months
- English-speaking
- no recent acute illnesses or hospitalizations
- unbiased interviewer not associated with either program

Quality of Life: Component Scores



p = NS

NHD vs PD: Illness Intrusiveness

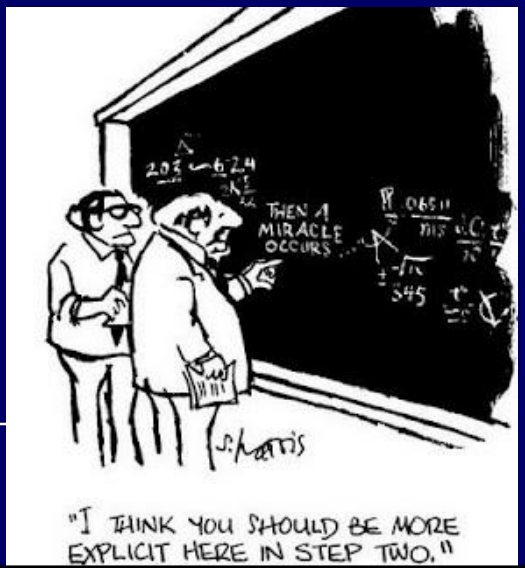
Variable	NHD	PD	P value
Physical wellbeing and diet	3.81 ± .30	3.98 ± .20	NS
Work and finance	3.77 ± .35	3.3 ± 1.64	NS
Marital/sexual/family	3.32 ± .31	2.78 ± .22	NS
Recreation and social relations	3.23 ± .28	3.11 ± .18	NS
Other aspects of life	2.46 ±.25	2.47 ± .20	NS

Pregnancy Outcomes

Table 1. Pregnancy outcomes[a]

	Number of Weeks at Delivery	Mode of Delivery	Baby's Birth Weight (g)	Baby's APGAR Scores at 1 and 5 min
Patient 1	36	C/S	2020	9/9
Patient 2: Pregnancy 1	38	SVD	3000	5/8
Patient 2: Pregnancy 2	37^{4}	SVD	2785	9/9
Patient 3	36^{5}	Induced labor, vacuum extraction	2690	6/9
Patient 4	38^{5}	C/S	2750	8/9
Patient 5	30	SVD	1260	5/7

[a]C/S, cesarean section; SVD, spontaneous vaginal delivery. Superscript numerals indicate days.



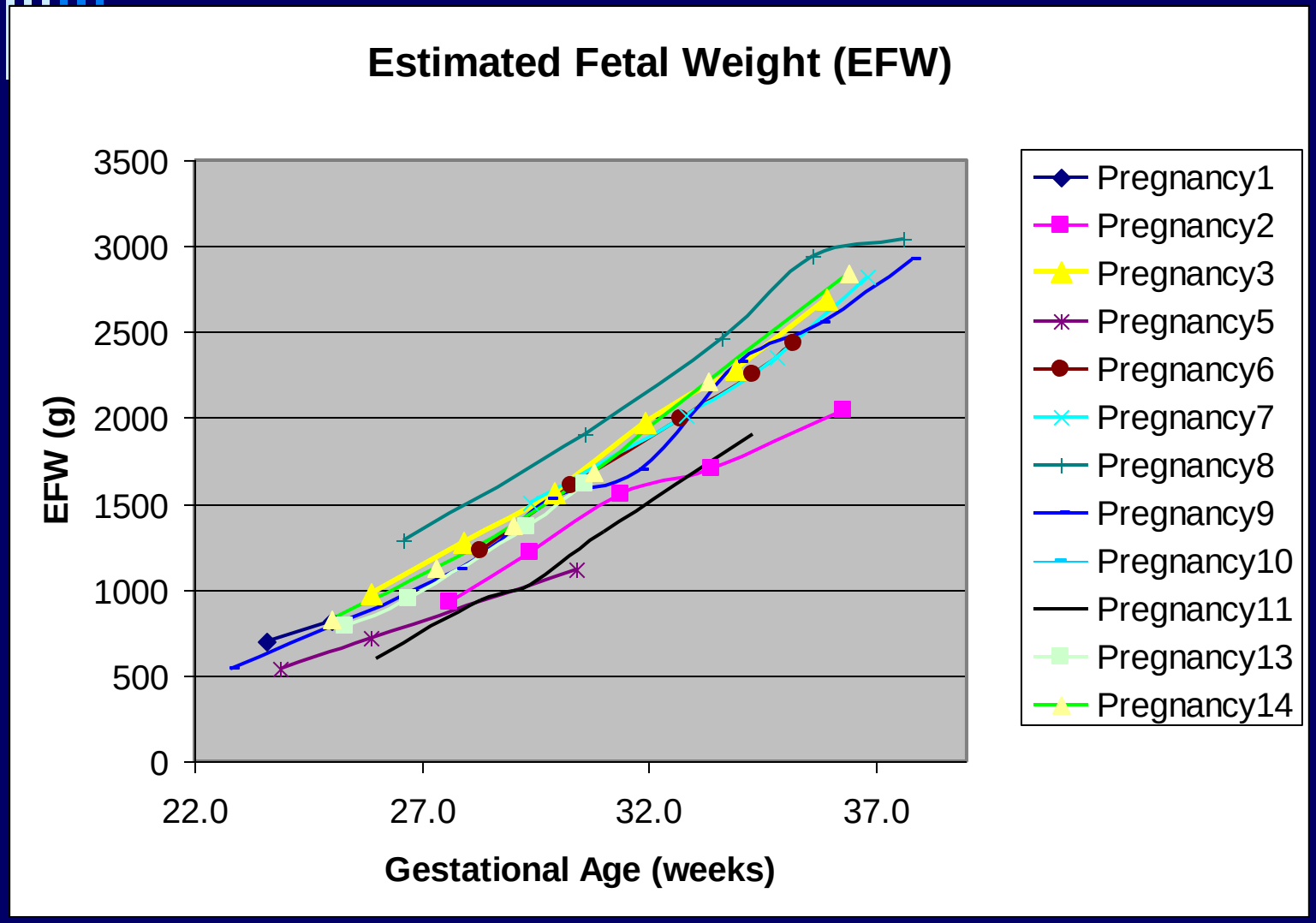
Barua M et al. Successful Pregnancies on Nocturnal Home Hemodialysis. Clin J Am Soc Nephrol 2008 Mar;3(2):392-6

Pregnancy Outcomes

TABLE 1. Incidence and outcome of pregnancy in women on chronic HD

Reference	Year	No. of pregnancies/no. of women	Incidence of pregnancy	Surviving infants	Neonatal deaths	Spontaneous abortion
3	1992	27/380	7%	30%	—	—
4	1994	58/1281	1.5%	37%	5%	44%
5	1998	184/6230	2.2%	40%	3%	46%
6	1998	15/1472	1%	50%	13%	—
7	1999[a]	172/5000	3.4%	49%	5%	12%
8	2002	18	—	50%	17%	—

[a]Detailed information on 74 pregnancies.
—, not reported.


Estimated Fetal Weight (EFW)
EFW (g)
3500
3000
2500
2000
1500
1000
500
0
22.0
27.0
32.0
37.0
Gestational Age (weeks)
Pregnancy1
Pregnancy2
Pregnancy3
Pregnancy5
Pregnancy6
Pregnancy7
Pregnancy8
Pregnancy9
Pregnancy10
Pregnancy11
Pregnancy13
Pregnancy14

Buttonhole

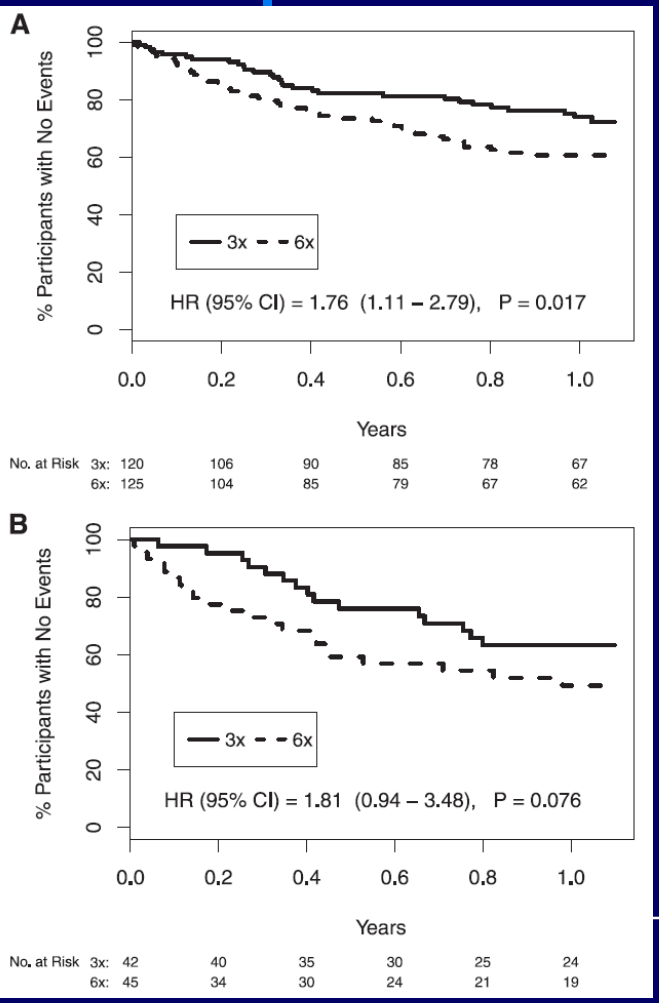
- AKA “Constant-site cannulation”
- Described in 1977 (Hospital for Miners, Poland)

- Cannulation:
  - Same spot
  - Same angle
  - Same depth
  - EVERY TIME

Scar tissue tunnel tract develops

Risk of Vascular Access Complications with Frequent Hemodialysis

Rita S. Suri,* Brett Larive,† Susan Sherer,† Paul Eggers,‡ Jennifer Gassman,† Sam H. James,§ Robert M. Lindsay,* Robert S. Lockridge,‖ Daniel B. Ornt,¶ Michael V. Rocco,** George O. Ting,†† Alan S. Kliger,‡‡ and the Frequent Hemodialysis Network Trial Group



Variable	Daily Trial			Nocturnal Trial		
	Conventional	Daily	HR (95% CI)	Conventional	Nocturnal	HR (95% CI)
AVF/AVG[a]						
Patients (*n*)	106 (79/28)[b]	114 (90/28)[b]		28 (23/6)[b]	32 (29/3)[b]	
Total follow-up (yr)	87.9 (67.1/20.8)	95.8 (76.9/18.9)		24.2 (18.8/5.4)	24.3 (22.0/2.3)	
Repairs						
Angioplasty	21 (11/10)	28 (14/14)		5 (3/2)	14 (13/1)	
Stent placement	2 (2/0)	2 (1/1)		0 (0/0)	0 (0/0)	
Thrombectomy	10 (3/7)	22 (5/17)		1 (0/1)	2 (1/1)	
Surgical revision	5 (3/2)	14 (7/7)		1 (1/0)	0 (0/0)	
Overall rate (per 100 patient-yr)	43	69	1.68 (1.13–2.51) *P*=0.011	29	66	2.29 (0.94–5.59) *P*=0.069

J Am Soc Nephrol 24: , 2013. doi: 10.1681/ASN.2012060595

Integrated Home Dialysis

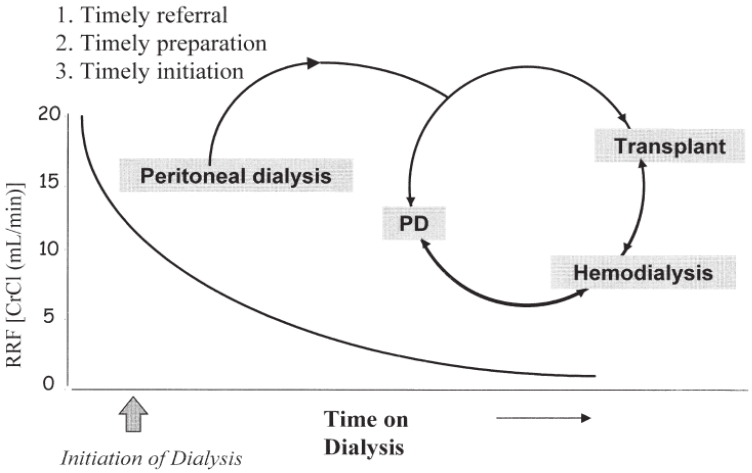


Figure 1 — The integrated care concept [based on Refs. (1), (3), and (4)].

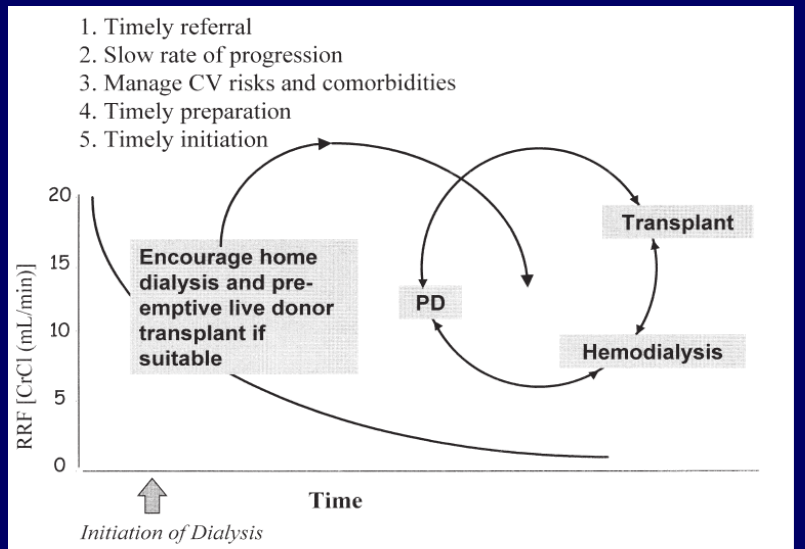
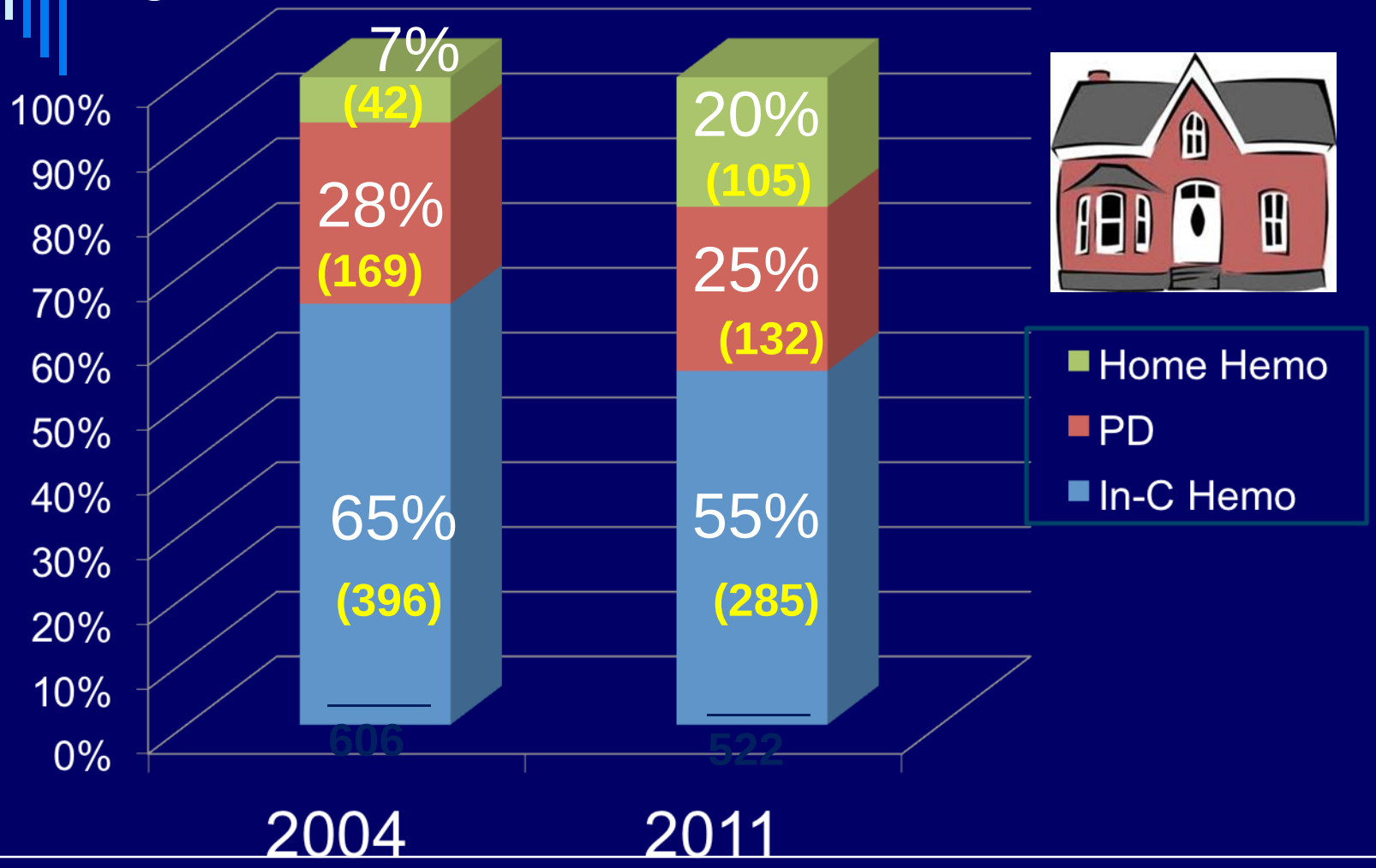


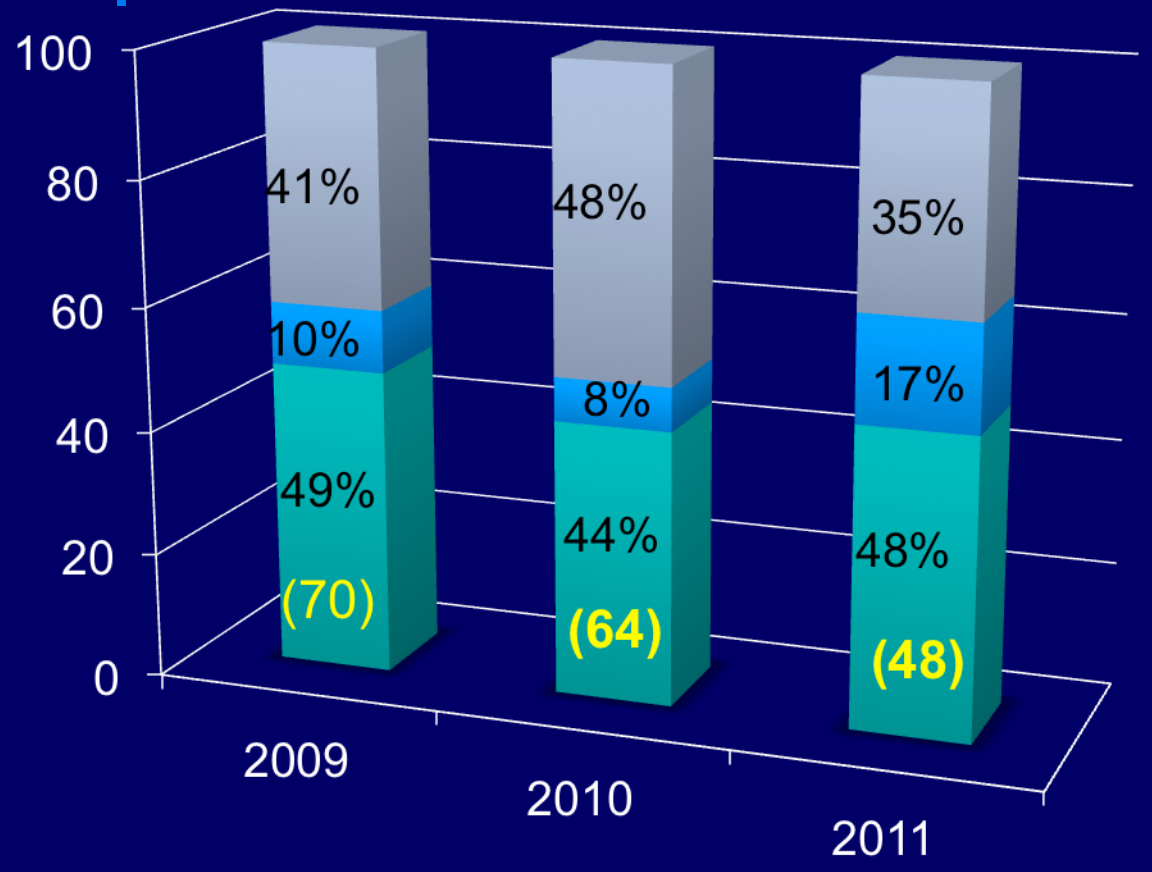
Figure 2 — A broader concept of integrated care.

MENDELSSOHN and PIERRATOS, PDI 2002

Prevalent UHN Patients 2004 - 2011

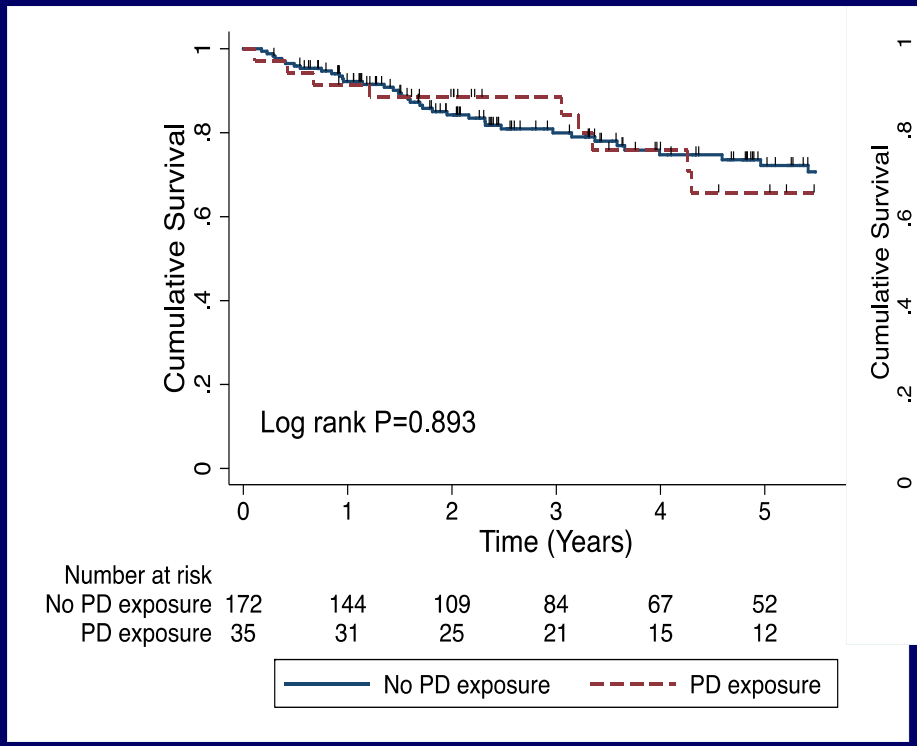


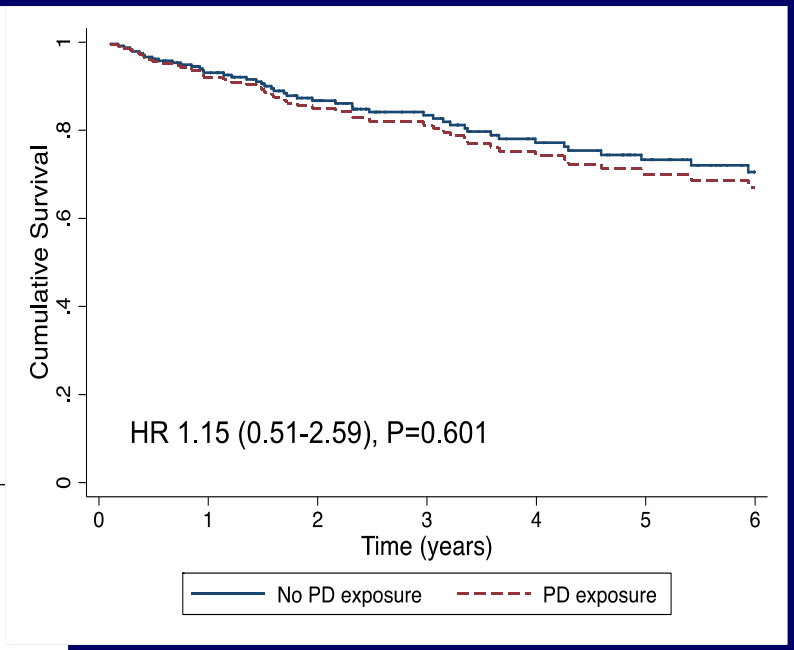
RMC Exits to Dialysis



PD
Home Hemo
Incenter Hemo

Cumulative patient and technique survival : Integrated Home Dialysis System





Nadeau-Fredette et al – PDI in press

Strategies to Enhance Home Dialysis Technique Survival

- HHD
- Training Quality
- CQI – Adverse Events
- Intervention to address High risk Home Dialysis Patients
- PD
- Assisted PD
- Bio-compaitable solutions
- Intervention to address High risk Home Dialysis Patients

Determinants of training and technique failure in home hemodialysis

Michael E. SCHACHTER,* Karthik K. TENNANKORE,* Christopher T. CHAN
Division of Nephrology, Department of Medicine, University Health Network, Toronto, Ontario, Canada

Table 2 Social and dialysis-associated factors among incident home hemodialysis patients

Characteristic	Failure ($n = 32$)	Success ($n = 145$)	P value
Social factors			
College/university education, *n* (%)	21 (68)	88 (61)	0.55
Renting current residence, *n* (%)	13 (41)	31 (21)	0.04
Living alone or with dependents, *n* (%)	9 (28)	26 (18)	0.22
Distance from HHD training unit, (median km, IQR)	19 (9–37)	22 (11–45)	0.18
Dialysis factors			
Nephrology follow-up before start of HHD, *n* (%)	27 (84)	140 (97)	0.02
Central venous catheter dialysis access, *n* (%)	22 (69)	71 (49)	0.05
RRT vintage, (median years, IQR)	0.8, 0–8.0	1.5, 0–12.0	0.71
Capacity to perform HHD independently, *n* (%)	26 (81)	101 (70)	0.28

HHD = home hemodialysis; IQR = interquartile range; RRT = renal replacement therapy.

Procedure-Related Serious Adverse Events Among Home Hemodialysis Patients: A Quality Assurance Perspective

Ben Wong, MD,[1] Deborah Zimmerman, MD,[2] Frances Reintjes, BScN,[3] Mark Courtney, MD,[1] Scott Klarenbach, MD,[1] Graeme Dowling, MD,[4] and Robert P. Pauly, MD, MSc, FRCPC[1]

Table 2. Causes of Adverse Events

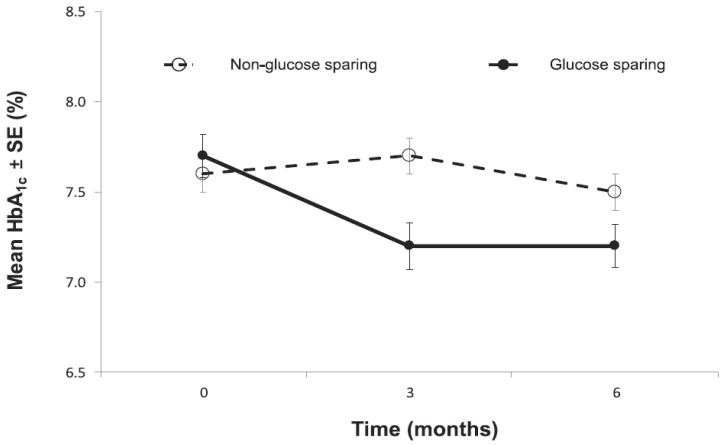
Case No.	Human Error(s) or Machine/ Disposable Defects	Immediate Cause of Adverse Event	Details
1	Human error	Blood loss	Ignored machine alarms; improper threading of connections; placement of wetness detectors in incorrect position
2	Human error	Air embolism	Neglected to clamp CVC
3	Possible human error, possible disposable defect	Blood loss	Possible failed integrity of cap; possibly did not correctly thread connections
4	Possible human error, possible disposable defect	Blood loss	Improper placement of clamp; failed integrity of cap
5	Human error	Blood loss	Improper machine setup; neglected to use wetness detectors
6	Human error	Blood loss	Improper threading of connections; placement of wetness detector in incorrect position
7	Human error	Blood loss	Did not follow machine setup protocol specific to local home HD program

Abbreviations: CVC, central venous catheter; HD, hemodialysis.

Wong et al AJKD 2013

Randomized, Controlled Trial of Glucose-Sparing Peritoneal Dialysis in Diabetic Patients

Philip K.T. Li,* Bruce F. Culleton,† Amaury Ariza,‡ Jun-Young Do,§ David W. Johnson,‖ Mauricio Sanabria,† Ty R. Shockley,† Ken Story,† Andrey Vatazin,¶ Mauro Verrelli,** Alex W. Yu,†† and Joanne M. Bargman,‡‡ *on behalf of the IMPENDIA and EDEN Study Groups*



Subjects			
Non-glucose sparing	125	107	118
Glucose sparing	119	86	99

Figure 2. Mean hemoglobin A_{1c} (±SEM) at baseline, month 3, and end of study by treatment group in the intention-to-treat population. HbA1c, hemoglobin A_{1c}.

Variable	All Adverse Events, *n* (Related Adverse Events, *n*)[a]		Serious Adverse Events, *n* (Related Serious Adverse Events, *n*)[a]	
	Control Group (*n*=127)	Intervention Group (*n*=124)	Control Group (*n*=127)	Intervention Group (*n*=124)
Total	345[b] (14)	373[b] (34)	78[c] (4)	105[c] (5)
Number of patients with any adverse event or serious adverse event (% of total group sample)	101[b] (80)	98[b] (79)	41[c] (32)	58[c] (47)

IMPENDIA, Improved Metabolic Control of Physioneal, Extraneal, Nutrineal versus Dianeal Only in DIAbetic continuous ambulatory peritoneal dialysis and automated peritoneal dialysis Patients; EDEN, Evaluation of Dianeal, Extraneal and Nutrineal versus Dianeal only in Diabetic CAPD Patients; PTH, parathyroid hormone.

[a]Relatedness was judged by the clinical trial site investigator. The numbers of related events are shown in brackets.

[b]P=0.15 for difference between groups in adverse event rate; P=0.92 for difference between groups in the number of patients with an adverse event.

[c]P=0.06 for difference between groups in serious adverse event rate; P=0.02 for difference between groups in number of patients with a serious adverse event.

Li et al JASN 2013

Is Assisted Peritoneal Dialysis Associated with Technique Survival When Competing Events Are Considered?

Thierry Lobbedez, Christian Verger,† Jean-Philippe Ryckelynck,* Emmanuel Fabre,† and David Evans†‡§*

Table 6. Cause-specific relative hazard and subdistribution relative hazard associated with assisted PD (event of interest: transfer to hemodialysis)

Assistance	Cause-Specific RH (95% CI)				Subdistribution RH for HD (95% CI)
	Death	Recovery	Transplantation	HD	
Family-assisted PD (reference group: nurse and self-care PD)	2.23 (1.97–2.53)	0.72 (0.40–1.31)	0.33 (0.24–0.46)	0.87 (0.75–1.01)	0.81 (0.70–0.94)
Nurse-assisted PD (reference group: family and self-care)	2.18 (1.96–2.42)	0.74 (0.48–1.13)	0.16 (0.12–0.22)	0.85 (0.76–0.95)	0.72 (0.63–0.81)
Assisted PD (reference group: self-care PD)	2.19 (1.98–2.43)	0.73 (0.49–1.10)	0.21 (0.17–0.26)	0.85 (0.77–0.95)	0.73 (0.65–0.81)

Adjusted for age, sex, modified Charlson comorbidity index, underlying nephropathy, failed transplantation, transfer to hemodialysis, early peritonitis, and center size. RH, relative hazard; CI, confidence interval; HD, hemodialysis; PD, peritoneal dialysis.

Lobbedez et al CJASN 2012

The Feasibility of Caregiver-Assisted Home Nocturnal Hemodialysis

Karthik K. Tennankore S. Joseph Kim Christopher T. Chan

University Health Network/Toronto General Hospital, University of Toronto, Toronto, Ont., Canada

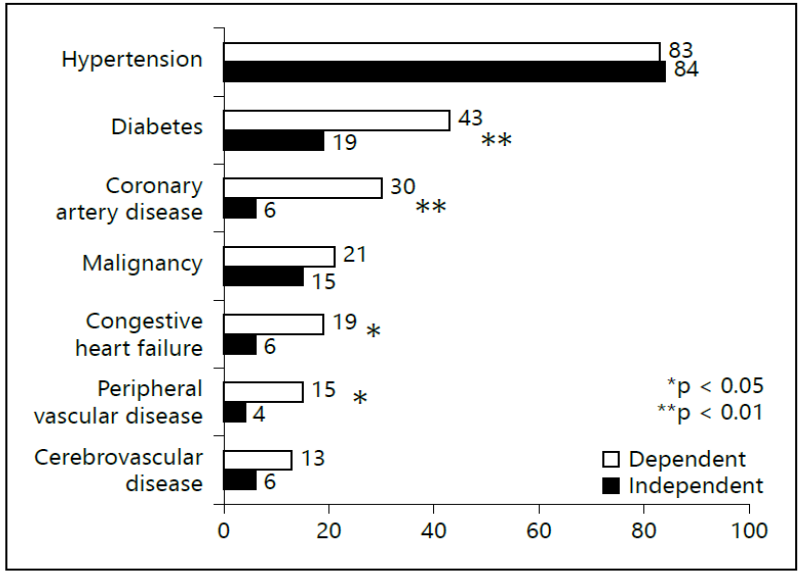
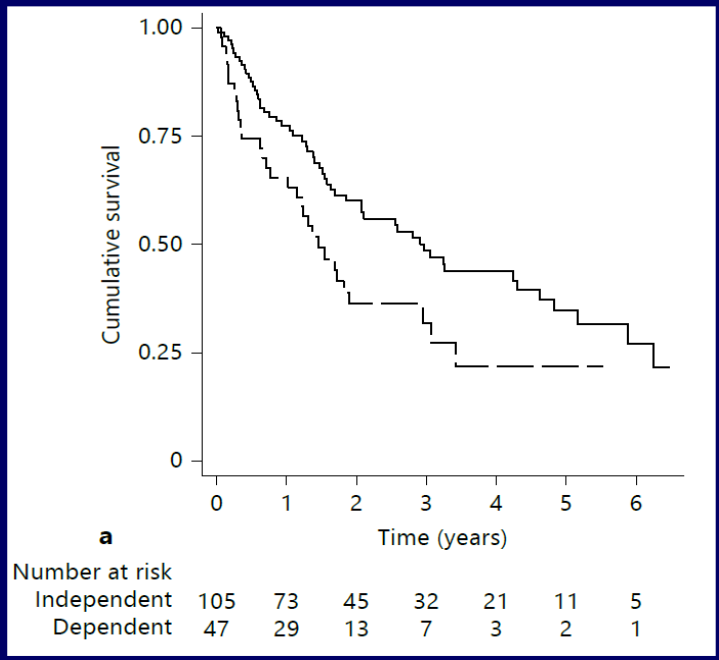


Fig. 2. Baseline comorbidities stratified by dependency status.



Canadian Home Dialysis Virtual Ward Team

- Multisite Study (Funded through Baxter CEC grant program)
- Protcolised Telephone F/U
- High Risk Patients during transition from care
  - Graduating from training
  - Use of antibiotics
  - AV access instrumentation
  - Hospitalization

Other important considerations…

PD PPS

Peritoneal Dialysis Outcomes and Practice Patterns Study

RESEARCH ARTICLE Open Access

Choosing to live with home dialysis-patients' experiences and potential for telemedicine support: a qualitative study

Ellen Rygh[1*], Eli Arild[1], Elin Johnsen[1] and Markus Rumpsfeld[2]

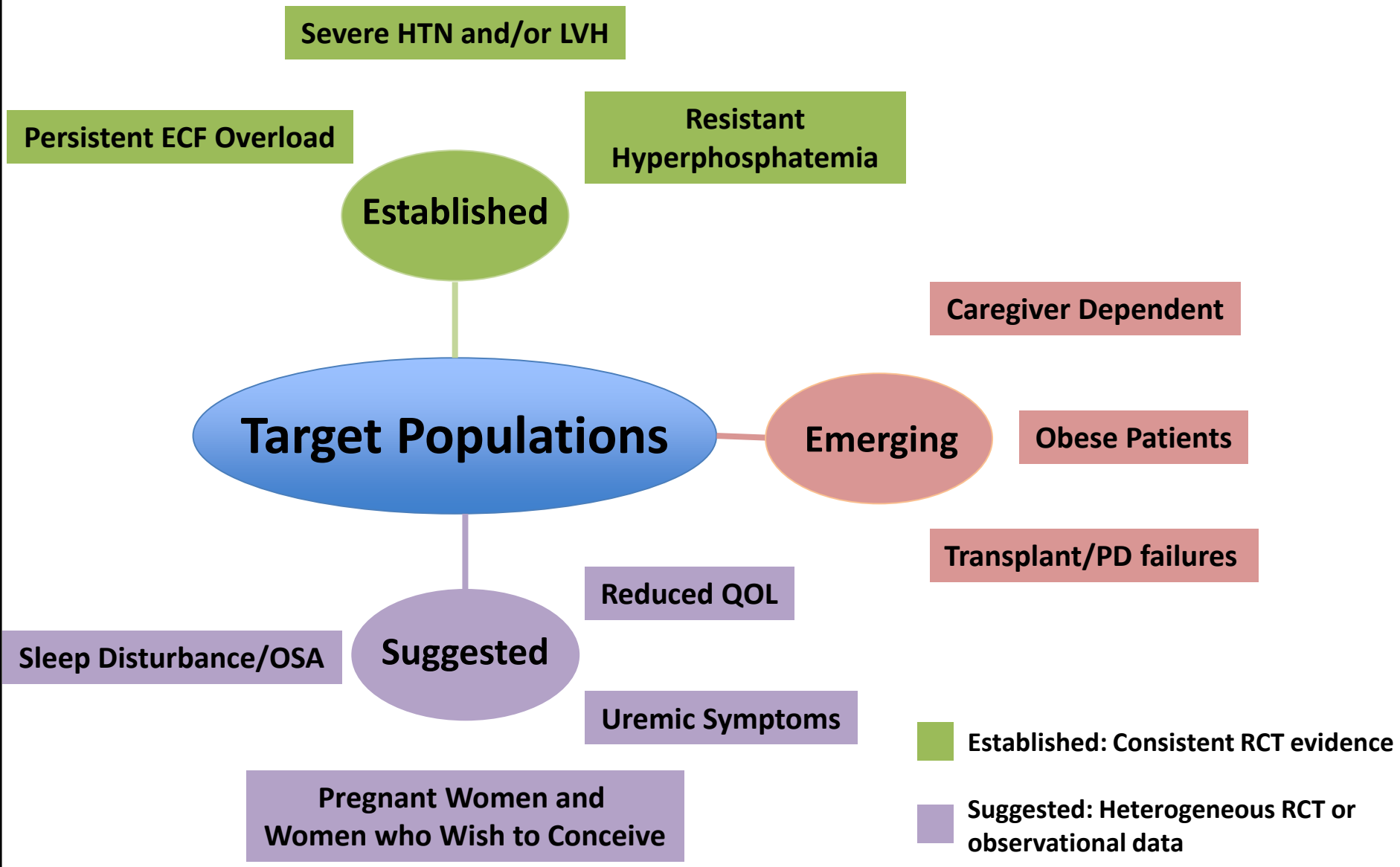


Figure 1. Established, suggested and emerging patient groups to whom IHHD may be considered

Summary

- There is a resurgence of interest in Home Dialysis
- Data suggest that augmented hemodialysis modifies
  - Survival
  - CVS outcomes
  - Pregnancy outcomes
- Adverse signal
  - Dialysis access
- Integrated Home Dialysis System
  - Education
  - Telehealth Strategies

Acknowledgments

- Human Cardiovascular Physiology Group
  - JS Floras
- Sleep Medicine
  - D Bradley
- Stem Cell Group
  - S Verma
  - H Messner
- Cardiovascular Genomics
  - Peter Liu
- Myocardial Mechanics
  - Harry Rakowski
- E-Health Group
  - J Cafazzo

GRANTING AGENCIES

- CIHR, HSFO, BUL – Medicine, PSI, Baxter Extramural Grant Program,Baxter CEC Program NIDDK

- FHN Consortium
- ACTIVE Consortium