Peritoneal Dialysis for Acute Kidney Injury

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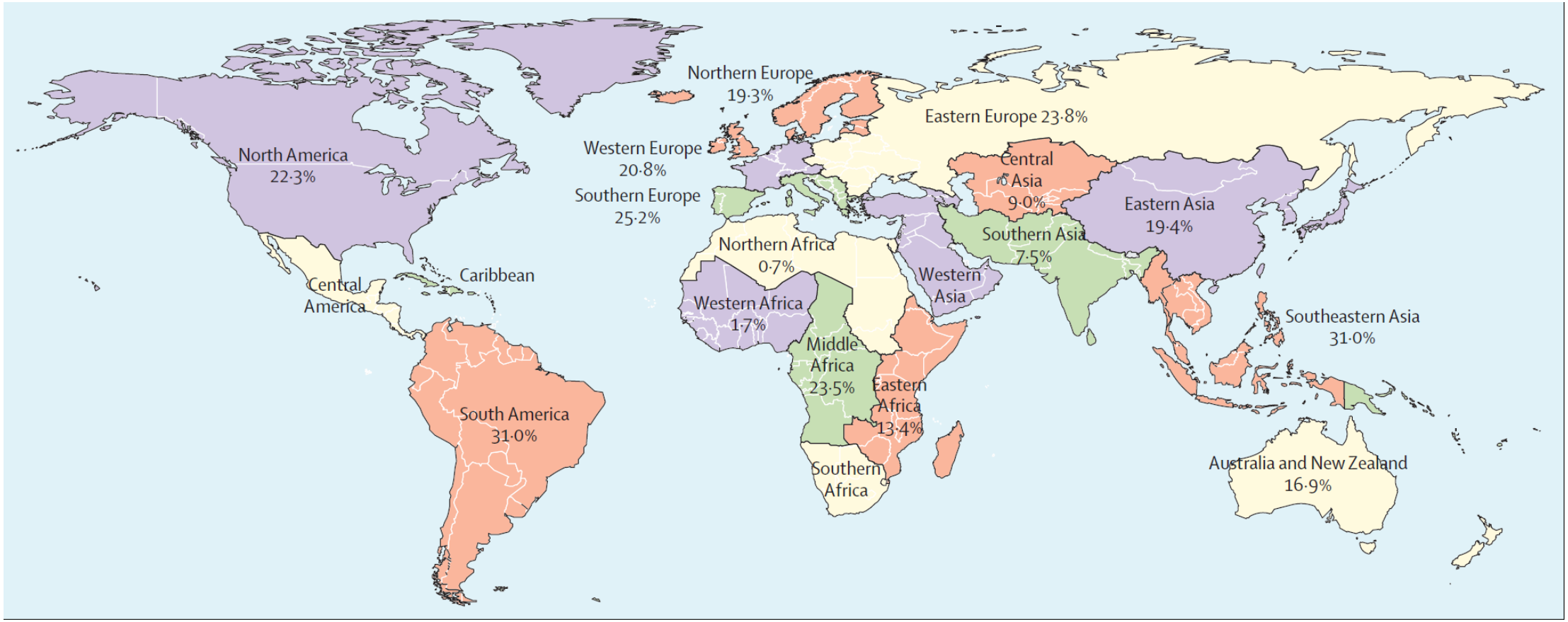
Outline

- Overview of global variation in the use of peritoneal dialysis for acute kidney injury
- Overview of potential advantages of acute peritoneal dialysis
- Overview of concerns resulting in underutilization of acute peritoneal dialysis
- Review of outcome data on acute peritoneal dialysis
- Review of acute peritoneal dialysis in refractory heart failure

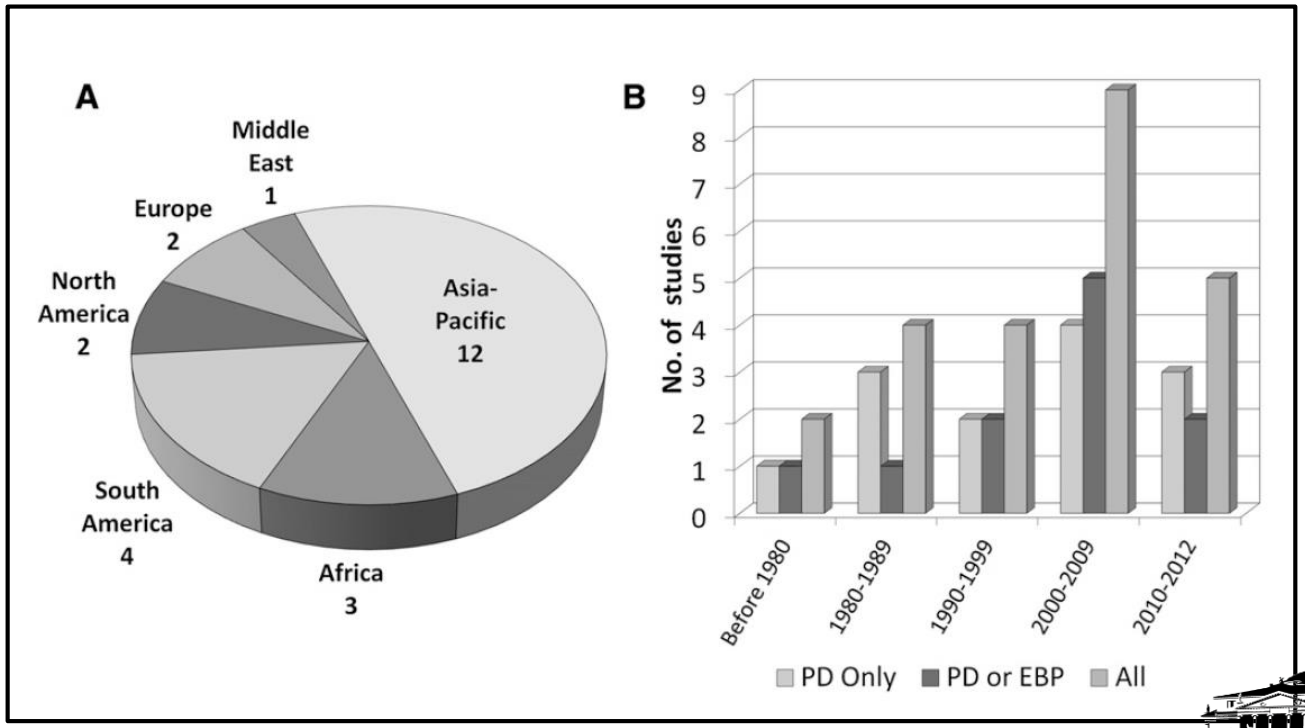
Worldwide Epidemiology of AKI



Lancet 2015;385:2616-2643

Epidemiology of Acute Peritoneal Dialysis Data

- Geographic distribution of studies describing outcomes in AKI treated with PD
  - Only 5 studies from high income areas
  - Most data published after 2000



Clin J Am Soc Nephrol 2013;8:1649-1660

Advantages and Disadvantages

Advantages	Disadvantages
Technically simple	Contraindicated in recent abdominal surgery
Less infrastructure	Requires intact peritoneal cavity
Cost effective	May not be effective in severe acute pulmonary edema / hyperkalemia
Avoids vascular access	Peritonitis can occur
Biocompatible	Clearance and ultrafiltration unpredictable
Continuous renal replacement therapy	Concerns for hyperglycemia
Hemodynamic stability	Concerns for impaired respiratory mechanics
Gradual solute removal	Concerns for protein loss

Semin Nephrol 2017;37(1):103-113

Several questions have been raised

- Is there a mortality difference between acute PD and extracorporeal therapies?
- Is there a difference in renal recovery between modalities?
- What should be the prescribed dialysis dose?
- Are infection rates different?
- Cost and economic implications

Acute PD in Critical Illness

HEMOFILTRATION AND PERITONEAL DIALYSIS IN INFECTION-ASSOCIATED ACUTE RENAL FAILURE IN VIETNAM

- RCT to assess efficacy and safety of acute PD in patients with either severe falciparum malaria or sepsis
- Comparison of continuous venovenous hemofiltration and manual acute PD
- Terminated early due to high mortality (47%) in PD patients ($p<0.005$)
- Several caveats
  - Use of rigid catheters, increasing risks of leaks
  - Manual exchanges with open drainage system
  - High rate of culture negative peritonitis

N Engl J Med 2002;347:895-902

Acute PD in Critical Illness

COMPARING CONTINUOUS VENOVENOUS HEMODIAFILTRATION AND PERITONEAL DIALYSIS IN CRITICALLY ILL PATIENTS WITH ACUTE KIDNEY INJURY: A PILOT STUDY

- RCT of CVVHDF (n=25) vs continuous manual PD (n=25)
- Similar mortality rates in both groups; 84% vs 72%
- No difference in composite correction of metabolic parameters
  - Improved correction of acidosis in PD group
  - Faster correction of fluid overload in CVVHDF group

Perit Dial Int 2011;31(4):422-429

Acute PD in Critical Illness

Acute Kidney Injury in Critically Ill Patients: A Prospective Randomized Study of Tidal Peritoneal Dialysis Versus Continuous Renal Replacement Therapy

- RCT investigating outcomes of continuous tidal PD (n=63) vs CVVHDF (n=62)
- Improved survival in tidal PD group (69.8% vs 46.8%, $p<0.01$)
- Improved metabolic control in PD arm
- Shorter duration of ICU stay in PD arm

Ther Apher Dial 2018;22(4):371-379

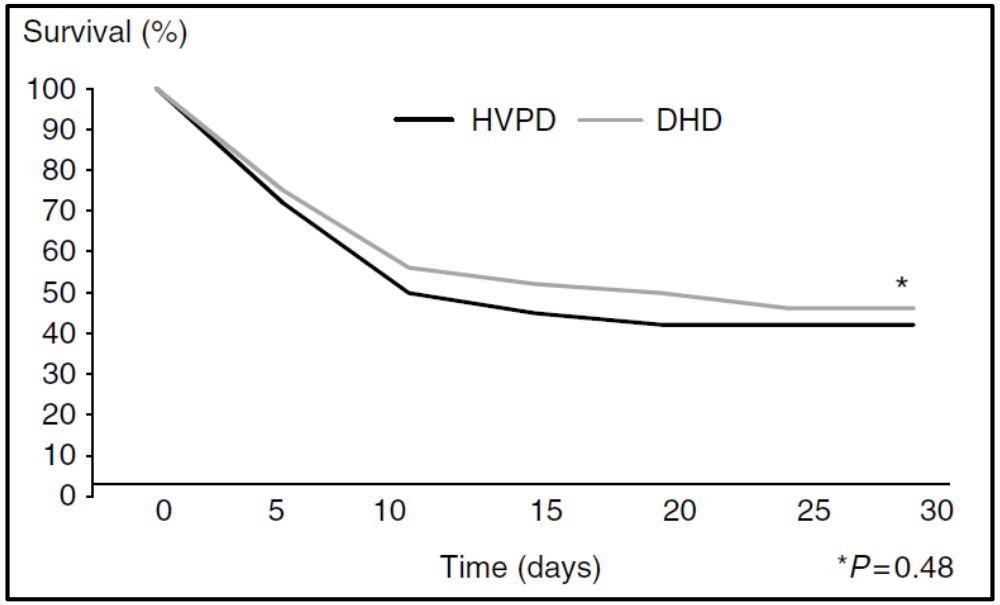
High Volume PD vs Daily Hemodialysis

High volume peritoneal dialysis vs daily hemodialysis: A randomized, controlled trial in patients with acute kidney injury

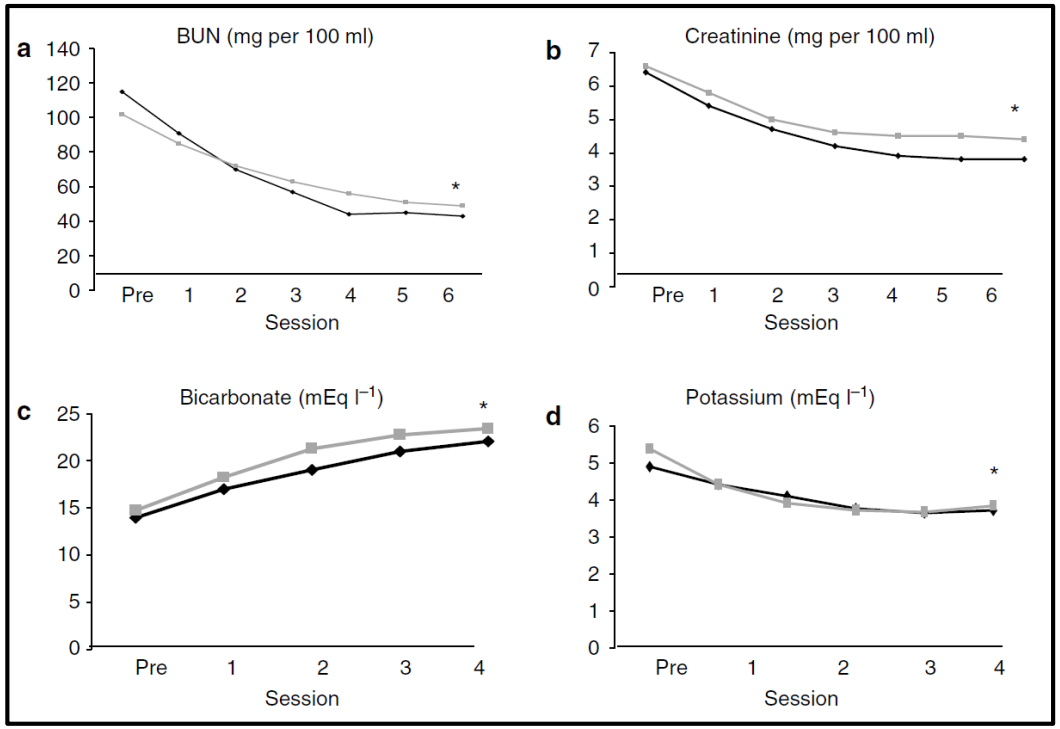
- Patients randomized to receive high volume PD (n=60) vs daily dialysis (n=60)
  - Prescribed Kt/V 0.65 per day (HVPD) and 1.2 per session (HD)
  - CCPD with 35-50 min dwell volume, 7 days a week
  - Daily HD sessions, 6 days per week
  - Higher delivered Kt/V in HD group

Kidney International 2008;73:S87-S93

High Volume PD vs Daily Hemodialysis



Similar overall mortality rates (58% vs 53%, p=0.48)



Similar outcomes in metabolic control
Stabilization of metabolic parameters after same number of dialysis sessions

Kidney International 2008;73:S87-S93

High Volume PD vs Extended Daily Hemodialysis

A randomized clinical trial of high volume peritoneal dialysis versus extended daily hemodialysis for acute kidney injury patients

- Patients randomized to receive high volume PD (n=61) vs extended daily dialysis (n=82)
- Patients in the HD group had higher ultrafiltration and faster metabolic control
- Similar overall mortality (63.9% vs 63.4%, p=0.94)

Int Urol Nephrol 2013;45:869-878

Impact on Renal Recovery

- Few studies have reported rates and time to renal recovery

Acute Kidney Injury in Critically Ill Patients: A Prospective Randomized Study of Tidal Peritoneal Dialysis Versus Continuous Renal Replacement Therapy

- Improved recovery of kidney function in PD arm, as well as shortened time for AKI resolution

Outcome	Group A $N = 62$	Group B $N = 63$	P-value
Infectious complications related to dialysis, N (%)	11 (17.7)	6 (9.5)	0.0084
Time to prepare dialysis access and initiate dialysis, (min), median (IQR)	35 (30–37)	38 (32–40)	0.2010
Recovery of kidney function, N (%)	22 (35.5)	38 (60.3)	0.0056
Resolution of AKI (days), median (IQR)	8 (7–10)	5 (4–6)	0.0044
ICU stay (days), median (IQR)	19 (13–20)	9 (7–11)	0.0031
Need of chronic dialysis, N (%)	7 (11.3)	6 (9.5)	0.3112
Mortality, N (%)	33 (53.2)	19 (30.2)	0.0028

Ther Apher Dial 2018;22(4):371-379

Impact on Renal Recovery

High volume peritoneal dialysis vs daily hemodialysis: A randomized, controlled trial in patients with acute kidney injury

- Similar rates of renal recovery, shorter time to renal recovery

	HVPD (n=60)	DHD (n=60)	P-value
Mortality (%)	58	53	0.48
Recovery of kidney function (%)	83	77	0.84
Duration of treatment (days)	5.5 ± 2.7	7.5 ± 3.1	0.02
Resolution of AKI (days)	7.2 ± 2.6	10.6 ± 4.7	0.04

Kidney International 2008;73:S87-S93

Impact on Renal Recovery

A randomized clinical trial of high volume peritoneal dialysis versus extended daily hemodialysis for acute kidney injury patients

- No difference in recovery or time to AKI resolution

	EHD ($n = 82$)	HVPD ($n = 61$)	p value
Mortality (%)	63.4	63.9	0.94
Recovery of kidney function (%)	26.9	29.6	0.11
Resolution of AKI (days)	11 (5.7–20)	9 (5.7–19)	0.58
Need for chronic dialysis (%)	9.7	6.5	0.23
Infectious complications related to dialysis method (%)	19.5	16.3	0.21

Int Urol Nephrol 2013;45:869-878

Dose of Dialysis

- Appropriate dose for acute PD is poorly defined
- Studies have reported similar outcomes compared to hemodialysis with delivered Kt/V of 3.6
- Both studies used CCPD with 35-50 min dwell time
- 36-44 liters and 18-22 exchanges per day

Kidney International 2008;73:S87-S93
Int Urol Nephrol 2013;45:869-878

Higher vs Lower Intensity High-Volume PD

- Only 1 RCT has investigated effect of PD dose on outcomes in AKI
  - 30 patients in high intensity PD (0.8 per session), 31 patients in low intensity (0.5 per session)
  - Delivered doses 0.59 per session and 0.49 per session respectively (p=0.03)
  - Similar mortality rate in both groups
  - Similar rates of renal recovery and time on dialysis
- ISPD guidelines recommend targeting a weekly Kt/V > 2.1
  - 2 liter dwell volume, 2 hour dwell time
  - Approximately 24 liters CAPD per day

Adv Perit Dial 2011;27:118-124
Perit Dial Int 2014; 34(5):494-517

Infectious and Mechanical Complications

- Few studies have reported rates of infectious and mechanical complications, and data has been inconsistent
  - High rates of culture negative peritonitis reported in study using open drainage system
  - Similar rates of peritonitis in high intensity PD vs low intensity PD

N Engl J Med 2002;347:895-902
Adv Perit Dial 2011;27:118-124

Infectious and Mechanical Complications

- Similar rates of peritonitis and blood stream infections in study comparing acute PD to daily hemodialysis, and extended daily hemodialysis
- Decreased rates of catheter infections and catheter change in tidal PD group vs CVVHDF

Kidney International 2008;73:S87-S93
Int Urol Nephrol 2013;45:869-878
Ther Apher Dial 2018;22(4):371-379

Cost and Economic Implications

- Varying data available
  - Cost of hemodialysis equipment vs PD equipment; INR 5000 vs INR 250-300
  - Cost of CCVHDF vs PD disposables; INR 7184 ± 1436 vs INR 3009 $\pm$ 1643 , $p<0.01$
  - Conflicting data from an earlier study; cost per PD survivor $ 6950 vs $ 2080 for CVVHF

Kidney Int 2002;61:747-757
Perit Dial Int 2011;31(4):422-429
N Engl J Med 2002;347:895-902

Cost and Economic Implications

- Cost implications significant for lower income countries
  - Lower costs associated with local production of peritoneal fluid ; varying dextrose percentages injected into bags of Lactated Ringer's
  - Much higher costs associated with commercially available solutions

Peritoneal Ultrafiltration for Refractory Heart Failure

- Diuretic refractory heart failure results in a significant burden of hospital admissions
- High 6 month (>50%) and 1 year (74%) mortality rates
- Peritoneal ultrafiltration has been proposed as treatment of home-based management of refractory heart failure
- Studied in small prospective and cohort studies

N Engl J Med 2003;348(20):2007-2018

Peritoneal Ultrafiltration for Refractory Heart Failure

- Varying regimens have been reported
  - Manual overnight exchange with single icodextrin dwell
  - 2 manual exchanges with overnight icodextrin dwell
  - Overnight automated PD 2-4 nights each week
- Several outcomes studied
  - NYHA functional status
  - Hospitalizations
  - Quality of life
  - Mortality
  - Echocardiographic parameters

Perit Dial Int 2014;34(1):64-70
Nephrol Dial Transplant 2010;25:605-610
Perit Dial Int 2014;34(1):100-108

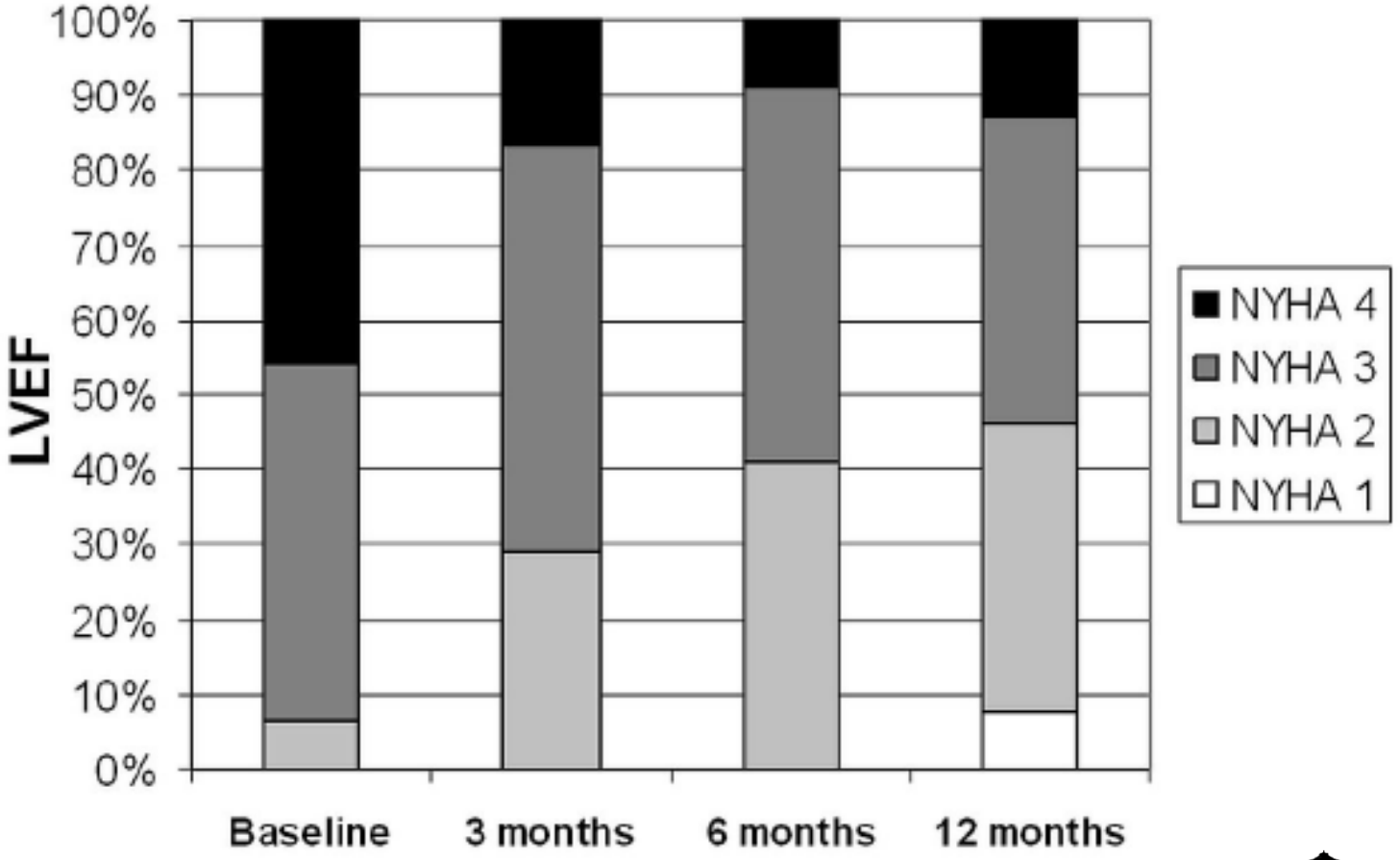
Peritoneal Ultrafiltration for Refractory Heart Failure

- Largest retrospective cohort included 126 patients
  - Decreased body weight during first 3 months of PD initiation (p=0.04)
  - Improved LVEF during first year of therapy (38% ± 19% vs 42% ± 17%)
  - Reduction in HF related hospitalization (3.3 ± 2.6 vs 0.3 ± 0.5 days/month)
  - 1 year mortality 42%
- Similar changes in hospitalization days noted in other studies
  - 62 ± 16 vs 11 ± 5 days/patient/year
  - 43 ± 33 vs 11 ± 17 days/patient-year

Perit Dial Int 2014;34(1):64-70
Nephrol Dial Transplant 2010;25:605-610
Perit Dial Int 2014;34(1):100-108

Peritoneal Ultrafiltration for Refractory Heart Failure

- NYHA functional class
  - At 1 year, 85% of patients had reduction by at least 1 NYHA class
- Echocardiographic parameters
  - Increase in LVEF
  - Decreased pulmonary artery systolic pressures



Perit Dial Int 2014;34(1):64-70

Conclusion

- Very few RCTs have compared acute PD with extracorporeal therapies
- Currently, all analyzed RCTs have been conducted in Brazil and India
- Sample sizes in these studies are <100 patients per group
- Varying methods and prescriptions of acute PD

Acute PD Prescription

- Ideally, flexible tunneled Tenckhoff catheter to be inserted
  - Rigid catheter/drainage tubes in resource scarce areas
- Closed system of fluid delivery and drainage
  - CCPD; reduces nursing time, can perform tidal PD
  - CAPD; ideal in resource poor settings

Perit Dial Int 2014;34(5):494-517

Acute PD Prescription

Perit Dial Int 2014;34(5):494-517

Conclusion

- Marked heterogeneity in the current RCTs
- Several important outcome measures need to be investigated
  - Length of ICU stay, length of hospital stay
- Need standardized reporting of technique dose, complications and cost

Conclusion

- Current data suggests that acute peritoneal dialysis is an appropriate modality for renal replacement therapy
- No significant difference in outcomes compared to extracorporeal therapies
- Acute PD been recommended by the ISPD as a suitable method for renal replacement
- Peritoneal ultrafiltration has been shown to be a suitable option in patients with refractory heart failure

Perit Dial Int 2014;34(5):494-517

Future Direction

ISN 0BY25 AKI INITIATIVE

- Aim to have 0 preventable deaths from AKI by 2025
- Saving Young Lives program established in 2012
  - Establishing sustainable acute PD programs in low-resource settings

Saving Young Lives centers Country (city)[a]	Cases treated Jan. 2013–Sep. 2015
Benin (Cotonou)	24
Cambodia (Phnom Penh)	3
Cameroon (Mbingo)	27
Ethiopia (Addis Ababa)	3
Ghana (Accra)	8
Ghana (Kumasi)	80
Ivory Coast (Abidjan)	24
Tanzania (Moshi)	6
Total	**175**

Kidney Int 2016;89(2):254-256

Thank You

- Questions ?