LE TECNICHE DIALITICHE

CAPD vs APD

Dr Marco Pozzi

UOC Nefrologia e Dialisi
ASST BRIANZA - Ospedale Pio XI -Desio

CAPD

Continuous Ambulatory PD

- Several manual exchanges per day
- Typically, continuous 24 hr/day dialysis
- Lower-dose options (incremental, palliative) may include dry periods (IAPD – intermittent ambulatory PD)
- Dwell times generally 4 – 6 hours during the day, with long overnight dwell

APD

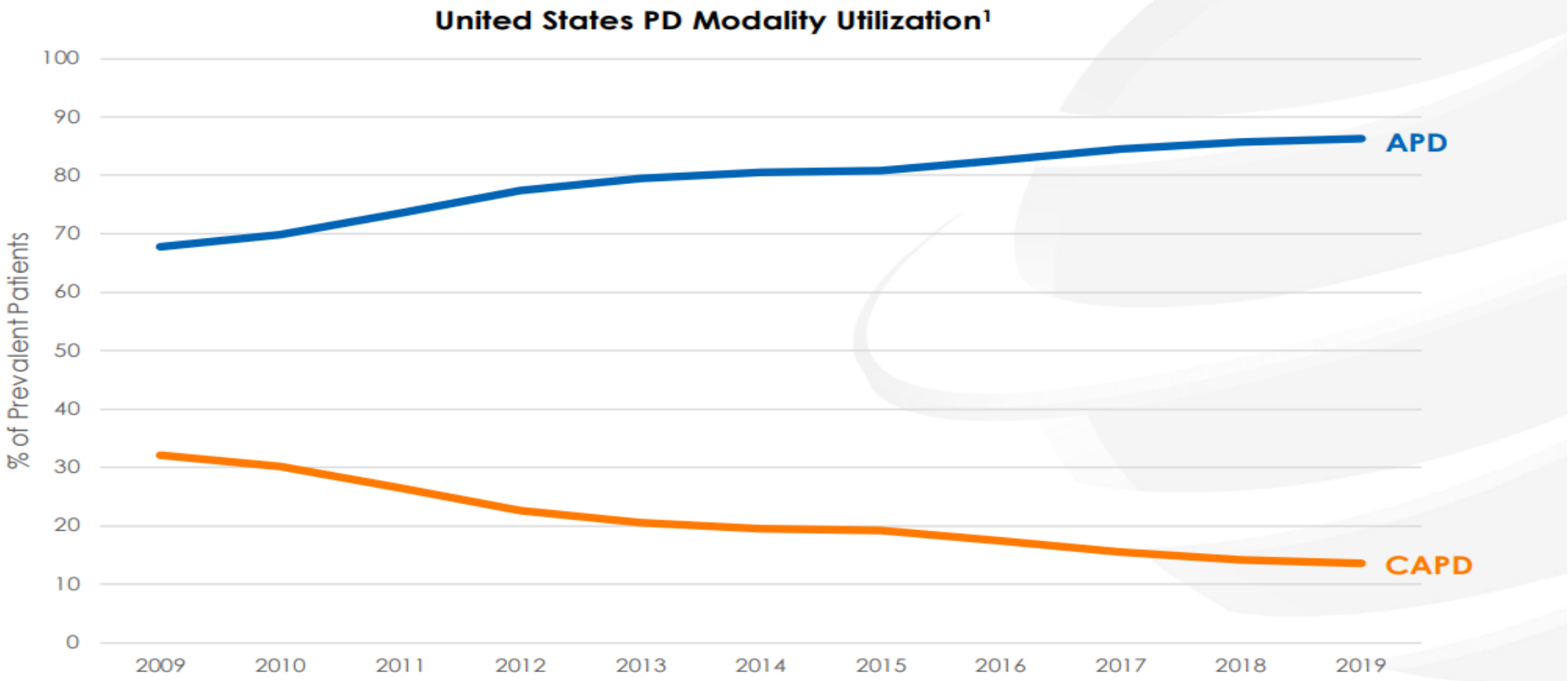
Automated PD

- Exchanges performed by automated cycler overnight
- Numerous programming options available (CCPD, NIPD, Tidal, PD Plus)
- Intermittent (dry day) or continuous therapy
- Dwell times generally 1 – 3 hours overnight
- Daytime can be a single long dwell or broken up

Tipo di APD	N° stasi diurne	N° stasi notturne	Volume degli scambi notturni
NIPD	0	3-10	come il 1°
NTPD	0	3-10	tidal (50% - 75%)
CCPD	1	3-10	come il 1°
CTPD	1	3-10	tidal (50% - 75%)
CCPD-2	2	3-10	come il 1°
CTPD-2	2	3-10	tidal (50% - 75%)

Virga GB, BEST PRACTICE – GDP DIALISI PERITONEALE 2013

CAPD Utilization is Declining



USRDS Annual Data Report 2021

International comparison of peritoneal dialysis prescriptions from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS)

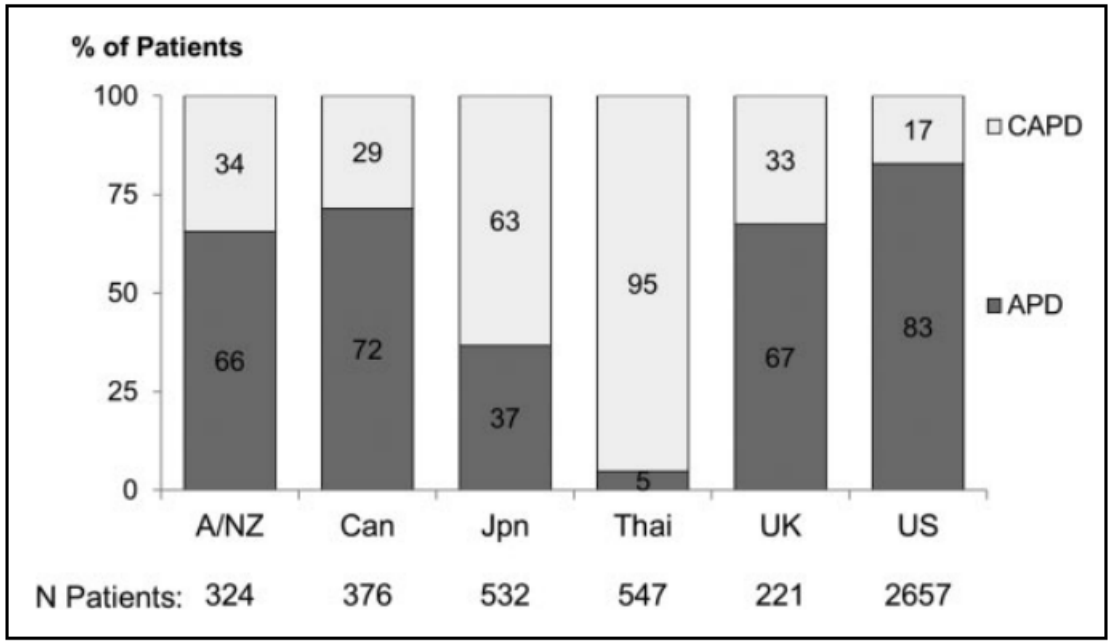


Figure 1. PD modality by country among PDOPPS initial cross section of sampled patients (2014–2017).
A/NZ: Australia/New Zealand; Can: Canada; Jpn: Japan; Thai: Thailand; UK: United Kingdom; US: United States; PD: peritoneal dialysis; PDOPPS: Peritoneal Dialysis Outcomes and Practice Patterns Study.

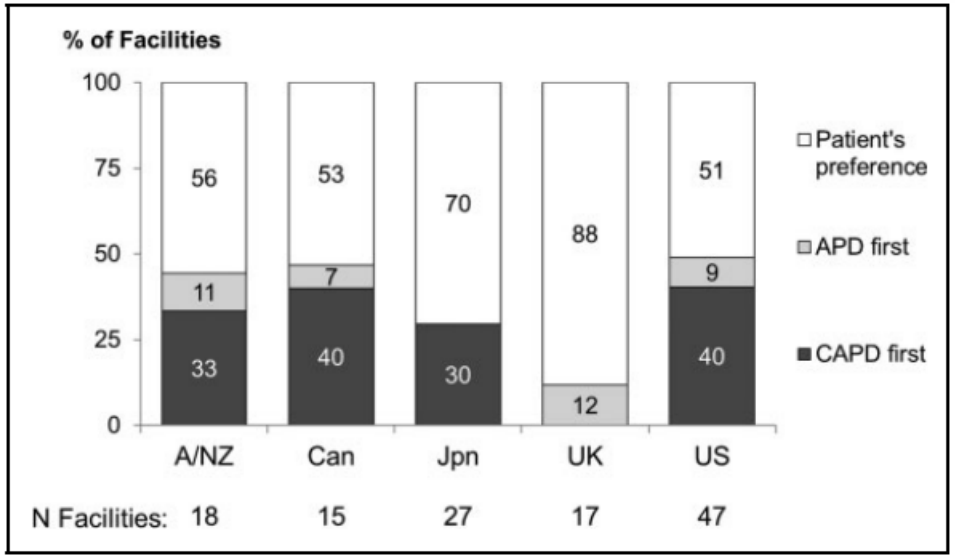


Figure 3. Facility policy regarding the initial prescription of PD modality by country according to PDOPPS facility medical directors. Data were not available in Thailand. "Patient's preference" indicates that the policy is to individualize the prescription according to the preference of the patients.
A/NZ: Australia/New Zealand; Can: Canada; Jpn: Japan; Thai: Thailand; UK: United Kingdom; US: United States; PD: peritoneal dialysis; PDOPPS: Peritoneal Dialysis Outcomes and Practice Patterns Study.

Wang AY-M, et al. Perit Dial Int. 2020;40(3):310-319

International comparison of peritoneal dialysis prescriptions from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS)

Table 2. CAPD prescription details by country.

	A/NZ	Canada	Japan	Thailand	UK	US
Number of CAPD patients	111	107	337	521	72	458
Number of exchanges, including the long or overnight exchange						
≤3	25%	21%	41%	10%	49%	17%
4	71%	73%	56%	82%	51%	75%
≥5	4%	6%	2%	9%	0%	8%
Prescribed total volume[a] (L)	7.2 (2.2)	7.2 (2.4)	5.5 (1.9)	7.9 (1.5)	6.5 (2.5)	8.1 (2.4)
Prescribed total volume per BSA[a] (L/1.73 m^2)	6.7 (2.1)	6.7 (2.2)	6.0 (2.1)	8.7 (1.9)	5.8 (2.2)	7.2 (2.2)
Dwell volume during daytime exchange (L)						
<2	18%	18%	70%	9%	20%	14%
2	71%	68%	29%	91%	68%	57%
>2	11%	14%	1%	0%	13%	28%
Dwell volume during nighttime exchange (L)						
<2	6%	1%	6%	2%	0%	3%
2	7%	14%	63%	4%	12%	10%
> 2	88%	85%	31%	95%	88%	87%

Results shown as mean (standard deviation) or prevalence. CAPD: continuous ambulatory peritoneal dialysis; A/NZ: Australia/New Zealand; UK: United Kingdom; US: United States; BSA: body surface area; LDO: LDO: large dialysis organization.

[a]In the US, data only provided by non-LDO facilities.

Wang AY-M, et al. Perit Dial Int. 2020;40(3):310-319

International comparison of peritoneal dialysis prescriptions from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS)

Table 3. APD prescription details by country.

	A/NZ	Canada	Japan	Thailand	UK	US
Number of APD patients	213	269	195	26	149	2199
Tidal APD (%)	19%	26%	39%	12%	46%	14%*
Total number of cycles						
≤3	7%	11%	40%	0%	11%	8%
4	34%	36%	32%	0%	32%	46%
5	34%	33%	16%	65%	26%	35%
≥6	25%	20%	11%	35%	32%	11%
Total cycler volume[a,b] (L)	10.2 (2.8)	9.98 (2.90)	6.39 (2.77)	10.1 (1.5)	10.1 (2.9)	10.4 (2.8)
Prescribed total volume[a,b] (L)	11.3 (3.9)	11.4 (3.7)	7.54 (3.09)	10.8 (2.4)	11.1 (3.7)	11.9 (3.6)
Total cycler volume per BSA[a,b] (L/1.73 m^2)	9.63 (2.63)	9.41 (2.57)	6.57 (2.90)	11.0 (1.9)	9.41 (2.89)	9.20 (2.56)
Prescribed total volume per BSA[a,b] (L/1.73 m^2)	10.7 (3.5)	10.8 (3.3)	7.81 (3.36)	11.9 (3.4)	10.4 (3.7)	10.5 (3.1)
Number of daytime exchanges						
Empty	43%	34%	42%	81%	50%	50%
1	48%	53%	44%	19%	47%	46%
>2	9%	13%	14%	0%	3%	5%
Dwell volume during daytime exchange (L)						
<2	62%	55%	70%	50%	46%	23%
2	30%	39%	29%	50%	47%	30%
2+	8%	6%	1%	0%	7%	47%
Dwell volume during nighttime cycles (L)						
<2	33%	27%	58%	46%	36%	11%
2	40%	36%	30%	50%	45%	25%
>2	27%	37%	12%	4%	19%	64%

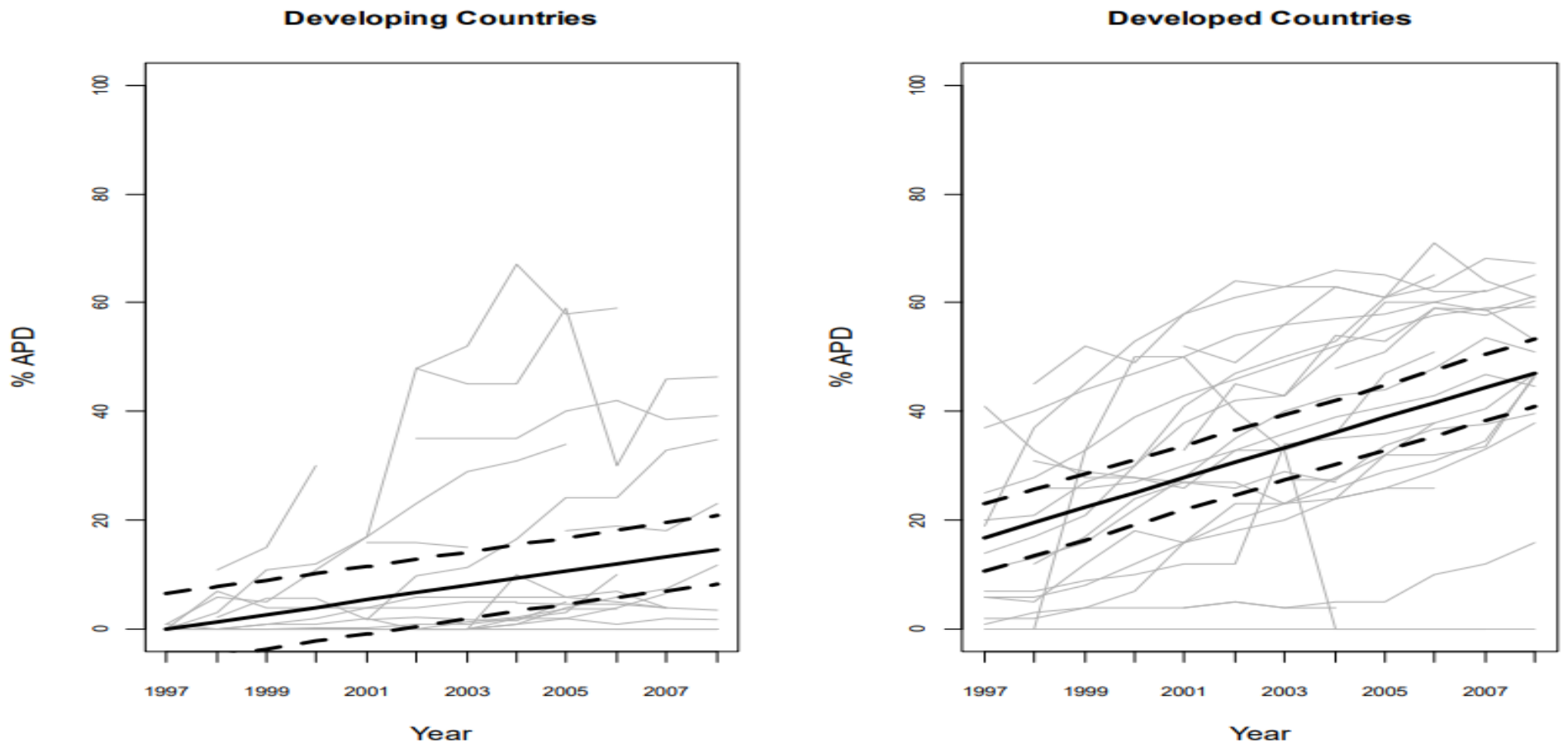
Results shown as mean (standard deviation) or prevalence. APD: automated peritoneal dialysis; A/NZ: Australia/New Zealand; BSA: body surface area; LDO: large dialysis organization; UK: United Kingdom; US: United States.

[a]In the US, data only provided by non-LDO facilities.

[b]Total cycler volume is the volume during nighttime. Total prescribed volume is daytime volume + nighttime volume.

Wang AY-M, et al. Perit Dial Int. 2020;40(3):310-319

Global Trends in Rates of Peritoneal Dialysis



Appendix Figure 3. Trends in the proportion of peritoneal dialysis patients treated with automated peritoneal dialysis (APD) from 1997 to 2008 in developing and developed countries. The grey lines represent trends in individual countries, and the black lines the overall trend with 95% confidence intervals.

Jain AK et al *Journal of the American Society of Nephrology* 23(3):p 533-544, March 2012

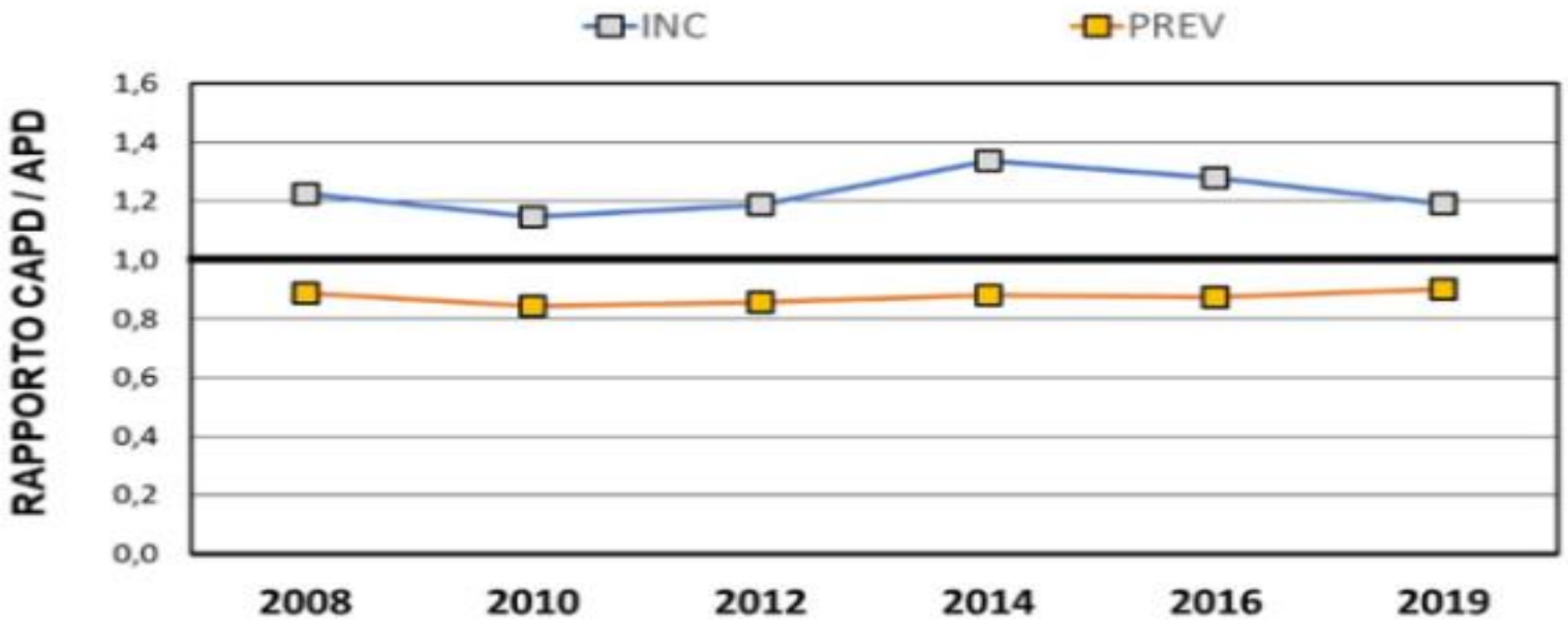
Modalità di DP nei pazienti incidenti e prevalenti negli anni.

GRUPPO di PROGETTO di DIALISI PERITONEALE
SOCIETA' ITALIANA di NEFROLOGIA

CENSIMENTO GSDP 2019

METODICA DI DP NEL TEMPO

CONFRONTO 2019 (198 CENTRI) vs ANNI PRECEDENTI



GRUPPO di PROGETTO di DIALISI PERITONEALE
SOCIETA' ITALIANA di NEFROLOGIA

CENSIMENTO GPDP 2022

Metodica di DP – 227 centri
1350 pazienti incidenti 4152 pazienti prevalenti

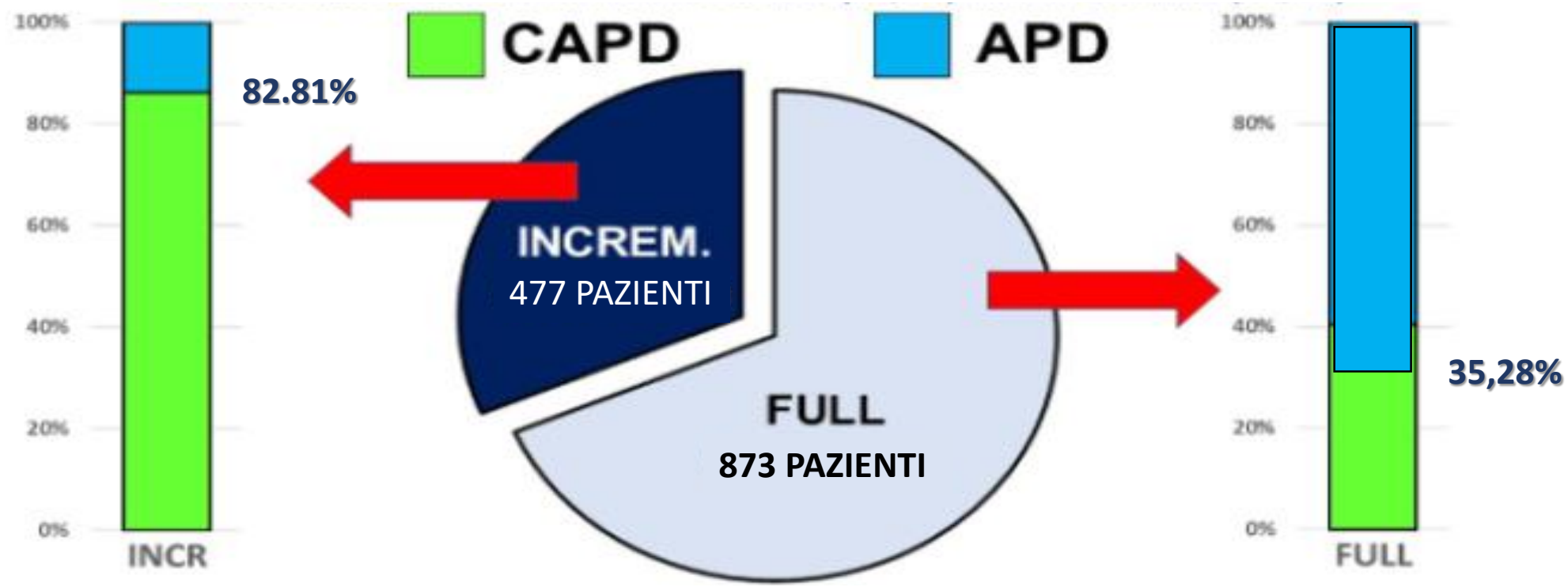
	INCIDENTI	PREVALENTI
CAPD	52,1%	43.4%
APD	47.9 %	56,6%
	1.08	0.76

CENSIMENTO GPDP 2022

DIALISI INCREMENTALE NEL 2022

227 CENTRI – 1350 PAZIENTI INCIDENTI

DP INCREMENTALE IN 477 PAZIENTI (35.3%) IN 136 CENTRI(59.9 DI TUTTI I CENTRI)



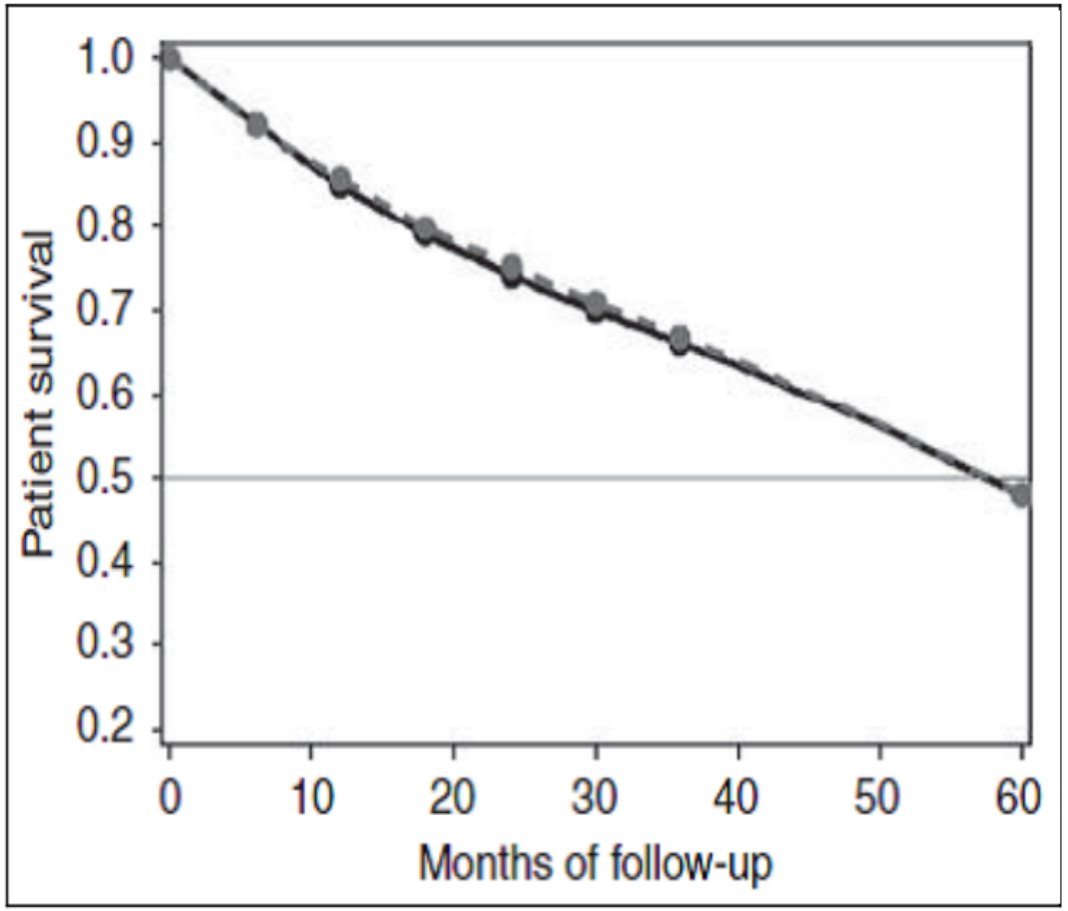


Figura 1.

Balasubramanian G, et al. Comparing automated peritoneal dialysis with continuous ambulatory peritoneal dialysis: survival and quality of life differences?

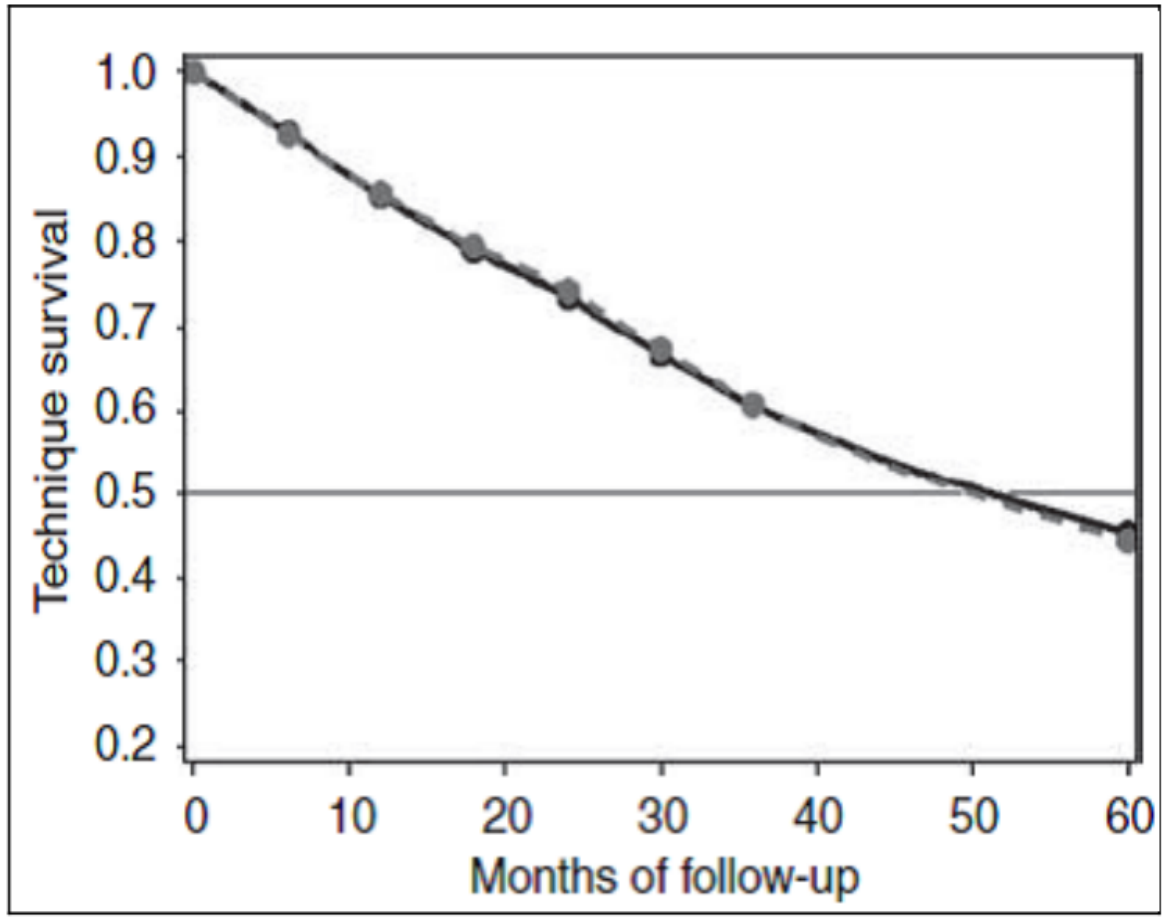


Figura 1.

Sopravvivenza della tecnica (adjusted, intention-to-treat) nel periodo 1996-2004 in USA (United States Renal Data System, CAPD vs. APD, p=NS) [8 [8]

Summary of studies comparing technique survival and all-cause mortality in individuals treated with continuous ambulatory peritoneal dialysis or automated peritoneal dialysis

First author, et al. (publication year)	Study type	Period/country	Data source	Sample size (CAPD, APD)	Follow-up duration	Outcome
De Fijter (1994) [18]	Randomized controlled trial	1988–1991 Netherlands	Single center	82 (41, 41)	24 month	No significant difference in technique survival or all-cause mortality
Mujais (2006) [56]	Post hoc analysis of prospectively collected data	2000–2003 United States	Multicenter Baxter Healthcare Corporation On-Call™ system	40,869		Better technique survival in APD (mostly concentrated in the first year of therapy); no difference in all-cause mortality
Badve (2008) [57]	National Registry Data	1999–2004 Australia and New Zealand	Multicenter Australia and New Zealand Dialysis and Transplant (ANZDATA)	4128 (2393, 1735)	5 year	No significant difference in technique survival or all-cause mortality
Sanchez (2008) [58]	Retrospective study	2003–2005 Mexico	Single center	237 (139, 98)	2 year	Technique survival significantly better and all-cause mortality lower in individuals undergoing APD
Mehrotra (2009) [54]	National Registry Data	1996–2004 United States	Multicenter United States Renal Data System (USRDS)	66,381 (42,942, 23,439)	2–10 years	No significant difference in technique survival or all-cause mortality
Michels (2009) [59]	Retrospective study	1997–2006 Netherlands	Multicenter The Netherlands Cooperative Study on the Adequacy of Dialysis (NECOSAD)	649 (562, 87)	5 year	No significant difference in technique survival or all-cause mortality

Scott D. Bieber, Applied Perit Dial 2021

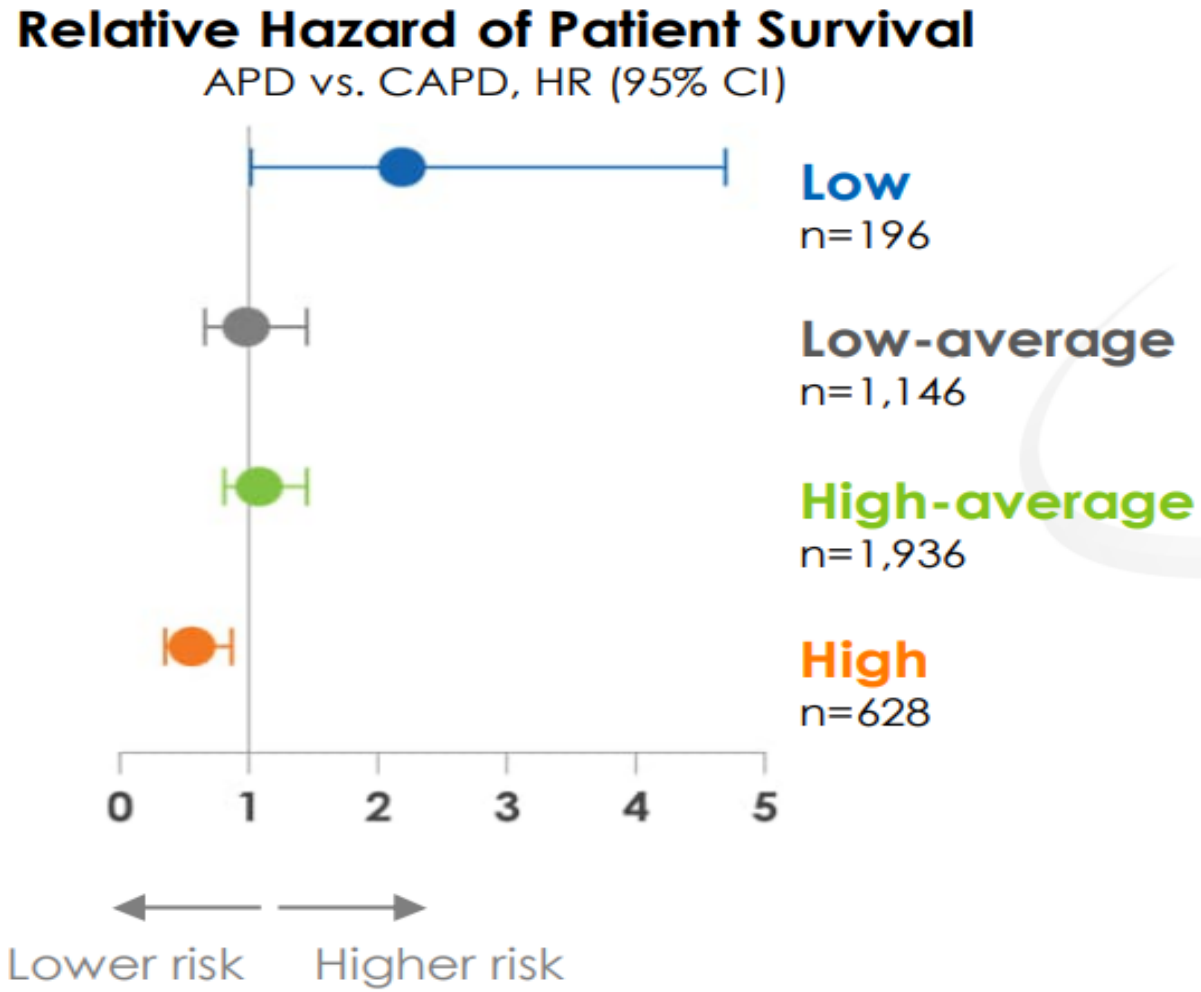
Summary of studies comparing technique survival and all-cause mortality in individuals treated with continuous ambulatory peritoneal dialysis or automated peritoneal dialysis

Johnson (2010) [60]	National Registry Data	1999–2004 Australia and New Zealand	Multicenter Australia and New Zealand Dialysis and Transplant (ANZDATA) Registry	High transporters (142, 486) Low transporters (n = 196)	3 month–10 years	Compared APD vs. CAPD in high transporters and APD vs. CAPD in low transporters. No significant difference in technique survival between groups, lower death risk in high transporters treated with APD and higher death risk in low transporters treated with APD
Cnossen (2011) [28]	Retrospective study	2001–2008 United States	Multicenter Renal Research Institute	620 (179, 441)	3 month–7 years	Significantly better technique survival in individuals undergoing APD, no significant difference in all-cause mortality
Sun (2011) [61]	Retrospective study	1997–2008 Taiwan	Single center	282 (121, 161)	3 month–10 years	Technique survival higher in APD group and lower all-cause mortality in APD group as a whole. For individuals older than 65, APD was associated with higher mortality
Beduschi (2015) [39]	Prospective cohort	2004–2011 Brazil	Multicenter	2890 (1445, 1445) Propensity score matched	60 months	CAPD patients had a higher risk for overall and cardiovascular mortality. No significant differences were seen in technique failure
Tang (2016) [55]	Retrospective study	1999–2011	Multicenter	4574 (2287, 2287) Propensity score matched	10 years	Differences were observed in various time sub-periods, but over the entire study, there were no differences in technique failure or mortality
Li (2018) [62]	Retrospective study	2005–2015 China (Baxter Data)	Multicenter	100,351 (99,983, 368)	10 years	APD associated with overall lower risk of death compared with CAPD. Benefit observed only up to 4 years of follow-up, after that risk of death similar

APD automated peritoneal dialysis, *CAPD* continuous ambulatory peritoneal dialysis

Scott D. Bieber, Applied Perit Dial 2021

ANZDATA Registry 1999 – 2004 3,906 Patients



LENTI TRASPORTATORI in APD:
Significantly higher risk of mortality

MEDI TRASPORTATORI in APD
No difference between modalities

RAPIDI TRASPORTATORI in APD
Significantly lower risk of mortality

Johnson DW, et al. 2010;25(6):1973-1979

Adeguatezza ULTRAFILTRATIVA

CAPD vs APD

Rimozione dell'acqua

Autore	CAPD	APD
Ortega [1]	1538	1047
Rodriguez-Carmona [2] (full text)	1367	907
Fourtounas [3]	1093	954
Davison [4] (full text)	572	811
Cnossen [5]	834	661
Gallar [6] (full text)	1312	964
Bavbek [7] (full text)	850	775
Bro [8] (full text)	1190	1092
Media	**1095**	**901**

Virga GB, BEST PRACTICE – GDP DIALISI PERITONEALE 2013

Adeguatezza ULTRAFILTRATIVA

CAPD vs APD

Rimozione del sodio

CAPD rimozione dialitica di sodio (MT Na) in assoluto (mEq/die) e per litro di ultrafiltrazione (mEq/L di UF)

Autore	MT Na (mEq/die)	Ultrafiltrazione (ml)	mEq/L di UF
Ortega [1]	195	1538	127
Rodriguez-Carmona [2] (full text)	173	1367	127
Fourtounas [3]	143	1093	131
Davison [4] (full text)	66	572	115
Cnossen [5]	109	834	131
Media	**137**	**1080**	**126**

APD: rimozione dialitica (Mass Tranfer= MT) di sodio

Autore	MT Na	UF netta	MT Na/L UF	Modalità di APD
Ortega [1]	87	1047	83	NIPD + CCPD + CCPD-2
Rodriguez-Carmona [2] (full text)	53	907	58	NIPD + CCPD
Fourtounas [3]	62	954	65	CCPD + CCPD-2
Davison [4] (full text)	99	811	122	CCPD-2
Cnossen [5]	81	661	123	NIPD + CCPD + CCPD-2
Boudville [6] (full text)	84	1340	63	NIPD + CCPD

La rimozione di sodio riportata in letteratura appare mediamente superiore in CAPD vs. APD sia in valore assoluto (137 vs. 78 mEq) che per litro di ultrafiltrazione (126 vs. 86 mEq/L)

la rimozione dialitica media di sodio sembra variare da un valore ≤ 60 mEq/L di UF per la NIPD a circa 90 mEq/L per la CCPD e 120 per la CCPD-2 (valore medio in APD 86 mEq/L di UF)

Virga GB, BEST PRACTICE – GDP DIALISI PERITONEALE 2013

Figure

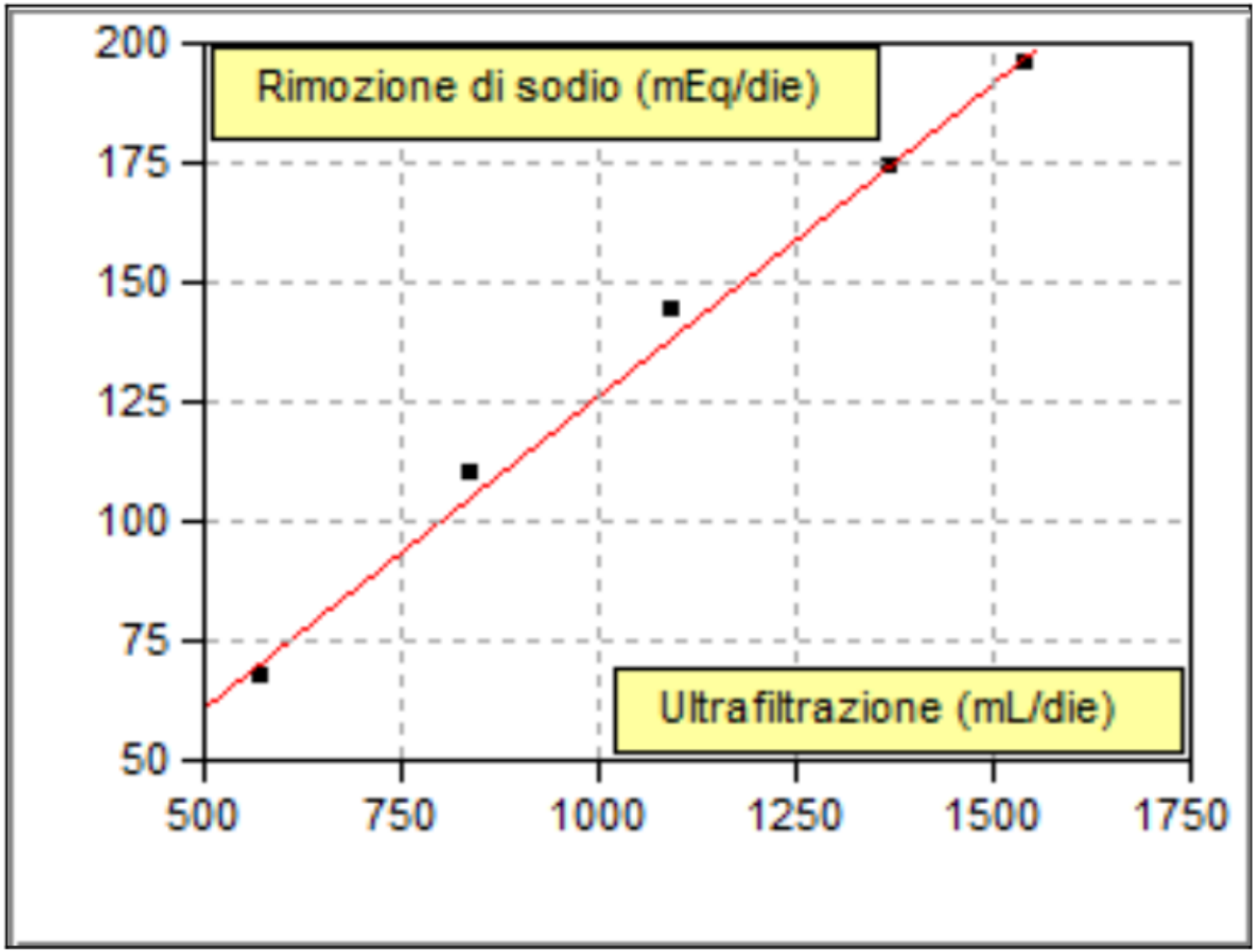
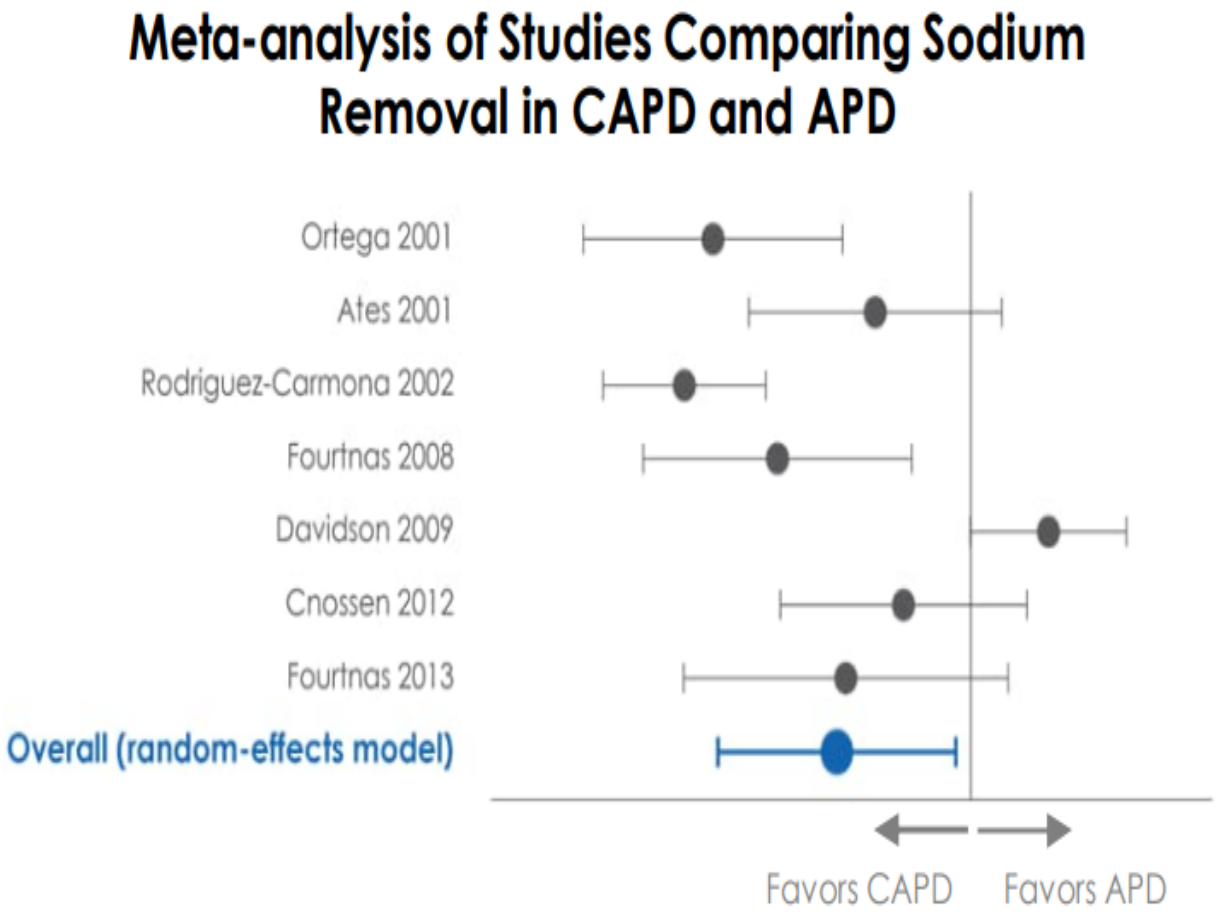
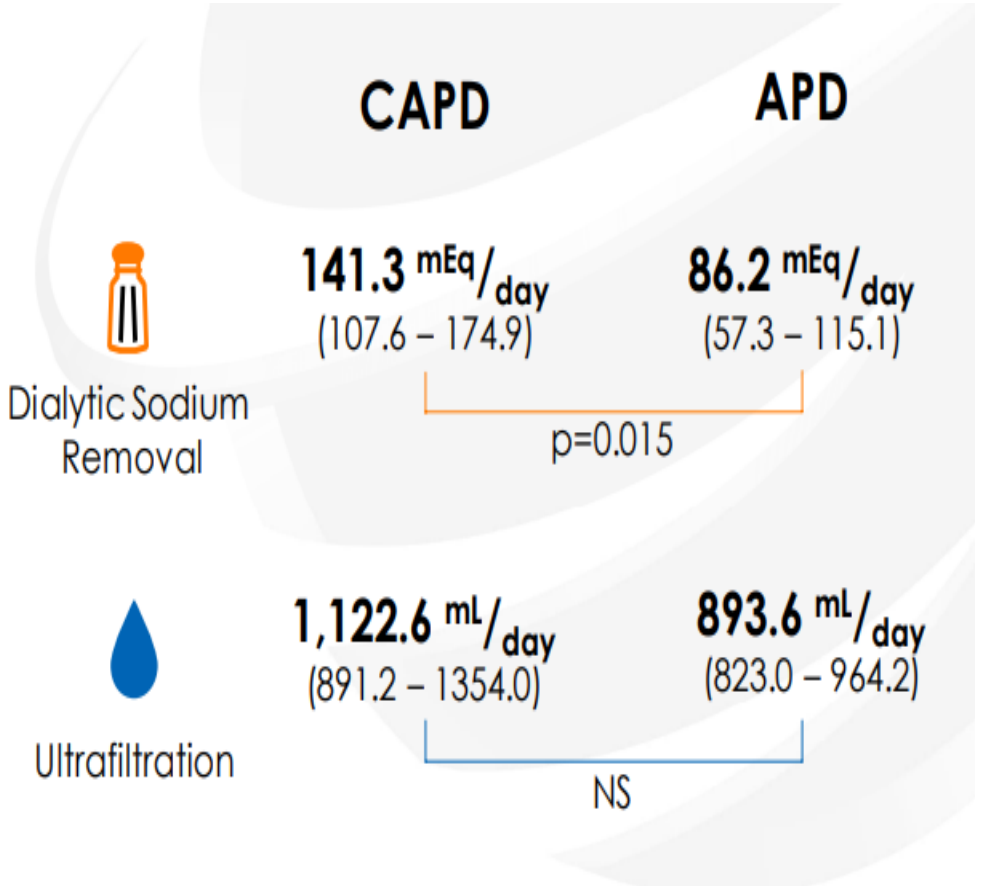


Figura 1.

Analisi della regressione lineare (R^2=0,99) tra rimozione peritoneale di sodio e ultrafiltrazione netta in CAPD [1, 2 3, 4, 5].

Dialytic sodium removal in CAPD is significantly greater than APD, while there is no difference in ultrafiltration volume





Borrelli S, et al. J Nephrol. 2019;32(2):231-239.

Comparison of sodium removal in peritoneal dialysis patients treated by continuous ambulatory and automated peritoneal dialysis

659 patients, mean age 57±16 years, 56.3% male, 38.9% diabetic, 24.0% treated by CAPD, 22.5% by APD and 53.5% APD with a day-time exchange, with icodextrin prescribed to 72.8% and 22.7 g/L glucose to 31.7%

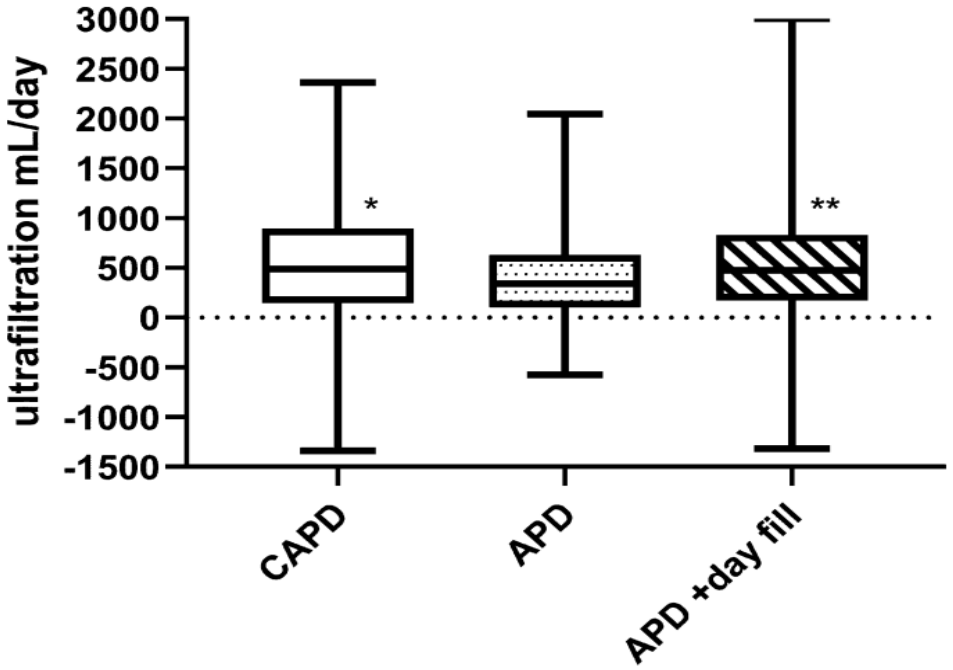


Fig. 1 Twenty-4-h peritoneal dialysate ultrafiltration volumes. Continuous ambulatory peritoneal dialysis (CAPD), automated peritoneal dialysis (APD) cyclers. Adjusted CAPD accounts for the flush before fill technique., **p < 0.01 vs APD with a day time exchange

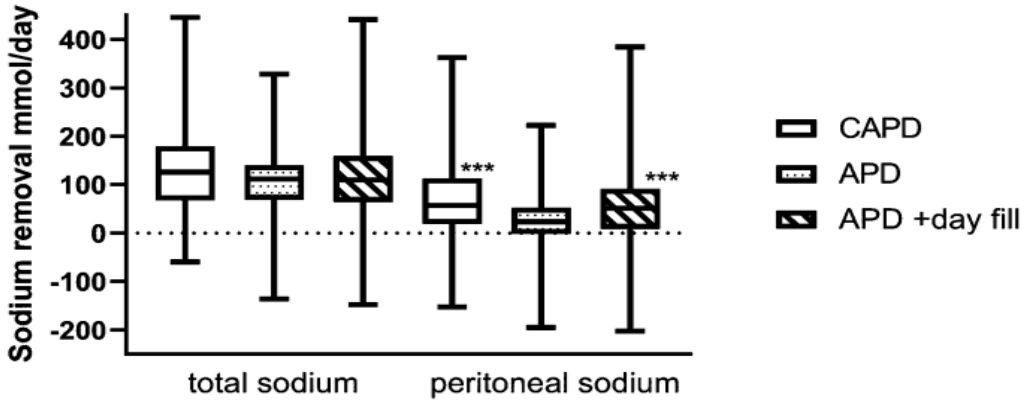
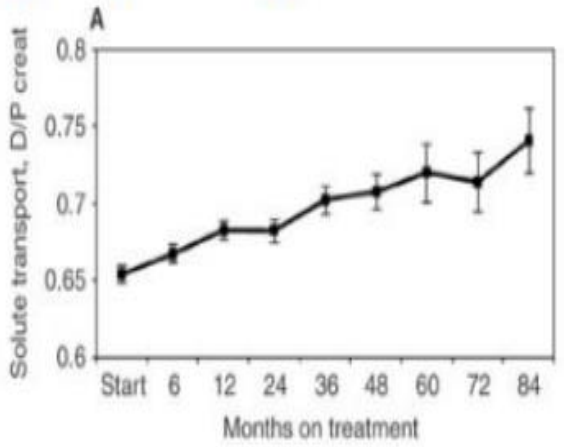
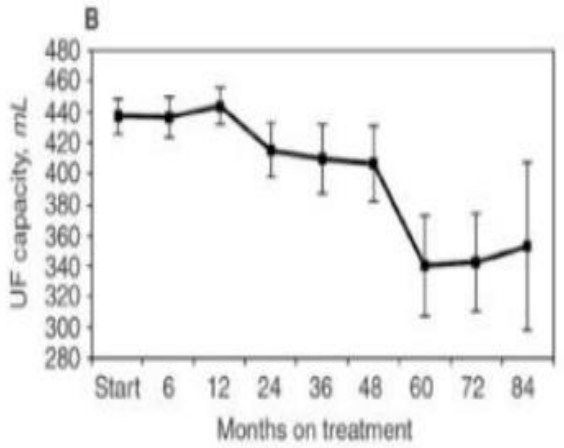


Fig. 2 Twenty-4-h sodium balance as the difference between sodium losses in urine and peritoneal dialysate minus sodium infused in peritoneal dialysate, and 24-h peritoneal sodium balance as the difference between sodium in drained peritoneal dialysate minus sodium infused in peritoneal dialysate. Continuous ambulatory peritoneal dialysis (CAPD), automated peritoneal dialysis (APD) cyclers. Adjusted CAPD accounts for the flush before fill technique., ***p < 0.001 vs APD with a day time exchange

Maharjan SRS et al. Journal of Nephrology (2019) 32:1011–1019

Longitudinal relationship between solute transport and UF capacity in PD patients





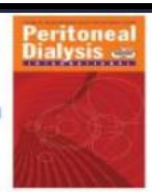
Davies SJ Kidney Int 2004

Test basati sui principi del PET

- PET Modificato (3.86%-PET)
- Standard Peritoneal Permeability Analysis (SPA)
- Mini-PET e Doppio Mini-PET
- PET Modificato con un drenaggio temporaneo
- PET-Unico (Uni-PET) (Doppio Mini-PET integrato con il 3.86%-PET)
- Altri test (es. Dialysis Adequacy and Transport Test or DATT; APEX)

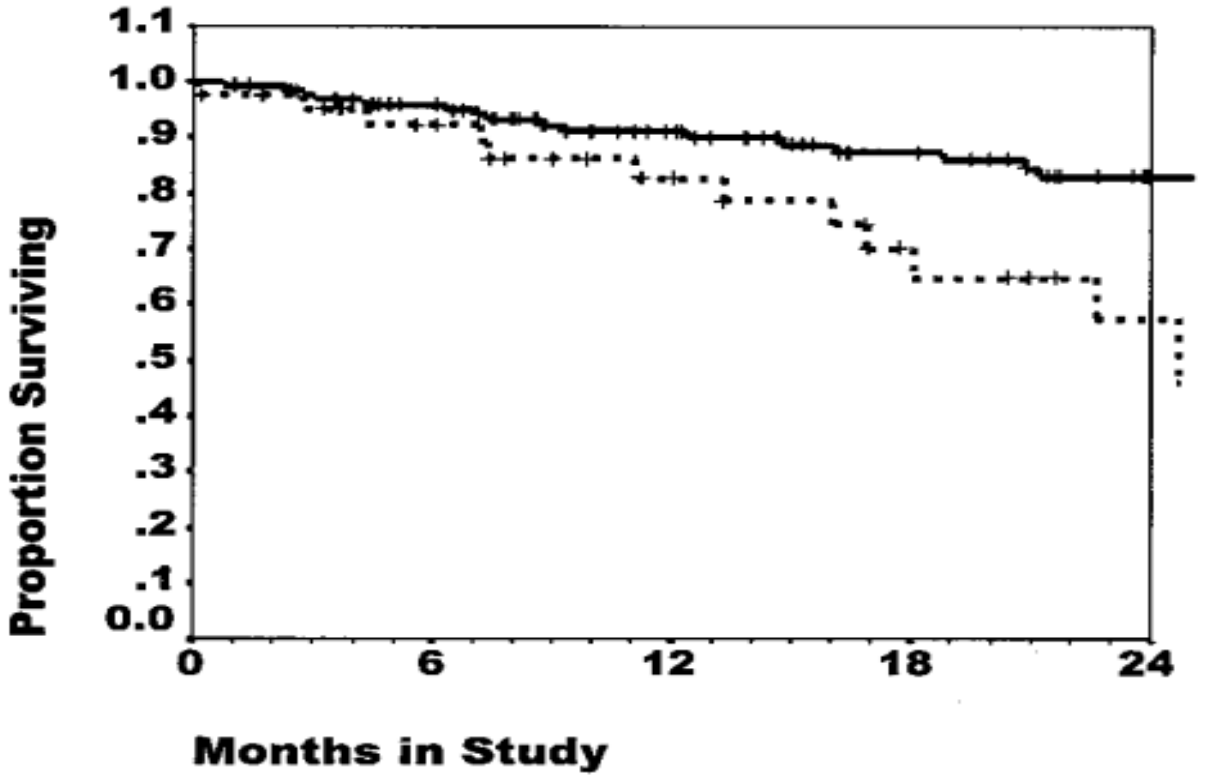
3.86% PET vs 2.27% PET

ISPD Ad Hoc Committee on Ultrafiltration Management in Peritoneal Dialysis Perit Dial Int 2000



- Risultati simili sul trasporto dei soluti di piccolo peso molecolare (Smit W et al Perit Dial Int 2000; Pride ET et al Perit Dial Int 2002)
- Migliori informazioni sulla UF peritoneale per il maggiore gradiente osmotico (coefficiente di variazione: 10% vs 25% (Davies SJ Kidney Int 2006;La Milia V et al. Kidney Int 2006)
- Fenomeno del sieving del sodio (D/P_{Na}) e valutazione indiretta del trasporto di acqua libera (Monquil M et al Perit Dial Int 1995)

Survival of Functionally Anuric Patients on Automated Peritoneal Dialysis: The European APD Outcome Study



>750 CC

<750 CC

Figure 3. Kaplan Meier patient survival according to baseline UF of >750 ml/d (▤) and <750 ml/d (- - -); $P = 0.0048$.

J Am Soc Nephrol 14: 2948–2957, 2003

Longitudinal membrane function in functionally anuric patients treated with APD: Data from EAPOS on the effects of glucose and icodextrin prescription

FUNZIIONE PERITONEALE NEL TEMPO

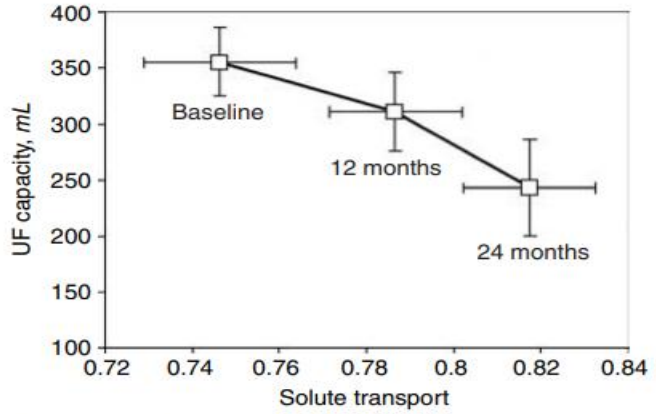


Fig. 1 Longitudinal membrane function for the whole patient cohort. Each data point represents the mean values (±SE) for the patients who remained in the study for the full two years. (For longitudinal paired statistics and mean values for all patients at each time point, see Table 3).

1,36% VS 2.27%/3.86%

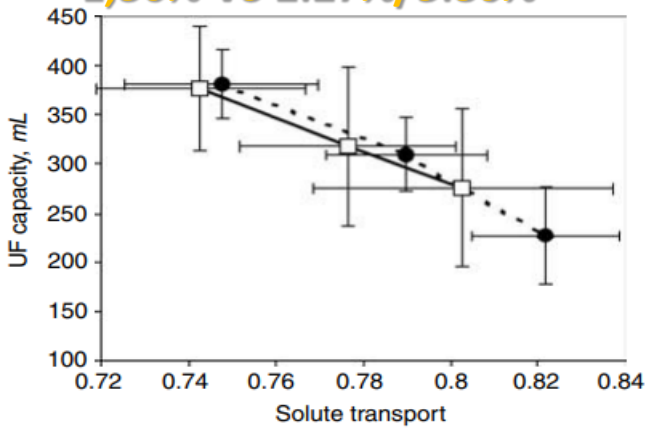


Fig. 2. Longitudinal membrane function according to baseline glucose exposure, patients using 1.36% only (□), 2.27% or 3.86% (●). As indicated in Figure 1, data points represent paired mean values (±SE) for patients remaining throughout the study that move from left to right at baseline, 12 and 24 months. (For longitudinal paired statistics and mean values for all patients at each time point, see Table 3).

ICO vs NO ICO

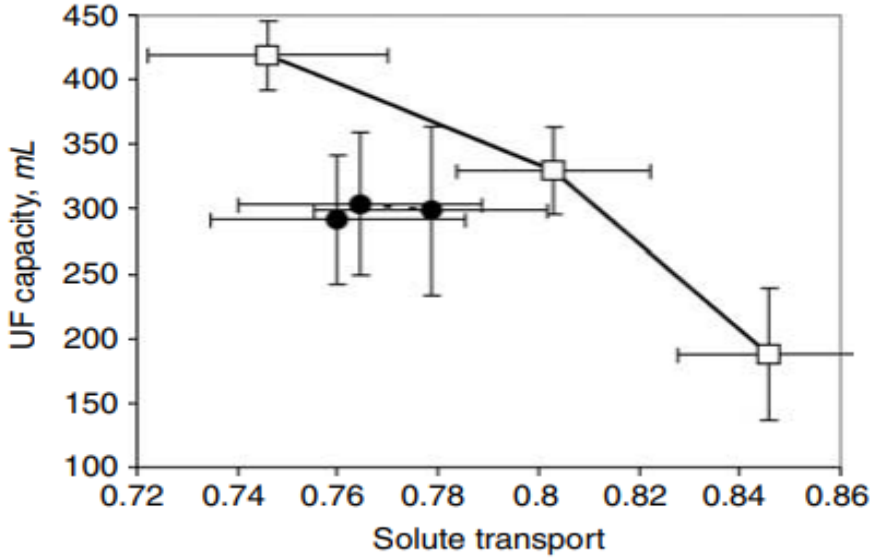


Fig. 3 Longitudinal membrane function according to baseline use of icodextrin (●) or no icodextrin (□). As indicated in Figure 1, data points represent paired mean values (±SE) for patients remaining throughout the study that move from left to right at baseline, 12 and 24 months. (For longitudinal paired statistics and mean values for all patients at each time point, see Table 3).

- Riduzione di UF NEL TEMPO
- USO DI ICODESTRINA E' ASSOCIATO A MINOR DETERIORAMENTO DELLA MEMBRANA PERITONEALE

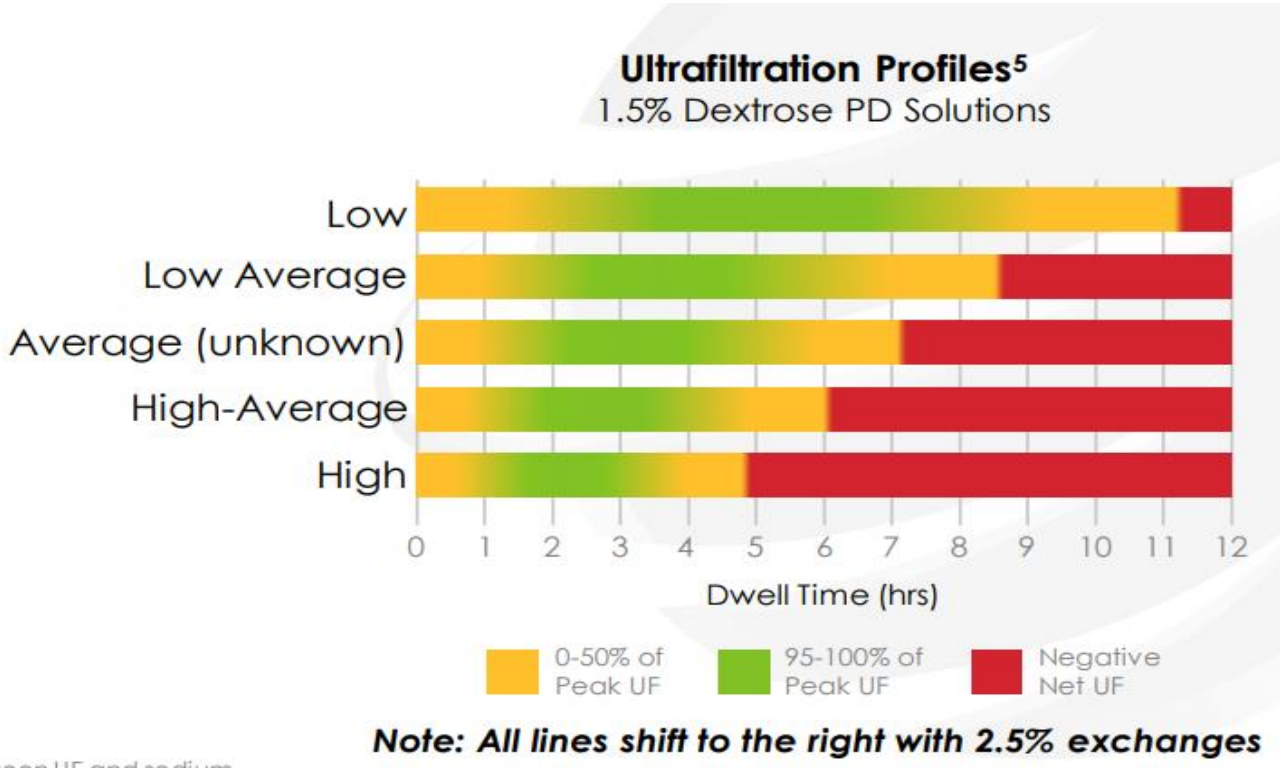
Devies SJ et al Kidney International, Vol. 67 (2005), pp. 1609–1615

Individualization of Dwell Time

Peak UF correlates with:
- Sodium removal[1-3*]
- Urea clearance[4]

Peak UF depends upon[5]:
- Transport type
- PD solution used

Avoid:
- Overly long dwells that result in reabsorption
- Inefficient short cycles that result in inadequate UF, Kt/V, and sodium sieving



Study results have varied. One study suggested the correlation between UF and sodium removal only occurs with CAPD2 , while others show a correlation for both modalities .

1Maharjan SRS, Davenport A. J Nephrol. 2019;32(6):1011-1019. 2Borrelli S, et al. J Nephrol. 2019;32(2):231-239. 3Wang T, Kidney Int. 1997;52(6):1609-1616. 4Akonur A, et al. Perit Dial Int. 2013;33(6):646-654. 5Mujais S, Vonesh E. Kidney Int Suppl. 2002;(81):S17-S22

Modality and Prescription Considerations

Transport Type	% of US Patients[1]	Estimated Peak UF[2] (hours)		Estimated Peak Urea Clearance* (hours)		Prescription Implications
Low	16	1.5%	3.5 – 6.0	1.5%	5.5 – 8.0	CAPD facilitates longer dwell times necessary for clearance. Larger dialysate volumes may be required with no RKF.
		2.5%	5.0 – 9.5	2.5%	6.5 – 10.0	
		4.25%	6.0 – 12.0	4.25%	7.5 – 11.5	
Low-Average High-Average	69	1.5%	2.0 – 4.5	1.5%	3.5 – 7.0	CAPD or APD could be appropriate. Modality can be largely based on patient preference
		2.5%	3.0 – 7.5	2.5%	4.0 – 8.0	
		4.25%	4.0 – 9.5	4.25%	4.5 – 9.5	
High	15	1.5%	1.5 – 2.5	1.5%	2.0 – 3.5	APD facilitates shorter dwell times necessary to prevent fluid reabsorption. Mid-day exchange or icodextrin may be required.
		2.5%	2.5 – 4.5	2.5%	2.5 – 3.5	
		4.25%	3.0 – 6.0	4.25%	3.0 – 4.0	

1Mehrotra R, et al. Clin J Am Soc Nephrol. 2015;10(11):1990-2001.
2Mujais S, Vonesh E. Profiling of peritoneal ultrafiltration. Kidney Int Suppl. 2002;(81):S17-S22.
3Akonur A, et al. Perit Dial Int. 2013;33(6):646-654.

Adeguatezza depurativa

CAPD vs APD

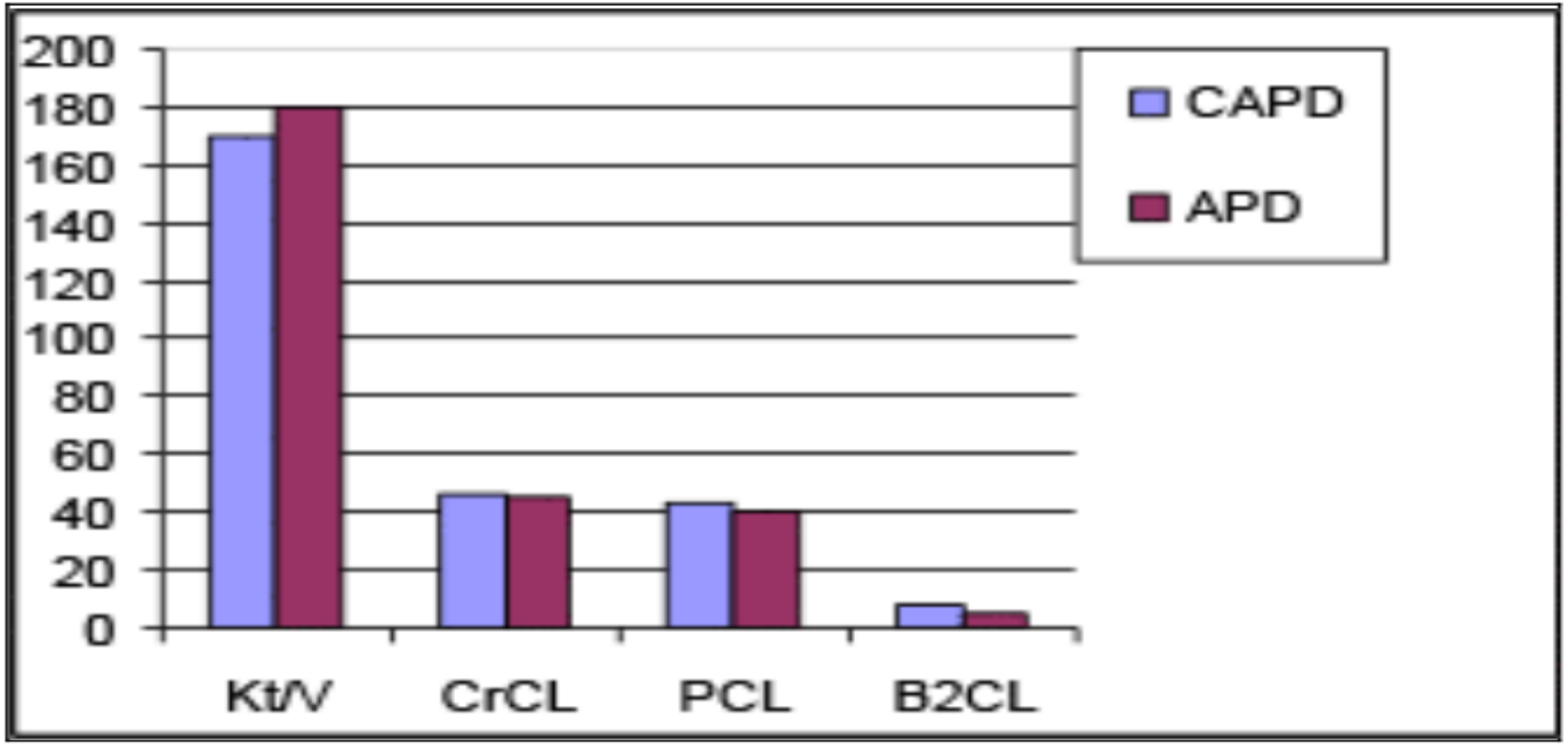


Figura 1.

Dati medi della letteratura sui rapporti di clearance (CL) peritoneali settimanali tra CAPD e APD: Kt/V=1,74 vs. 1,80 (x 100), (cioè -3,4%); creatinina (CrCL): 46,6 vs.45,3 L(+2,9%); fosfato (PCL): 43,3 vs.40,1 L(+8,0%); b2-microglobulina (B2CL): 7,7 vs.5,5 L(+40,0%) (vedi paragrafi relativi).

Virga GB, BEST PRACTICE – GDP DIALISI PERITONEALE 2013

Peritoneal Phosphate Clearance[1]

	CAPD	APD + Day Dwell	*p*
# Exchanges	**4** (2 – 5)	**6** (4 – 8)	
Total infused volume (L)	**8** (3 – 14)	**11.5** (4 – 22.5)	
Weekly peritoneal P clearance (L/week/1.73m^2)	**41.4** (14.8 – 76.9)	**33.4** (8.3 – 117.5)	0.001
Weekly peritoneal P clearance, High/HA	**44.8** (18.4 – 76.9)	**36.4** (16.3 – 89.7)	0.01
Weekly peritoneal P clearance, Low/LA	**36.6** (14.8 – 67.1)	**29.3** (8.3 – 117.5)	0.01

CAPD is associated with greater peritoneal P clearance and lower serum P levels

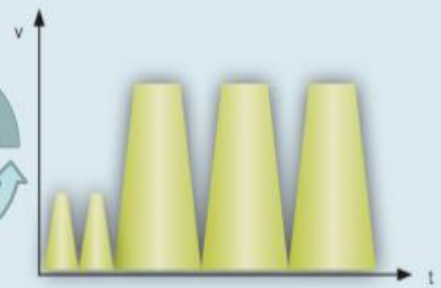
Low/low-average transporters have lower P clearance than high/high-average transporters

Courivaud C, Davenport A. Perit Dial Int. 2016;36(1):85-93
Debowska M, et al. Sci Rep. 2020;10(1):17504.

APD convenzionale

12 L = 6 x 2 L
540 min (9 h) = 6 x 90 min

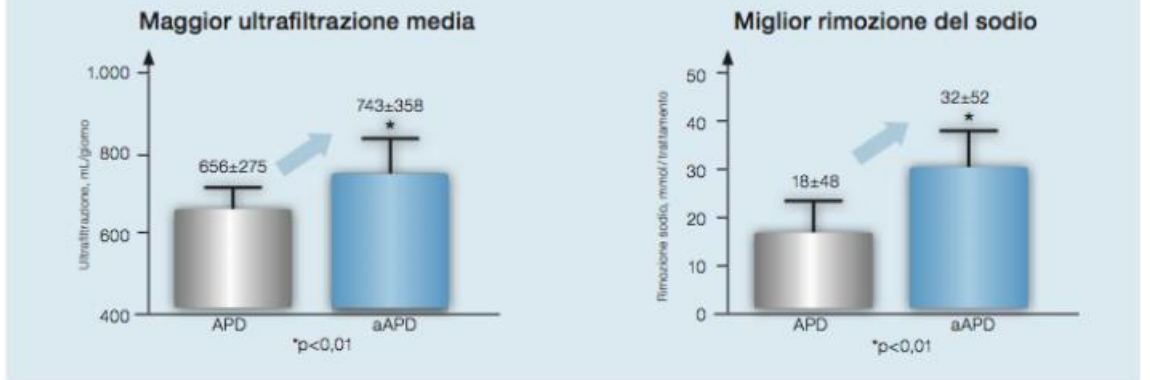
Adapted APD



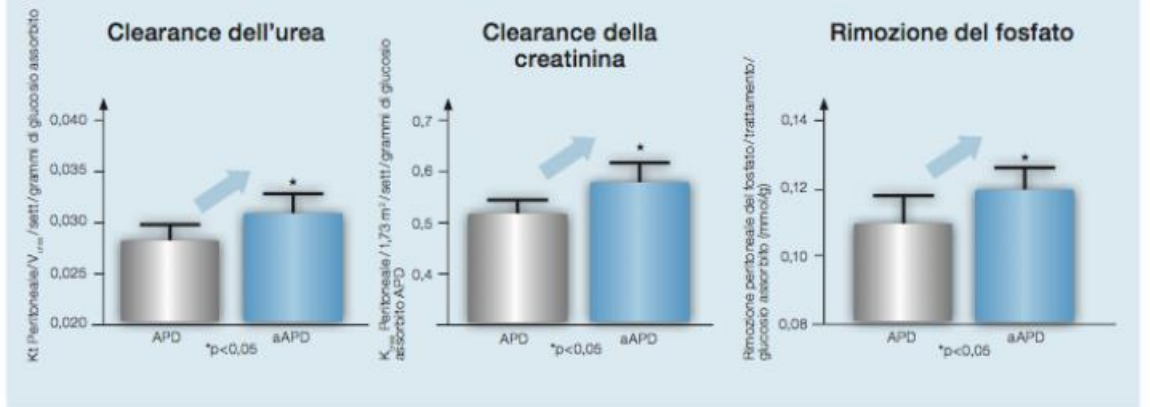
12 L = (2 x 1,5 L) + (3 x 3 L)
540 min (9 h) = (2 x 45 min) + (3 x 150 min)

L'approccio adapted APD è realizzabile senza incrementare il volume totale di infusione od il tempo totale di trattamento, mantenendo la stessa concentrazione di glucosio.

Confronto dopo 45 giorni[1]

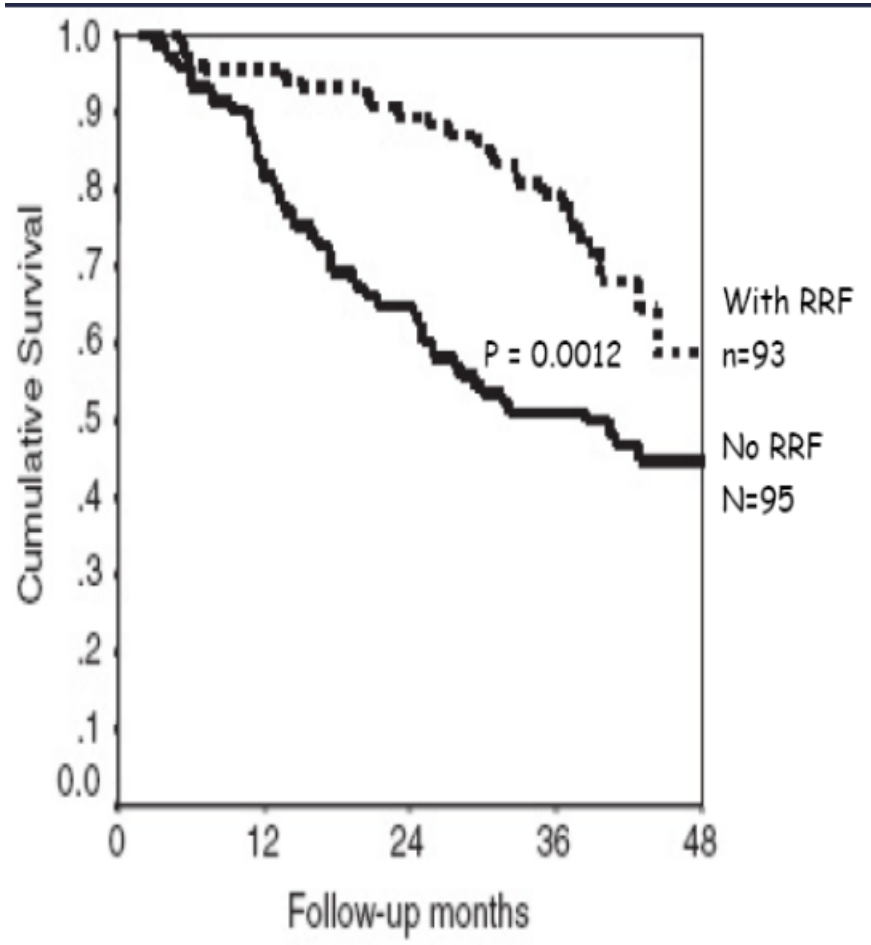


Clearance significativamente aumentate e minor assorbimento del glucosio con adapted APD[1]



Fischbach M. Perit Dial Int 2011; 31(4):450-8

FUNZIIONE RENALE RESIDUA



- Migliora la sopravvivenza dei pazienti
- Miglior controllo della volemia e del rischio CV
- Riduce lo stato infiammatorio e migliora lo stato nutrizionale
- Aumenta la rimozione di Medie-Molecole
- Migliora l'assetto metabolico e l'asse Calcio-Fosforo
- Migliora la qualità di vita

Wang , NDT 2005

Summary of data from studies that have compared rate of loss of residual kidney function in end-stage kidney disease treated with continuous ambulatory peritoneal dialysis and automated peritoneal dialysis (1)

First author (year)	Study type	Period/ country	Data source	Sample size (CAPD, APD)	Follow-up duration	Measure of GFR	Outcome
De Fijter (1994) [18]	Randomized controlled trial	1988–1991 Netherlands	Single center	82 (41, 41)	24 month	24-hour urine CrCl ml/min/1.73 m^2	No significant difference in change in the two groups (CAPD, 4.0 to 2.8 ml/ min/1.73 m^2; APD, 5.4 to 2.1 ml/ min/1.73 m^2)
Hiroshige (1996) [19]	Prospective cohort study	1992–1994 Japan	Single center	18 (5, 13)	6 month	24-hour urine CrCl ml/min/1.73m^2	Approximately 0.3 ml/min/month decline of residual kidney function in APD group compared with no significant change in CAPD group ($p < 0.01$)
Hufnagel (1999) [20]	Prospective cohort study	1995–1997 France	Single center	36 (18, 18)	12 month	24-hour urine CrCl ml/min/1.73m^2	Significantly greater decrease in APD group (−0.28 ml/min/month) vs. the CAPD group (−0.1 ml/min/month) at 6 months ($p = 0.04$). At 1 year, −0.26 ml/min/month with APD vs. −0.13 ml/min/month with CAPD ($p = 0.005$)
Bro (1999) [21]	Randomized controlled trial	1995–1999 Denmark	Multicenter	34 (17,17)	6 month	24-hour urine CrCl ml/min	No significant difference in decline in residual kidney function; mean clearances at the end of 6 months: APD, 3.0 ml/min; CAPD, 3.5 ml/min
Gallar (2000) [22]	Prospective cohort study	Spain	Single center	20 (11, 9)	12 month	Unclear ml/min	No difference in kidney function between groups at baseline or at 1 year. Change in CAPD, 6.11 to 4.9 ml/min; change in APD, 7.1 to 5.5 ml/min

Scott D. Bieber, Applied Perit Dial 2021

Summary of data from studies that have compared rate of loss of residual kidney function in end-stage kidney disease treated with continuous ambulatory peritoneal dialysis and automated peritoneal dialysis (2)

First author (year)	Study type	Period/ country	Data source	Sample size (CAPD, APD)	Follow-up duration	Measure of GFR	Outcome
Hamada (2000) [23]	Prospective cohort study	Japan	Single center	34 (17, 17)	24 month	Daily urine volume, ml/d	Daily urine volume declined significantly more in the CAPD group (381 ml to 147 ml) compared to the APD (223 ml to 157 ml), ($p < 0.01$)
Moist (2000) [10]	National Registry Data	1997 United States	Dialysis Morbidity and Mortality Wave 2 Study of United States Renal Data System	1032 (722, 310)	8–18month	Time to anuria (<200 ml/24 hours)	No significant difference in time to anuria in individuals treated with CAPD and APD
Singhal (2000) [11]	Prospective cohort study	1994–1997 Canada	Single center	242 (211, 31)	27 ± 14 month	Mean of 24-hour urine urea and creatinine clearances, L/week	PD modality a significant predictor of decline in kidney function only when the volume of PD fluid used daily was not included in analysis
Hidaka (2003) [24]	Prospective cohort study	1995–2001 Japan	Single center	34 (27, 7)	12–48 month	Mean of 24-hour urine urea and creatinine clearances, L/week	More rapid loss in kidney function in APD group (22 months vs. 28 months to a 50% reduction in glomerular filtration rate) $p < 0.001$
Johnson (2003) [14]	Prospective cohort study	1995–2001 Australia	Single center	146 (134, 12)	21 ± 15month	Mean of timed urine urea and creatinine clearances, ml/ min/ 1.73m^2	No difference in rate of decline in kidney function in individuals treated with CAPD and APD
Rodriguez-Carmona (2004) [25]	Prospective cohort study	1998–2002 Spain	Single center	104 (53, 51)	12–24 month	Mean of 24-hour urine urea and creatinine clearances, ml/min	Independent significant association of treatment with APD to lower residual kidney function at 1 year

Scott D. Bieber, Applied Perit Dial 2021

Summary of studies comparing surrogate measures of volume management in individuals treated with continuous ambulatory peritoneal dialysis or automated peritoneal dialysis (1)

First author, et al. (publication year)	Study type	Period/ country	Data source	Sample size (CAPD, APD)	Follow-up duration	Outcome
De Fiijter (1994) [18]	Randomized controlled trial	1988–1991 Netherlands	Single center	82 (41, 41)	24 month	No difference in mean arterial pressure or mean dry weight over time. Antihypertensive meds were used in 60% of individuals undergoing CAPD and 74% undergoing APD
Bro (1999) [21]	Randomized controlled trial	1995–1999 Denmark	Multicenter	34 (17,17)	6 month	No episodes of weight > 2 kg above dry weight in CAPD group, two cases in APD group. Mean systolic blood pressure similar in both groups
Frankenfield (1999) [34]	Retrospective study	1995–1997 United States	Multicenter	(~700, 500)	Three different 2-month time periods	No significant difference in proportion of individuals with hypertension by modality
Ortega (2001) [42]	Prospective cohort study	2001 Spain	Single center	36 (16, 20)	24-hour (sodium balance studies)	In CAPD group, daily peritoneal sodium removal and net ultrafiltration volume were significantly higher and systolic blood pressure lower
Rodriguez-Carmona (2002) [43]	Baseline cross-sectional data and prospective cohort study	2002 Spain		141 (63, 78) 32 individuals before and after change from CAPD to APD	3-month, 24-hour collections for sodium balance	Sodium removal was significantly greater in the CAPD group, independent of ultrafiltration volume. Sodium removal decreased significantly after switching from CAPD to APD

Scott D. Bieber, Applied Perit Dial 2021

Summary of studies comparing surrogate measures of volume management in individuals treated with continuous ambulatory peritoneal dialysis or automated peritoneal dialysis (2)

Rodriguez-Carmona (2004) [25]	Prospective cohort study	1998–2002 Spain	Single center	104 (53, 51)	12–24 month	Ultrafiltration and sodium removal rates were consistently and significantly lower in APD group. Better control of systolic blood pressure in CAPD group
Bavbek (2007) [44]	Cross-sectional study	2007 Turkey	Two centers	62 (32, 30)	–	APD group with significantly lower daily ultrafiltration volume, higher serum brain natriuretic peptide, and left ventricular mass index but no significant difference in blood pressure, compared to CAPD group
Davison (2009) [45]	Cross-sectional study	2004–2006 Canada	Single center	158 (90, 68)	–	No significant difference in sodium removal, ultrafiltration, or blood pressure between groups. Liberal use of icodextrin, limited number of nocturnal exchanges, and supplemental daytime exchange in APD group
Van Biesen (2011) [46]	Cross-sectional study	Europe	Multicenter	661 (53% APD)		Individuals without access to icodextrin were excluded. PD modality was not associated with extracellular volume excess as measured by bioimpedance
Cnossen (2012) [47]	Cross-sectional study	Netherlands	Multicenter	44 (24, 20)	~21–30 month	Total sodium removal lower in APD compared with CAPD but no statistically significant difference in systolic blood pressure, ultrafiltration volumes, or brain natriuretic peptide UF

APD automated peritoneal dialysis, *CAPD* continuous ambulatory peritoneal dialysis

Scott D. Bieber, Applied Perit Dial 2021

Automated vs continuous ambulatory peritoneal dialysis: a systematic review of randomized controlled trials

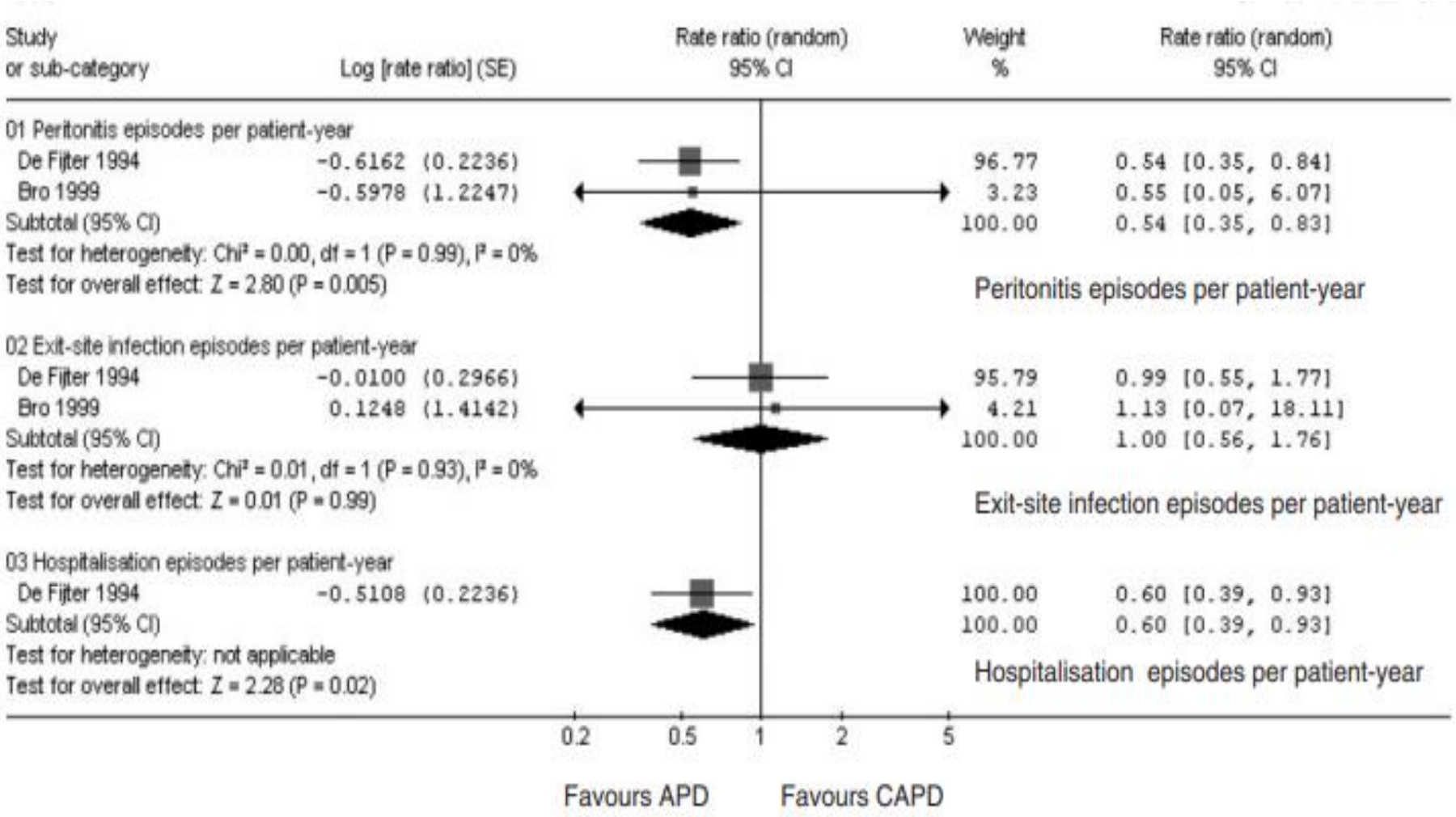
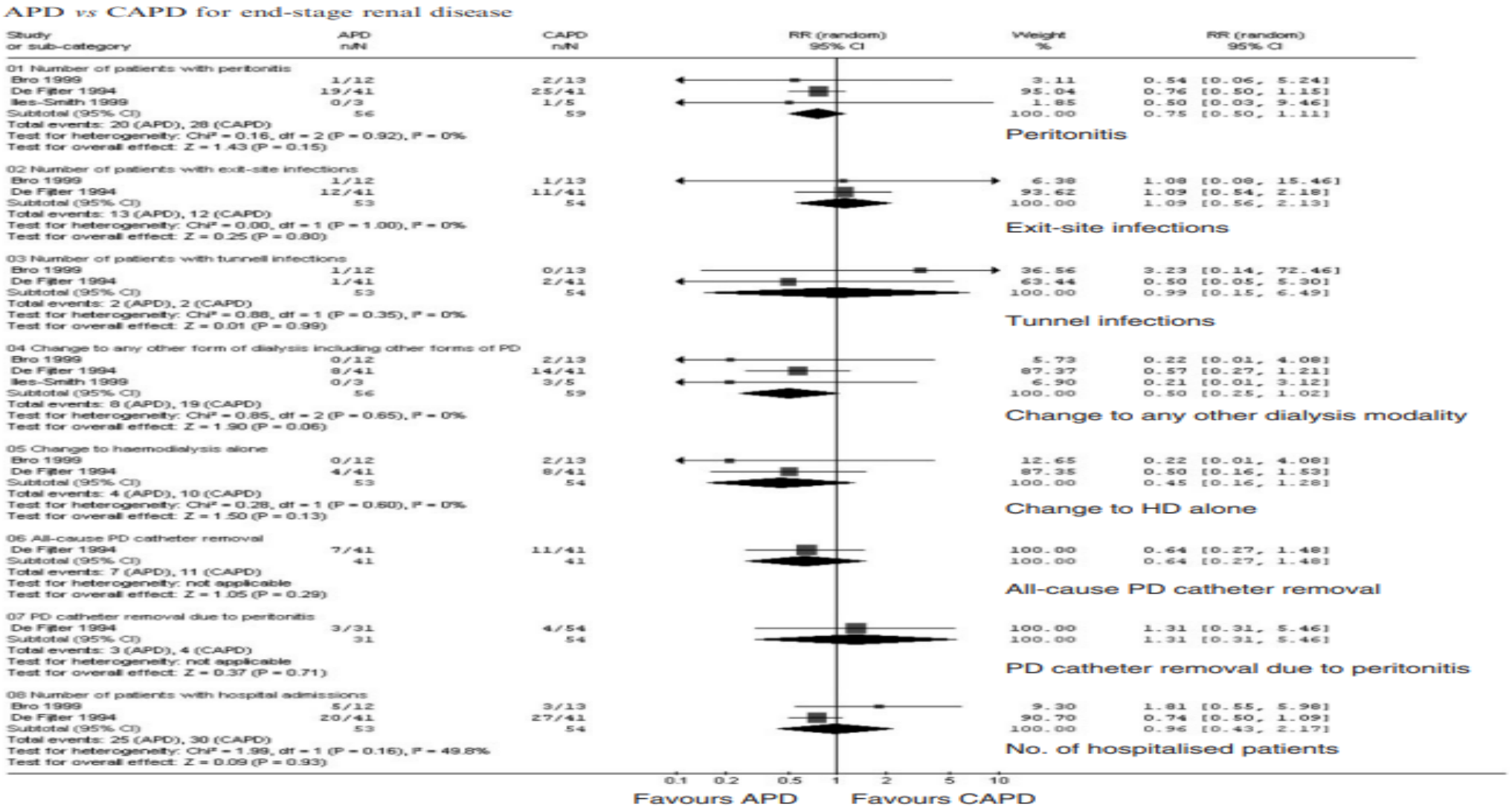


Fig. 3. Complications expressed as episodes per patient-year.

Rabindranath KA et al Nephrol Dial Transplant (2007) 22: 2991–2998

Automated vs continuous ambulatory peritoneal dialysis: a systematic review of randomized controlled trials



Rabindranath KA et al Nephrol Dial Transplant (2007) 22: 2991–2998

Summary of data from studies that have compared risk of peritonitis in end-stage kidney disease treated with continuous ambulatory peritoneal dialysis and automated peritoneal dialysis (1)

First author, et al. (publication year)	Study type	Period/ country	Data source	Sample size (CAPD, APD)	Follow-up duration	Outcome
De Fijjter (1994) [18]	Randomized controlled trial	1988–1991 Netherlands	Single center	82 (41, 41)	24 month	Overall rate (episodes per patient year) was 0.94 for CAPD and 0.54 for APD, difference of 0.43 episodes per patient year ($p = 0.03$). Median time to first episode of peritonitis was 18 months for APD and 11 months for CAPD ($p = 0.06$)
Bro (1999) [21]	Randomized controlled trial	1995–1999 Denmark	Multicenter	34 (17,17)	6 month	2 cases of peritonitis in CAPD group and 1 case in APD group
Oo (2005) [32]	National Registry Data	1994–1997 United States	Multicenter	11,975 (9190, 2785)	6 month–2 years	Average time to first peritonitis longer with CAPD compared to APD (17.1 vs. 16.1 months (0.70 vs. 0.74 episodes per patient-year, respectively) $p = 0.008$)
Davenport (2009) [33]	Retrospective study	2002–2003 United Kingdom	Multicenter	863 (538, 325)	2 years	Average number of months between peritonitis episodes 14.7 for CAPD and 18.1 for APD (0.81 vs. 0.66 episodes per patient year, respectively) ($p < 0.05$). Significant variation in peritonitis rates between facilities
Nessim (2009) [35]	Retrospective study	1996–2005 Canada	Multicenter	3180 (unclear)		No difference in peritonitis rate ratio between CAPD and APD (RR = 1.03, 95% CI 0.91–1.16, $p = 0.65$). CAPD was not associated with shorter time to peritonitis than APD (HR 1.02, 95% CI 0.92–1.13, $p = 0.69$)
Balasubramanian (2011) [27]	Retrospective study	2003–2008 United Kingdom	Single center	372 (178, 194)	5 years	CAPD peritonitis rate 1:29 patient months, APD peritonitis rate 1:37 (0.41 vs. 0.32 episodes per patient year, respectively). Odds ratio 0.78 in favor of APD (95% CI 0.63–0.98)

Scott D. Bieber, Applied Perit Dial 2021

Summary of data from studies that have compared risk of peritonitis in end-stage kidney disease treated with continuous ambulatory peritoneal dialysis and automated peritoneal dialysis (2)

First author, et al. (publication year)	Study type	Period/ country	Data source	Sample size (CAPD, APD)	Follow-up duration	Outcome
Ruger (2011) [36]	Retrospective study	1993–2007 Netherlands	Single center	205 (112, 93)	Review of all cases of peritonitis, 14-year period	Peritonitis frequency in CAPD 1:18.6 patient months and 1:19.4 patient months in APD (0.65 vs. 0.62 episodes per patient year, respectively), difference not statistically significant
Lan (2014) [38]	Prospective cohort	2003–2011 Australia, New Zealand	Multicenter	6959 (2761,4198)	1.9 years	PD modality was not associated with a higher likelihood of developing peritonitis. APD was associated with a borderline reduction in the likelihood of a first episode of Gram-positive peritonitis and with lower rates of culture-negative peritonitis and higher rates of Gram-negative peritonitis. Peritonitis outcomes were comparable between both modalities
Beduschi (2015) [39]	Prospective cohort	2004–2011 Brazil	Multicenter	2890 (1445, 1445) Propensity score matched	60 months	No difference in time to first peritonitis between groups (HR 1.04; CI95% 0.90 to 1.20). No difference in peritonitis rates between groups: CAPD 0.23 vs. APD 0.26 episodes per patient year
El-Reshaid (2016) [37]	Retrospective study	2005–2014 Kuwait	Single center	208 (180, 128)	Variable	The peritonitis rates were 1 in 29 months in CAPD and 1 in 38 months in APD ($p < 0.05$). Percentages of peritonitis-free patients over 10-year period in CAPD and APD were 49 and 60%, respectively ($p < 0.05$). Time to develop peritonitis was 10.25 ± 3.1 months in CAPD compared to 16.1 ± 4 months in APD ($p < 0.001$). Relapse and recurrence rates were similar in both groups

APD automated peritoneal dialysis, *CAPD* continuous ambulatory peritoneal dialysis

Scott D. Bieber, Applied Perit Dial 2021

Riassorbimento glucidico e perdite proteiche peritoneali

Riassorbimento peritoneale del glucosio

Anche se i dati disponibili in letteratura sono scarsi, l'assorbimento glucidico (g/24 ore) sembra mediamente più elevato in APD vs. CAPD) verosimilmente in virtù dei maggiori volumi di soluzione dializzante utilizzati. L'assorbimento glucidico in APD vs. CAPD è superiore anche in percentuale sulla quantità contenuta nel dializzante (57% vs. 41%)

Perdite proteiche peritoneali

Le perdite proteiche peritoneali non sembrano mediamente differenti in CAPD vs. APD (NIPD + CCPD) anche se gli studi comparativi sono esigui Le perdite proteiche non sono risultate diverse tra CAPD vs. NIPD (7,6 vs. 7,6 g/die) [8] o tra CAPD vs. CCPD (6,2 vs. 6,3 g/die [9] e 6,5 vs. 6,2 g/die

QUALITA' DI VITA

Table 7.5 Summary of studies comparing health-related quality of life in individuals treated with continuous ambulatory peritoneal dialysis or automated peritoneal dialysis

First author, et al. (publication year)	Study type	Period/ country	Data source	Sample size (CAPD, APD)	Follow-up duration	Outcome
Bro (1999) [21]	Randomized controlled trial	1995–1999 Denmark	Multicenter	34 (17,17)	6 month	Significantly more time for work, family, and social activities but greater problems with sleep disturbances in APD group
de Wit (2001) [63]	Cross-sectional study	1993–2001 Netherlands	Multicenter The Netherlands Cooperative Study on the Adequacy of Dialysis (NECOSAD)	96 (59, 37)		Mental health better in APD group: less depression and anxiety. No difference in physical functioning.
Sunder (2008) [64]	Prospective observational study (fixed crossover design)	India	Single center	18 (all high or high average transporters)	All individuals underwent 6 month CAPD followed by 6 month APD	No significant difference in parameters of physical or mental quality of life
Guney (2010) [65]	Cross-sectional study	Turkey	Single center	68 (48, 20)		No significant difference in health-related quality of life, sleep quality, or depression
Balasubramanian (2011) [27]	Retrospective study	2003–2008 United Kingdom	Single center	372 (178, 194)	5 years	No significant difference in health status, physical or mental health scores by SF-36 questionnaire
Michels (2011) [29]	Prospective cohort study	1997–2006 Netherlands	The Netherlands cooperative study on the adequacy of Dialysis (NECOSAD)	550 (486, 64)	3 month–3 year	No significant differences in quality-of-life scores between groups
Yang (2018) [66]	Cross-sectional study	2009–2013	Singapore Multicenter	266 (145,121)	2 surveys	No significant difference in quality-of-life scores between groups

APD automated peritoneal dialysis, *CAPD* continuous ambulatory peritoneal dialysis

Scott D. Bieber, Applied Perit Dial 2021

APD NEI BAMBINI

Miglior personalizzazione del trattamento in base ad età, corporatura ed esigenze metaboliche del bambino in fase di sviluppo

Maggior tempo libero durante il giorno per i bambini e genitori , evitando necessità di scambio peritoneale in orario scolastico

Miglior qualità di vita nei bambini in APD e loro genitori

APD ASSISTITA NEGLI ANZIANI

Se necessità di caregiver , APD dovrebbe essere la modalità di scelta : riduce il carico di lavoro del caregiver, vantaggioso in RSA

Roumeliotis A et al International Urology and Nephrology (2021) 53:1149–1160

APD vs. CAPD

Studies have generally shown no significant differences between CAPD and APD for:

- **Mortality**[1,2]
- **Hospital admissions**[1]
- **Risk of peritonitis**[1]
- **Loss of RKF***[2]
  *Controversial, some smaller observational studies have shown faster loss of RKF with APD, but a majority do not show a difference[2].
- **Volume management**[1,2]
- **Technique survival**[1]
- **Fluid leaks or hernia**[1]
- **Health-related QoL**[2]

1 Rabindranath KS, et al. Cochrane database Syst Rev. 2007;2007(2):CD006515.
2Bieber SD, et al. Am J Kidney Dis. 2014;63(6):1027-1037

Benefits and Challenges

CAPD

Potential Benefits

- Simple
- Shorter training time
- Emergency preparedness
- Ease of travel
- Better sleep

Challenges

- Workload and burnout
- Exchange schedule fitting into daily life
- Lower dwell volume during waking hours

APD

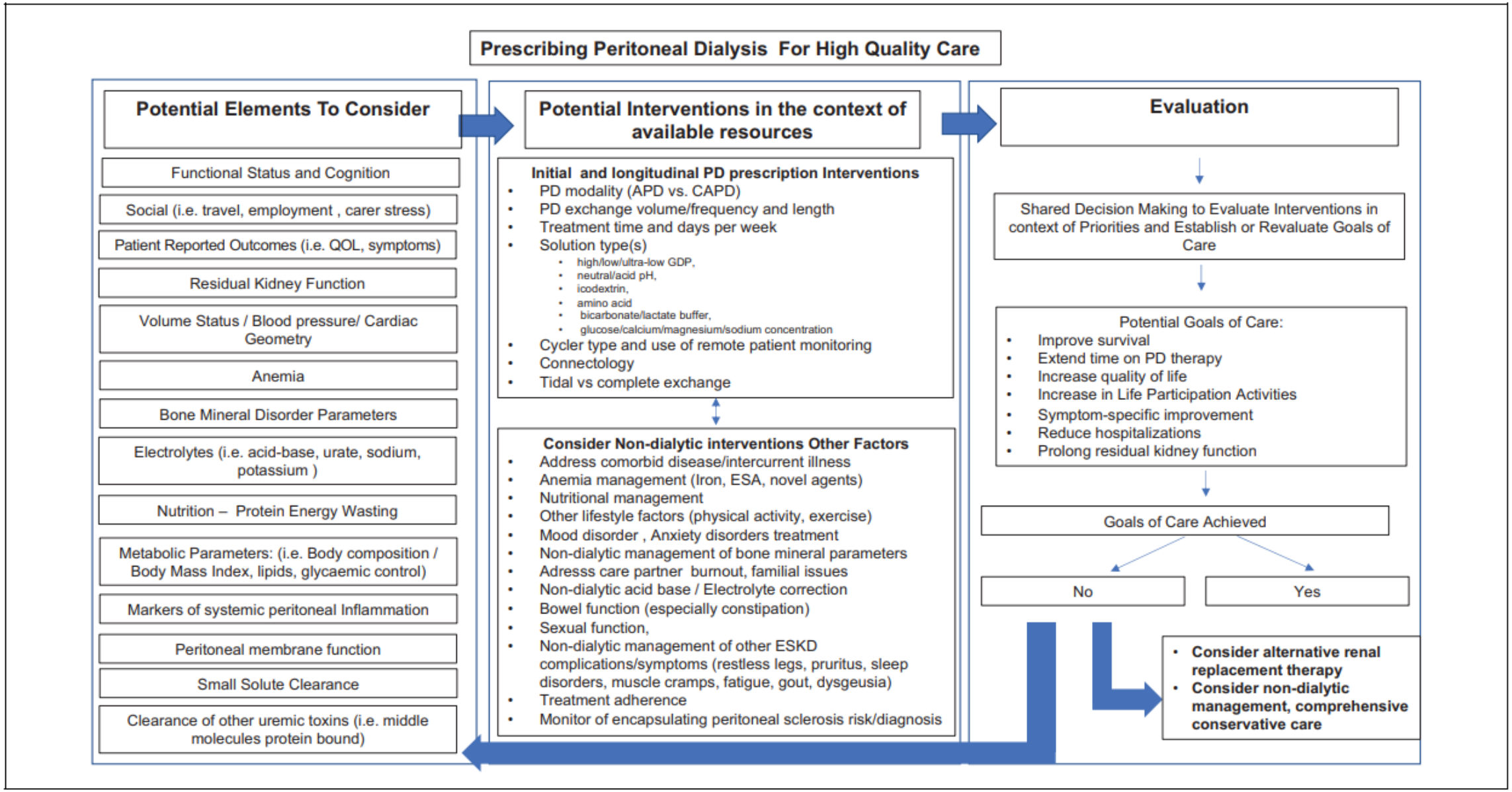
Potential Benefits

- Fewer hands-on procedures
- Lower burnout
- Free days may be easier for work or school

Challenges

- Requires machine
- Technical training
- Sleep interruption

Blake PG, Daugirdas JT. Handbook of Dialysis. 5th ed. 2015:464-482

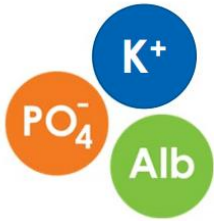


Brown EA, et al. Perit Dial Int. 2020;40(3):244-253

Components of High Quality, Goal-Directed PD Care

Maximized quality of life & minimized therapy burden

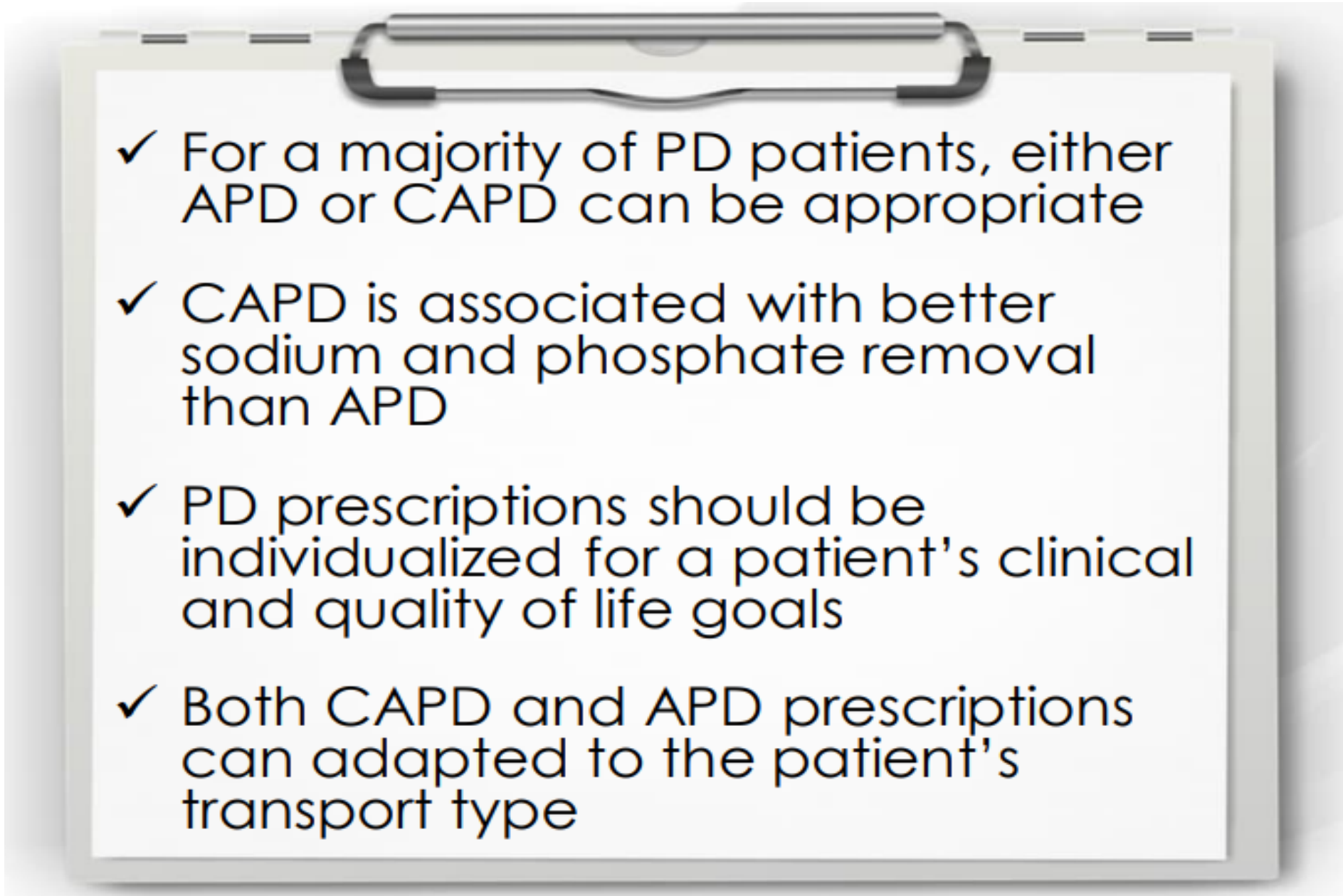
Fluid balance, BP control, cardiac markers acceptable



Biochemical & nutritional markers within acceptable ranges

Small solute clearance targets are met

Brown EA, et al. Perit Dial Int. 2020;40(3):244-253


✓ For a majority of PD patients, either APD or CAPD can be appropriate
✓ CAPD is associated with better sodium and phosphate removal than APD
✓ PD prescriptions should be individualized for a patient's clinical and quality of life goals
✓ Both CAPD and APD prescriptions can adapted to the patient's transport type