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Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease (Review)

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Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease.
Cochrane Database of Systematic Reviews 2007, Issue 2. Art. No.: CD006515.
DOI: 10.1002/14651858.CD006515.

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[Intervention Review]

Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

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Editorial group: Cochrane Kidney and Transplant Group.
Publication status and date: Edited (no change to conclusions), published in Issue 1, 2010.

Citation: Rabindranath KS, Adams J, Ali TZ, MacLeod AM, Vale L, Cody JD, Wallace SA, Daly C. Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease. *Cochrane Database of Systematic Reviews* 2007, Issue 2. Art. No.: CD006515. DOI: 10.1002/14651858.CD006515.

ABSTRACT

Background

Peritoneal dialysis (PD) can be performed either manually as in continuous ambulatory peritoneal dialysis (CAPD) or using mechanical devices as in automated PD (APD). APD has been considered to have several advantages over CAPD such as reduced incidence of peritonitis, mechanical complications and greater psychosocial acceptability.

Objectives

To assess the comparative efficacy of CAPD and APD in patients who are dialysed for end-stage renal disease (ESRD).

Search methods

We searched MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Renal Group's specialised register and CINAHL. Authors of included studies were contacted, reference lists of identified RCTs and relevant narrative reviews were screened.

Date of most recent search: May 2006

Selection criteria

RCTs comparing CAPD with APD in patients with ESRD.

Data collection and analysis

Data were abstracted independently by two authors onto a standard form. Risk ratio (RR) for dichotomous data and a mean difference (MD) for continuous data were calculated with 95% confidence intervals (CI).

Main results

Three trials (139 patients) were included. APD did not differ from CAPD with respect to mortality (RR 1.49, 95% CI 0.51 to 4.37), risk of peritonitis (RR 0.75, 95% CI 0.50 to 1.11), switching from original PD modality to a different dialysis modality (RR 0.50, 95% CI 0.25 to 1.02), hernias (RR 1.26, 95% interval 0.32 to 5.01), PD fluid leaks (RR 1.06, 95% CI 0.11 to 9.83), PD catheter removal (RR 0.64, 95% CI 0.27 to 1.48) or hospital admissions (RR 0.96, 95% CI 0.43 to 2.17). There was no difference between either PD modality with respect to residual renal function (MD -0.17, 95% CI -1.66 to 1.32). One study found that peritonitis rates and hospitalisation were significantly less in patients on APD when results were expressed as episodes/patient-year. Another study found that patients on APD had significantly more time for work, family and social activities.

Authors' conclusions

APD has not been shown to have significant advantages over CAPD in terms of important clinical outcomes. APD may however be considered advantageous in select group of patients such as in the younger PD population and those in employment or education due to its psychosocial advantages. There is a need for a RCT comparing CAPD with APD with sufficiently large patient numbers looking at important clinical outcomes including residual renal function, accompanied by an economic evaluation to clarify the relative clinical and cost-effectiveness of both modalities.

PLAIN LANGUAGE SUMMARY

Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Peritoneal dialysis (PD) can be performed either manually as in continuous ambulatory peritoneal dialysis (CAPD) or using mechanical devices as in automated PD (APD). The aim of this review was to compare the effectiveness of CAPD and APD. Only three small randomised controlled trials (RCTs) (139 patients) were identified after an extensive literature search, and we found no difference between CAPD and APD for clinically important outcomes. APD may however be considered advantageous in select group of patients such as in the younger PD population and those in employment or education due to its psychosocial advantages. These outcomes were only reported in one trial. Large, long-term RCTs are needed in this area.

BACKGROUND

Continuous ambulatory peritoneal dialysis (CAPD) involves performing the PD exchanges manually whereas, automated PD (APD) is a broad term that is used to refer to all forms of PD employing a mechanical device to assist the delivery and drainage of dialysate. The various forms of APD include continuous cyclical PD (CCPD), intermittent PD (IPD), nightly intermittent PD (NIPD), and tidal PD (TPD). In CAPD, the patient or carer must perform at least three to five exchanges every day. Many problems inherent to CAPD such as lack of sustained patient motivation over long periods of time, technique failure, and recurrent peritonitis, led to a resurgence of interest in APD and the introduction of CCPD in 1981 (Diaz-Buxo 1985; Venkataraman 2002). APD has been reported to have several advantages over CAPD including lesser incidence of peritonitis (Brunkhorst 1994; Holley 1990a), better small solute clearances (Rodriguez 1998) and reduced incidences of hernias (Kathuria 1994). APD (in the form of NIPD) has also been suggested to offer a number of unproven psychosocial benefits over CAPD, which relate directly to fewer connections and patient independence from dialysis during the daytime, particularly for workers, school pupils or carers of elderly or debilitated patients (Wrenger 1996). Additional benefits of APD include possibly reduced back pain and body image difficulties due to being free of fluid in the abdomen during the daytime (Wrenger 1996). Performing APD at night in the supine position has been shown to result in reduced intra-abdominal pressures compared with the upright position in CAPD (Twardowski 1983). APD is also considered to be more suitable form of PD in patients who have a rapid rate of solute transfer across their peritoneal membrane (high transporters) because of the ability to perform rapid frequent exchanges with shorter dwell times (EBPG 2005). APD has in fact been proposed as an alternative to CAPD in all patients for whom PD is considered suitable (Diaz-Buxo 1985). The Renal Association (UK) and the European Best Practice Guidelines for peritoneal dialysis recommend APD for PD patients who have high peritoneal transporter status, in those with need to avoid high

intraperitoneal pressures and in patients with psychosocial reasons (EBPG 2005; UKRA 2002).

The proportion of PD patients on APD has been steadily increasing over the past decade. In the US the percentage of PD patients on APD has risen from 9% in 1993 to 28% in 1997 and to 54% on 2000 (Blake 1999b; Flanigan 2001). The direct costs of APD have been shown to be 1.22 times greater than CAPD (Bro 1999). Given the consistently increasing trend towards greater APD usage it is important to know the proposed psychosocial and clinical benefits of APD have to be weighted against its increased cost and the risk of likely acceleration of residual renal function decline compared to CAPD.

OBJECTIVES

We evaluated the comparative clinical efficacy of CAPD with all forms of APD.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs) comparing APD with CAPD.

Types of participants

All adult patients undergoing PD for end-stage renal disease (ESRD).

Types of interventions

- APD versus CAPD.
- All forms of APD (NIPD, CCPD, TPD, IPD, PD-plus) were considered eligible for inclusion.

Types of outcome measures

- Frequency of PD-related peritonitis
- Frequency of exit-site and tunnel infections
- Frequency of PD-catheter changes
- Incidence of abdominal hernias, hydrothoraces and exit-site leaks
- Incidence of technique failure
- Dialysis adequacy measures such as Kt/V and creatinine clearance (weekly)
- Hospitalisation (number of patients hospitalised, number of hospitalisation episodes and number of days of hospitalisation)
- Quality of life (any measure)
- Mortality
- Blood pressure (systolic, diastolic and mean arterial)
- Residual renal function

Search methods for identification of studies

Relevant trials were obtained from the following sources (see Appendix 1 - *Electronic search strategies*).

1. Cochrane Central Register of Controlled Trials (CENTRAL) and the Database of Abstracts of Reviews of Effectiveness (DARE) in *The Cochrane Library* (Issue 2, 2006)
2. Cochrane Renal Group's specialised register (May 2006)
3. MEDLINE and Pre MEDLINE (1966 to May 2006)
4. EMBASE (1980 to May 2006).
5. American College of Physicians database (May 2006)
6. CINAHL (1872 to May 2006)
7. Reference lists of nephrology textbooks, review articles and relevant trials.

Both published and unpublished trials were included without language restriction. Additionally, the authors sent letters seeking information about unpublished or incomplete trials to investigators known to be involved in previous trials. When duplicate publications of a trial existed, the most recently published version was used. Where relevant outcomes were only published in earlier versions, their data was also included and the source was, and any discrepancies between published versions were highlighted.

Data collection and analysis

The review was undertaken by eight authors (KSR, JA, TA, CD, JC, SW, LV, AMM). The search strategies described were used to obtain titles and abstracts of studies that might be relevant to the review. Authors KSR and TA independently assessed, and retrieved titles and abstracts. The full text (if published) of all potentially relevant studies were retrieved and independently assessed for inclusion by TA and KSR. Data extraction was carried out independently by KSR and JA using standard data extraction forms. It was planned that studies reported in non-English language journals (if any) would be translated before assessment. Where more than one publication of one trial existed, only the publication with the most complete data was included. Any further information or clarification required from the authors was requested by written or electronic correspondence and relevant data obtained in this manner were included in the review. Disagreements were resolved in consultation with a third author (AMM).

Study quality

The methods quality of included studies was assessed independently by KSR and TA without blinding to authorship or journal using the checklist developed by the Cochrane Renal Group. Discrepancies were resolved by discussion with a third author (AMM). The quality items assessed were allocation concealment, blinding of investigators, participants and outcome assessors, intention-to-treat analysis and the completeness of follow-up.

Quality checklist

1. Allocation concealment

- Adequate - Randomisation method described that would not allow investigator/participant to know or influence intervention group before eligible participant entered in the study
- Unclear - Randomisation stated but no information on method used is available
- Inadequate - Method of randomisation used such as alternate medical record numbers or unsealed envelopes; any information in the study that indicated that investigators or participants could influence intervention group

2. Blinding

- Blinding of investigators: Yes/No/not stated
- Blinding of participants: Yes/No/not stated
- Blinding of outcome assessor: Yes/No/not stated
- Blinding of data analysis: Yes/No/not stated

3. Intention-to-treat analysis

- Yes: Specifically reported by authors that intention-to-treat analysis (ITT) was undertaken and this was confirmed on study assessment, or not stated but evident from study assessment that ITT was undertaken
- Unclear: Reported but unable to confirm on study assessment, or not reported and unable to confirm by study assessment.
- No: Lack of intention-to-treat analysis confirmed on study assessment (patients who were randomised were not included in the analysis because they did not receive the study intervention, they withdrew from the study or were not included because of protocol violation) regardless of whether ITT reported or not

4. Completeness of follow-up

The percentage of participants for whom data was complete at defined study end-point. Where interim analyses are reported 'not stated' were recorded.

Statistical analysis

For dichotomous outcomes (mortality, number of patients with PD-related infections, number of hospitalised patients, number of patients with technique failure) results were expressed as risk ratios (RR) with 95% confidence intervals (CI) for individual studies.
When outcomes were measured by continuous scales of measurement (quality of life measures, Kt/V, blood pressure, frequency of peritonitis, exit site and tunnel infections, abdominal hernias, exit site leaks, hydrothoraces), the mean difference (MD) was used to evaluate the difference between end-of treatment values of the outcome in the treatment versus the control group or the difference in the change from the beginning to the end of treatment values in the treatment versus the control group.
Data were pooled using a random effects model. For each analysis, the fixed effects model was also evaluated to ensure robustness of the model chosen and susceptibility to outliers.
Subgroup analyses were planned to explore how possible sources of heterogeneity (diabetic status, peritoneal solute transporter status) might have influenced treatment effect. Unfortunately there were insufficient studies identified to perform these analyses.
Heterogeneity of treatment effects between studies was formally tested using the Q and the I^2 statistics.

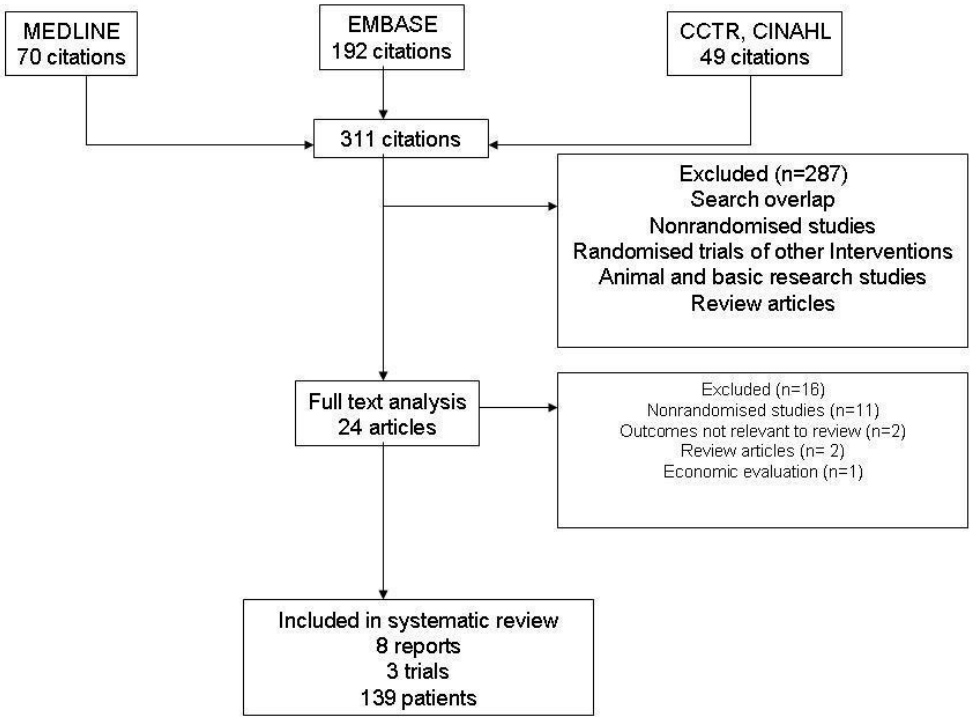
RESULTS

Description of studies

The combined search of MEDLINE, EMBASE, CINAHL, and CENTRAL identified 311 potentially relevant studies. After reviewing titles and abstracts, 287 studies were excluded. The full text-versions of 24 studies were retrieved, and we excluded 16 of these reports of studies. The major reason for exclusion was that the identified studies were not randomised. Finally, three studies (Bro 1999; De Fijter 1994; Iles-Smith 1999) published in eight reports were included (see Figure 1 - *Flowchart of study screening process*). The characteristics of the populations and interventions in the included trials are reported in the Characteristics of included studies.

Figure 1. Flowchart indicating the number of citation retrived by individual searches and the final number and grouping of included trials; reasons for exclusions are provided

Figure 1. Flowchart indicating the number of citations retrieved by individual searches and the final number and grouping of included trials; reasons for exclusions are provided.



Authors of all included trials were contacted for clarification regarding trial methodology and additional unpublished data. All three studies had a parallel design.

Risk of bias in included studies

Allocation concealment

All trials stated that patients were randomised into treatment and control groups. All three studies had an adequate method of allocation concealment. The method of allocation concealment in two studies (De Fijter 1994; Iles-Smith 1999) was obtained by contacting the authors. For De Fijter 1994 and Iles-Smith 1999 allocation concealment was by sealed envelopes. Bro 1999 used centralised randomisation and permuted blocks stratified according to clinical centre, age and diabetic status.

Blinding

Due to the nature of the investigation we did not expect blinding of participants and investigators. None of the studies reported blinding of outcome assessors.

Reported intention-to treat analysis

None of the trials (0%) were analysed on an intention-to-treat basis.

Completeness of follow-up

Dropouts were lost to follow-up for reasons other than death. A total of 67/139 patients dropped out. Reasons were; transplants (31), recovery of renal function (3), technique failure (peritonitis, poor ultrafiltration, general medical conditions and psychosocial reasons) (33).

Effects of interventions

Infectious complications

PD-related peritonitis

There was no difference in the risk of PD-related peritonitis between APD and CAPD (Analysis 1.2.1 (3 trials, 115 patients): RR 0.75, 95% CI 0.50 to 1.11). Heterogeneity was not significant (χ^2 = 0.16, P = 0.92; I^2 = 0%).

Exit-site infections

There was no difference in risk of exit-site infections between patients in either group (Analysis 1.2.2 (2 trials, 107 patients): RR 1.09, 95% CI 0.56 to 2.13). Heterogeneity was not significant (χ^2 = 0.00, P = 1.00; I^2 = 0%).

Tunnel infections

There was no difference in the risk of tunnel infections between patients in the two groups (Analysis 1.2.3 (2 trials, 107 patients): RR 0.99, 95% CI 0.15 to 6.49). Heterogeneity was not significant (χ^2 = 0.88, P = 0.35; I^2 = 0%).

Change of dialysis modality

Number switching to other dialysis modalities including other forms of PD

There was no significant difference in the risk of patients for switching from their original PD modality to a different dialysis modality including an alternate form of PD (Analysis 1.3.1 (3 trials, 115 patients): RR 0.50, 95% CI 0.25 to 1.02). Heterogeneity was not significant (χ^2 = 0.85, P = 0.65; I^2 = 0%).

Number switching to haemodialysis alone

Patients on APD did not have a significantly lower risk of switching to haemodialysis alone (Analysis 1.3.2 (2 trials, 107 patients): RR 0.45, 95% CI 0.16 to 1.28). Heterogeneity was not significant (χ^2 = 0.28, P = 0.60; I^2 = 0%).

Mechanical complications

Hernias

There was no difference between either group for the risk of developing hernias (Analysis 1.4.1 (2 trials, 107 patients): RR 1.26, 95% CI 0.32 to 5.01). There was no heterogeneity (χ^2 = 0.44, P = 0.51; I^2 = 0%).

PD fluid leaks

Patients on APD did not have a significantly lower risk of PD fluid leaks (Analysis 1.4.2 (2 trials, 107 patients): RR 1.06, 95% CI 0.11 to 9.83). Heterogeneity was not significant (χ^2 = 1.00, P = 0.32; I^2 = 0.5%).

Hydrothoraces

There was no difference between either group for the risk of developing this complication (Analysis 1.4.3 (1 trial, 82 patients): RR 1.00, 95% CI 0.06 to 15.45).

PD catheter removal

Removal due to all causes

There was no difference between the patient groups for this complication (Analysis 1.5.1 (1 trial, 82 patients): RR 0.64, 95% CI 0.27 to 1.48).

Removal due to peritonitis episodes

There was no difference between treatment groups (Analysis 1.5.2(1 trial, 85 patients): RR 1.31, 95% CI 0.31 to 5.46).

Hospital admissions

APD did not reduce the risk of hospital admissions compared with CAPD (Analysis 1.6 (2 trials, 107 patients): RR 0.96, 95% CI 0.43 to 2.17). Heterogeneity was not significant (χ^2 = 1.99, P = 0.16; I^2 = 49.8%). De Fijter 1994 reported that when hospitalisation rates were expressed as episodes/patient-year, patients on APD had significantly lower hospitalisation rates than those on CAPD.

Dialysis adequacy measures

Weekly Kt/V

There was no difference in weekly Kt/V values achieved by patients on APD and those on CAPD (Analysis 1.7.1(2 trials, 49 patients): MD 0.12, 95% CI -0.22 to 0.47). Heterogeneity was not significant (χ^2 = 0.30, P = 0.58; I^2 = 0%).

Weekly creatinine clearance

Patients on APD did not have significantly higher weekly creatinine clearance values according to the only study that reported this analysis (Analysis 1.7.2 (1 trial, 52 patients): MD -6.60, 95% CI -24.19 to 10.99).

Residual renal function

End of study creatinine clearances were not different between either study group (Analysis 1.8 (2 trials, 49 patients): MD -0.17, 95% CI -1.66 to 1.32).

Quality of Life

Only De Fijter 1994 reported data in a meta-analysable format. This study assessed quality of life using the Karnofsky score and there was no difference between the two groups (Analysis 1.9.1 (1 trial, 24 patients): MD 6.00, 95% CI 0.00 to 12.00).

Iles-Smith 1999 used an unvalidated tool. 'The Ladder Scale' reported that whilst there was a small reduction (from 5.5 to 5.25) of the scores during the study period in those on CAPD, there was a small improvement in the scores obtained (from 5.7 to 6) in patients on APD. This study also showed that whilst patients on APD showed no change (group mean score 86.7) in Karnofsky scores between the start and end of study, those on CAPD experience a small decline (from 82.5 to 80).

Bro 1999 used the Short Form-36 (SF-36) (a validated tool) to assess quality of life. They found no significant difference in scores between either patient group. Patients on APD and CAPD had similar ESR-Related symptom score. This study however found in their 'Patient satisfaction with treatment score' that patients on APD had significantly more time for work, family and social activities ($P < 0.0005$).

Mortality

There was no difference in mortality between patients on CAPD and APD (Analysis 1.1.1 (2 trials, 122 patients): RR 1.49, 95% CI 0.51 to 4.37). Tests for heterogeneity were not applicable to this analysis as only one study had occurrence of death during the study period.

Blood pressure (systolic, diastolic and mean arterial)

There was no difference in systolic (Analysis 1.10.1 (1 trial, 25 patients): MD 6.00, 95% CI -14.08 to 26.08) or diastolic (Analysis 1.10.2 (1 trial, 25 patients): MD 6.00, 95% CI -6.48 to 18.48) blood pressures between treatment groups.

DISCUSSION

APD did not differ from CAPD with respect to important clinical benefits such as mortality, risk of peritonitis, switching from their original PD modality to a different dialysis modality including an alternative form of PD, hernias, PD fluid leaks, PD catheter removal and hospital admissions. Dialysis adequacy measures were also not different between both PD modalities. It must be noted that one study (De Fijter 1994) found that peritonitis rates and hospitalisation were significantly less in patients on APD when these results were expressed as episodes/patient-year. Whilst most of the quality of life measures were not different between patients on APD and CAPD, Bro 1999 found that patients on APD had significantly more time for work, family and social activities. It is important to note that whilst there were no statistically significant differences between either PD modality with respect to most outcomes, the 95% CIs were wide enough to suggest that clinically important differences may indeed exist.

The effect of APD on peritonitis rates when compared to CAPD is controversial with some favouring APD (Brunkhorst 1994; Holley 1990a; Rodriguez-Carm 1999), some CAPD (Golper 1996; Oo 2005) and a few others finding peritonitis rates to be similar between both modalities (Howard 1990; Troidle 1998; Viglino 1995). Our meta-analysis of number of patients with peritonitis during the trial period did not find any difference. An analysis of a large cohort of patients (> 30,000) starting PD over a three-year period showed that in the first year of dialysis patients on APD had a significantly better patient and dialysis technique (Guo 2003). Although patients on APD were found to younger than CAPD patients, the differences in patient and technique survival were significant even after adjustment for age and diabetes status. In contrast to this study our evidence, derived from RCTs, did not show any evidence of better patient or technique survival between APD and CAPD.

The CANUSA study and other studies have shown an increased mortality in CAPD patients with peritoneal membrane high or rapid solute transport characteristics (Blake 1999b; Churchill 1998). Although APD may offer better small solute clearances in such patients compared to CAPD, currently there is no evidence that this translates into improved survival rates (Brown 2003). In the study by Bro 1999, only patients with high or high-average peritoneal transport characteristics were included. This study allowed us to explore the hypothesis that patients with such peritoneal transport characteristics might do better on APD than on CAPD. This study did not show any advantage with APD with regards to patient or technique survival in this specific PD population group but this may be due to the study's small patient population and short follow-up period.

Although APD has the potential to offer better small solute clearances than CAPD, our meta-analysis did not demonstrate any differences in dialysis adequacy. This is not surprising as previous studies have shown that in real life situations the differences between both modalities with respect to creatinine clearances are modest at best. The 1996 Peritoneal Dialysis Core Indicators Study showed that weekly creatinine clearances were 58.9 L for CAPD and 60.7 L for APD (Blake 1999b).

Preservation of residual renal function is of great importance as it has been shown to be a predictor of patient survival for those on PD (Bargman 1995). Some studies have shown that APD is associated

with a more rapid loss of residual renal function when compared to those on CAPD (Hiroshige 1996; Hufnagel 1999). However subsequent studies have given contradictory results (Holley 2001; Moist 2000). Our review did not show any difference in end of study period residual renal function, between either PD modality.

The strength of this analysis is that this is a comprehensive systematic review of RCTs comparing APD and CAPD. We had rigid inclusion criteria of including RCTs alone and have used a very comprehensive search strategy of all major medical electronic databases and other sources. The data from RCTs have greater validity than observational studies as the process of randomisation removes potential biases by ensuring that the patient groups are equal in terms of both known and unknown characteristics (Altman 1999). There has been one previous systematic review (Macleod 1997) which only included the only study published at that time (De Fijter 1994). We have included two additional studies (Bro 1999; Iles-Smith 1999).

The major limitations of this review include the small number of identified trials, variability in their design, conduct, and intervention protocols. Two of the three studies were less than a year in duration. These trials are also not appropriate for the assessment of long-term clinical outcomes.

There were only a total of 139 included patients which makes it very unlikely that these trials would have been able to detect significant differences with respect to the clinically important outcomes assessed. The included trials did not give us any information regarding peritoneal characteristics. It is a well recognised feature of these treatment modalities that patients' peritoneal transport characteristics have an impact on their efficacy with high transporters performing better on APD whilst low-transporters do better on CAPD.

There have been two economic evaluations comparing APD and CAPD. Macleod 1997 showed that the cost for APD compared to CAPD/patient/year to prevent one episode of peritonitis was £11000 (1997 prices). The other economic evaluation which was done using the data obtained from Bro 1999 and showed that APD was 1.22 times more expensive than CAPD.

Whilst the use of APD has been expanding rapidly mainly at the expense of CAPD (Wilson 2002) it is surprising there are only three RCTs with 139 patients comparing it with CAPD, and none since 1999. The increase in use of APD may due to its perceived psychosocial advantages and patient choice as a result of such advantages, however this has not been properly investigated.

AUTHORS' CONCLUSIONS

Implications for practice

APD does not have significant advantages over CAPD in terms of important technical outcomes. However it may be considered in select group of patients based on their peritoneal transport characteristics and in the younger PD population and those in employment or study due to its psychosocial advantages.

Implications for research

There is a need for an RCT comparing CAPD with APD with sufficiently large patient numbers looking at important clinical and psychiosocial outcomes including residual renal function, accompanied by an economic evaluation to clarify the relative clinical and cost-effectiveness of both modalities

ACKNOWLEDGEMENTS

The authors wish to thank Mrs De Fijter and Mrs Iles-Smith for very kindly providing us with additional data regarding their studies. They also wish to Gail Higgins and Ruth Mitchell of the Cochrane Renal Group for offering valuable help with the search strategy.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Bro 1999

Methods	Country: Denmark Setting: Multicentre Timeframe: NS Parallel RCT Randomisation method - Adequate - Performed centrally using random permuted blocks, with stratification according to clinical centre, age and diabetic status Blinding - Participants: No - Investigators: No - Outcome assessors: No Intention-to-treat analysis: No Follow-up period: 6 months Lost to follow-up: 9/34
Participants	INCLUSION CRITERIA Age: minimum 18 years Minimum 1 month on CAPD Patient should be able to use APD machine Recent PET test showing high or high-average peritoneal transport characteristics Normalized Kt/V > 1.70/wk and total creatinine clearance > 50 L/wk TREATMENT GROUP Number: 12 Mean age: 50.2 years Sex (M/F): 8/4 CONTROL GROUP Number: 13 Mean age: 54.2 years Sex (M/F): 8/5 EXCLUSION CRITERIA Age < 18 years, pregnancy, lactation, mental retardation, psychiatric illness, inability to speak Danish, any major medical or surgical event in the previous 3 months, malignancy Recent PET test showing low or low-average transport characteristics Normalized Kt/V < 1.70/wk or total CrCl < 50 L/wk UF failure despite adequate CAPD treatment
Interventions	TREATMENT INTERVENTION APD - to maintain normalized Kt/V > 1.70/wk and total CrCl > 50 L/wk initially by NIPD alone. If this was not possible a last bag in the morning or a last bag in the morning plus an additional one in the afternoon was added CONTROL INTERVENTION CAPD

Bro 1999 (*Continued*)

Outcomes	1. Mortality 2. Change of dialysis modality 3. Infection (peritonitis, exit-site infections, tunnel infections) 4. Mechanical complications (hernia, leaks) 5. Kt/V 6. Residual renal function 7. Blood pressure
Notes	EXCLUSIONS POST RANDOMISATION BUT PRE-INTERVENTION The following patients did not receive interventions despite being randomised; transplant (3), changed to HD (2), deterioration of health status (1), psychosocial factors (1), subjective feeling of inadequate dialysis (1), could not handle cycler (1), never started study because if sudden impairment of visual acuity (1) STOP OR END POINT/S - NS ADDITIONAL DATA REQUESTED FROM AUTHORS: No COMPLETENESS OF FOLLOW-UP Enrolled/randomised: 34 Analysed: 25 Per cent followed: 79.42%

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

De Fijter 1994

Methods	Country: The Netherlands Setting: University hospital Timeframe: January 1988 to July 1991 Parallel RCT Randomisation method - Adequate - Performed centrally by a physician unconnected with the study using sealed envelopes Blinding - Participants: No - Investigators: No - Outcome assessors: No Intention-to-treat analysis: Yes Follow-up period - 688 patient-months in those on CAPD - 723 patient-months in those on APD Dropouts: 57/97
Participants	INCLUSION CRITERIA All new ESRD patients entering PD TREATMENT GROUP

De Fijter 1994 (*Continued*)

	Number: 47 Median age: 54 years (range 21-76) Sex (M/F): 25/22 CONTROL GROUP Number: 50 Median age: 55.5 years (range: 18-86) Sex (M/F): 27/23 EXCLUSION CRITERIA Previous serious abdominal inflammation with adhesions Ostomies including colostomies, ileostomies, nephrostomies
Interventions	TREATMENT INTERVENTION APD - 4 to 5 litre exchanges/night and one diurnal exchange - all 2 litres in volume to achieve desired Kt/V of 2.1 CONTROL INTERVENTION CAPD to achieve Kt/V of 2.1
Outcomes	1. Mortality 2. Change of dialysis modality 3. Infection (peritonitis, exit-site infections, tunnel infections) 4. Mechanical complications (hernia, leaks) 5. Kt/V 6. Residual renal function 7. Blood pressure 8. Karnofsky score
Notes	EXCLUSIONS POST RANDOMISATION BUT PRE-INTERVENTION The following number of patients did not receive interventions despite being randomisation Death (6), transplant (3), hydrothorax (1), preference for HD (2), recovery of renal transplantation (2), inadequate housing (1) STOP OR END POINT/S: NS ADDITIONAL DATA REQUESTED FROM AUTHORS: No COMPLETENESS OF FOLLOW-UP Enrolled/randomised:97 Analysed: 82 Per cent followed: 84.5%

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Low risk	A - Adequate

Iles-Smith 1999

Methods	Country: United Kingdom Setting: University hospital Timeframe: NS Parallel RCT Randomisation method - Adequate - Performed using sealed opaque envelopes Blinding - Participants: No - Investigators: No - Outcome assessors: No Intention-to-treat analysis: Yes Follow-up period: 4 weeks Lost to follow-up: 1/8
Participants	INCLUSION CRITERIA Age: 18-80 years Patient should be able to use APD machine Well, able-bodied English-speaking Free of infection Anuric Under-dialysed On CAPD for minimum of 3 months Free of peritonitis and exit-site infection for at least 8 weeks prior to study onset Urine output < 500 mL/24 h Kt/V < 1.7/wk or CrCl < 50 L/wk/1.73 m^2 TREATMENT GROUP Number: 3 Sex (M/F): 2/1 Mean age: 42 years (range 29-65) CONTROL GROUP Number: 5 sex (M/F): 5/0 Mean age: 53 years (range 33-69) EXCLUSION CRITERIA Unstable hyperparathyroidism Unstable diabetes Carcinoma Severe coronary disease
Interventions	TREATMENT INTERVENTION APD - to achieve Kt/V of 1.9/wk or creatinine clearance of 60 L/wk CONTROL INTERVENTION CAPD - to achieve Kt/V of 1.9/wk or CrCl of 60 L/wk
Outcomes	1. Change of dialysis modality 2. Infection (peritonitis) 3. Karnofsky score 4. Dialysis adequacy

Iles-Smith 1999 (*Continued*)

Notes	EXCLUSIONS POST RANDOMISATION BUT PRE-INTERVENTION: None STOP OR END POINT/S:NS ADDITIONAL DATA REQUESTED FROM AUTHORS: No COMPLETENESS OF FOLLOW-UP Enrolled/randomised: 8 Analysed: 8 Per cent followed: 100%

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Cr Cl = creatinine clearance; NS = not stated

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Basile 2001	Not RCT
Blake 1999a	Review article
Davies 2001	Not RCT
De Fijter 1992	Outcomes not relevant to review
De Fijter 1994a	Outcomes not relevant to review
De Wit 2001	Only an economic evaluation of different renal replacement therapy modalities
Diaz-Buxo 2003	Review article
Gallar 2001	Not RCT
Hiroshige 1996	Not RCT
Holley 1990	Not RCT
Hufnagel 1999	Not RCT
Rodriguez 1998	Not RCT

(*Continued*)

Rodriguez Carm 2004	Not RCT
Rodriguez-Carm 1999	Not RCT
Rodriguez-Carm 2002	Not RCT
Rottembourg 1989	Not RCT

DATA AND ANALYSES

Comparison 1. APD versus CAPD

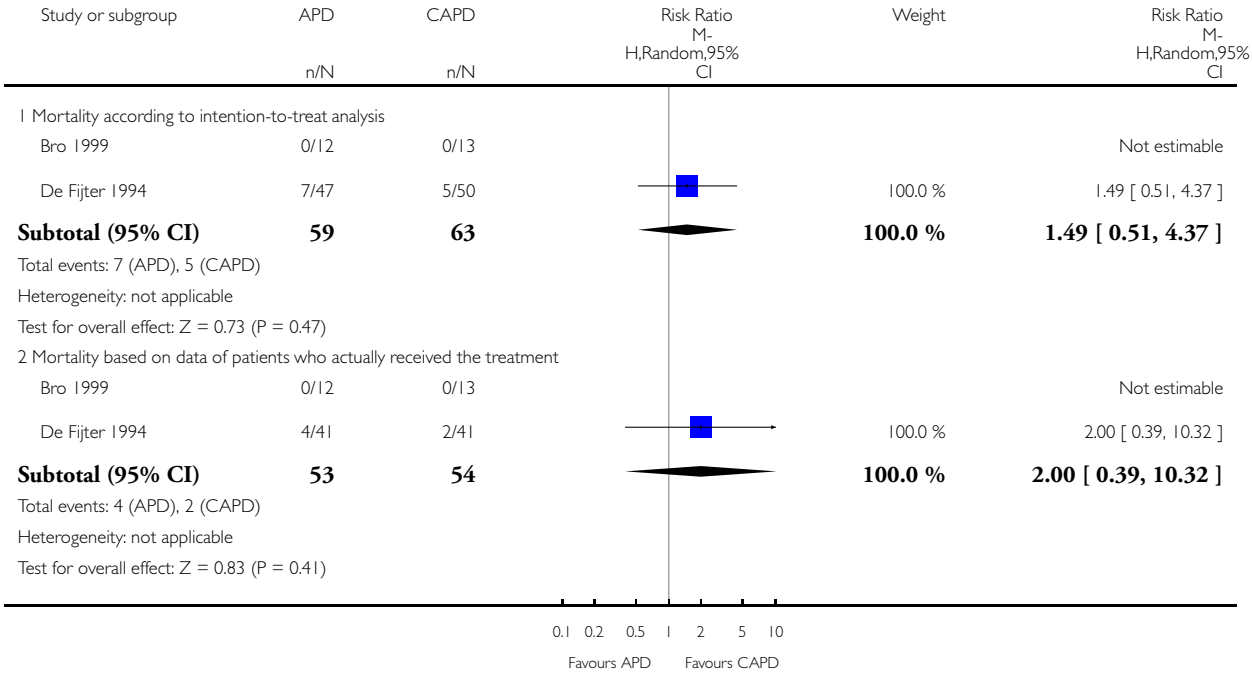
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mortality	2		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
1.1 Mortality according to intention-to-treat analysis	2	122	Risk Ratio (M-H, Random, 95% CI)	1.49 [0.51, 4.37]
1.2 Mortality based on data of patients who actually received the treatment	2	107	Risk Ratio (M-H, Random, 95% CI)	2.0 [0.39, 10.32]
2 Infectious complications	3		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
2.1 Peritonitis	3	115	Risk Ratio (M-H, Random, 95% CI)	0.75 [0.50, 1.11]
2.2 Exit-site infections	2	107	Risk Ratio (M-H, Random, 95% CI)	1.09 [0.56, 2.13]
2.3 Tunnel infections	2	107	Risk Ratio (M-H, Random, 95% CI)	0.99 [0.15, 6.49]
3 Change of dialysis modality	3		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
3.1 Change to any other form of dialysis modality including other forms of PD	3	115	Risk Ratio (M-H, Random, 95% CI)	0.50 [0.25, 1.02]
3.2 Change to haemodialysis	2	107	Risk Ratio (M-H, Random, 95% CI)	0.45 [0.16, 1.28]
4 Mechanical complications	2		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
4.1 Hernias	2	107	Risk Ratio (M-H, Random, 95% CI)	1.26 [0.32, 5.01]
4.2 PD fluid leaks	2	107	Risk Ratio (M-H, Random, 95% CI)	1.06 [0.11, 9.83]
4.3 Hydrothoraces	1	82	Risk Ratio (M-H, Random, 95% CI)	1.0 [0.06, 15.45]
5 PD catheter removal	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5.1 Removal due to all causes	1		Risk Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
5.2 Number removed during peritonitis episodes	1		Risk Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
6 Hospital admissions	2	107	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.43, 2.17]
7 Dialysis adequacy measures	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
7.1 Weekly Kt/V	2	49	Mean Difference (IV, Random, 95% CI)	0.12 [-0.22, 0.47]
7.2 Weekly creatinine clearance (L/min/1.73 sqm)	1	52	Mean Difference (IV, Random, 95% CI)	-6.60 [-24.19, 10.99]
8 Residual renal function	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
8.1 End of study creatinine clearance	2	49	Mean Difference (IV, Random, 95% CI)	-0.17 [-1.66, 1.32]
9 Quality of life	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
9.1 Karnofsky score	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
10 Blood pressure	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
10.1 Systolic blood pressure (mmHg)	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
10.2 Diastolic blood pressure (mmHg)	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]

Analysis 1.1. Comparison 1 APD versus CAPD, Outcome 1 Mortality.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 1 Mortality

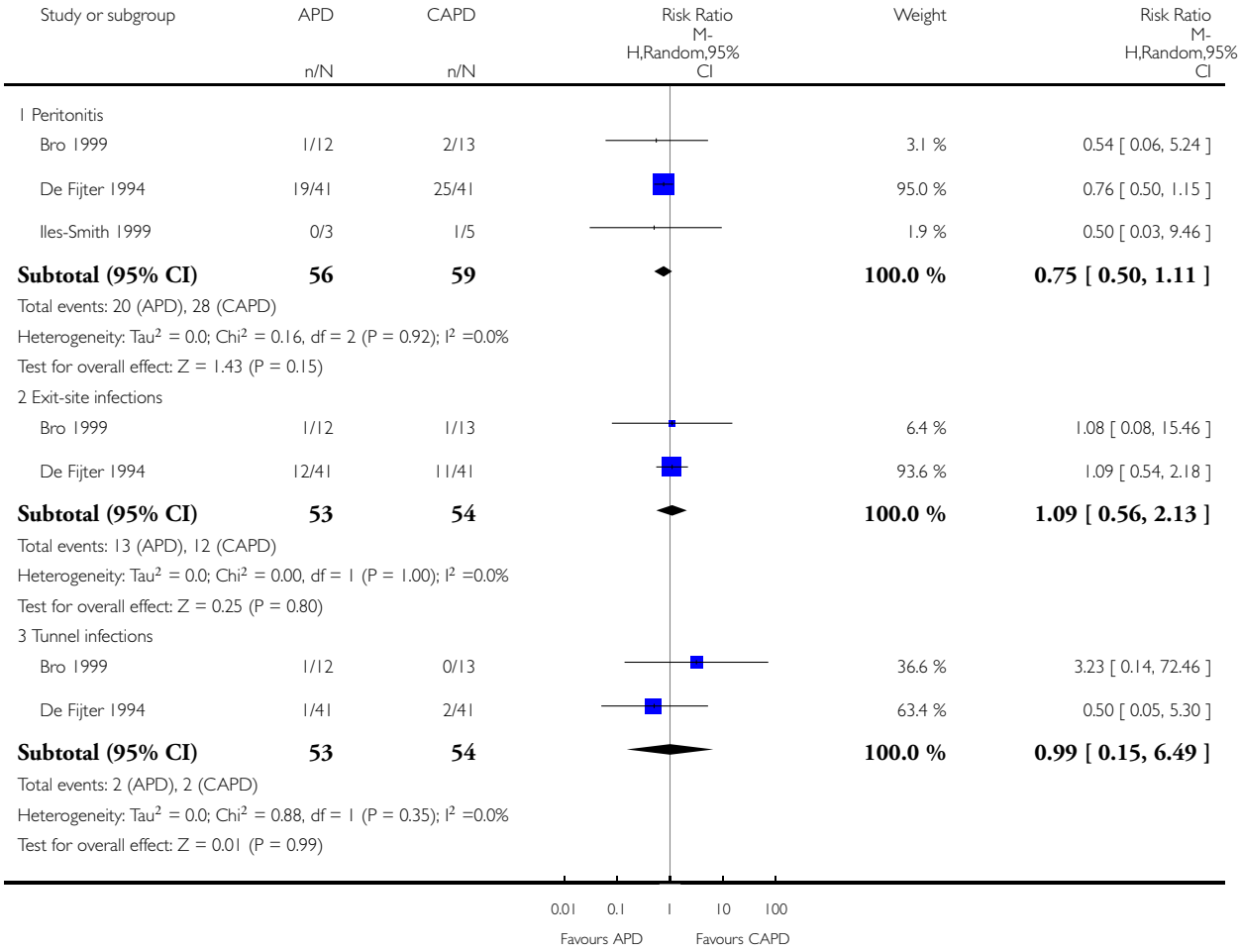


Analysis 1.2. Comparison 1 APD versus CAPD, Outcome 2 Infectious complications.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 2 Infectious complications

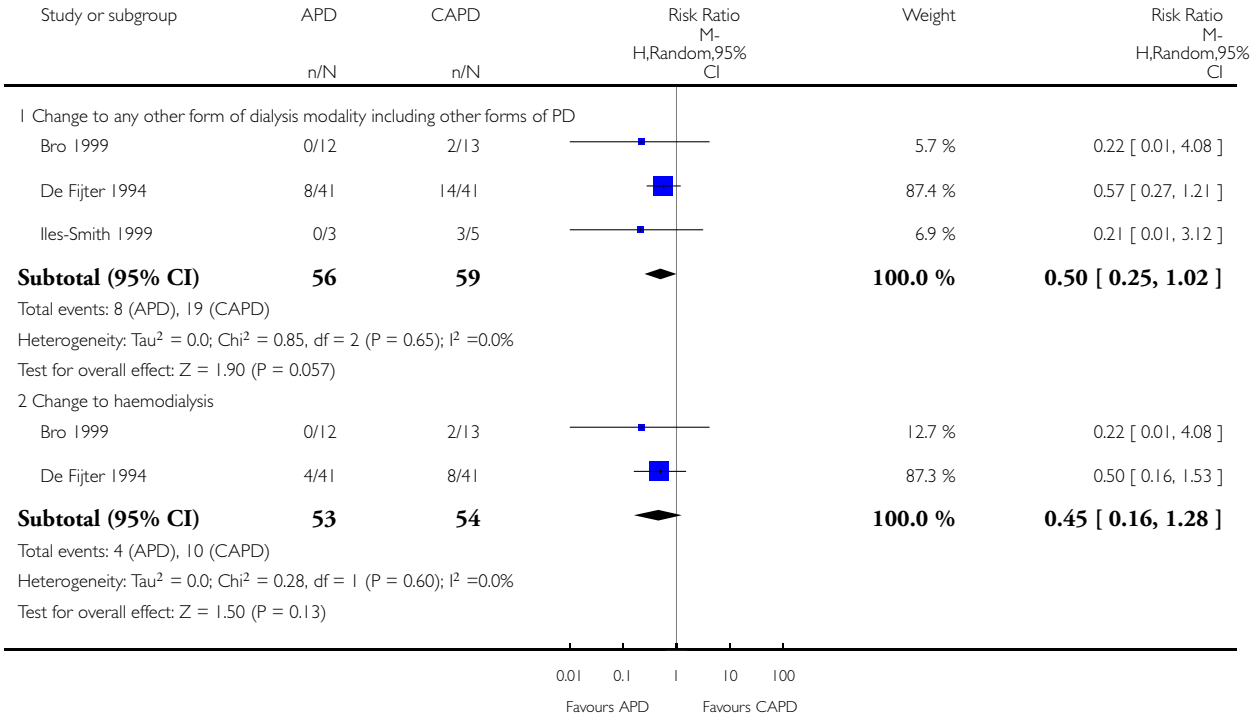


Analysis 1.3. Comparison 1 APD versus CAPD, Outcome 3 Change of dialysis modality.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 3 Change of dialysis modality

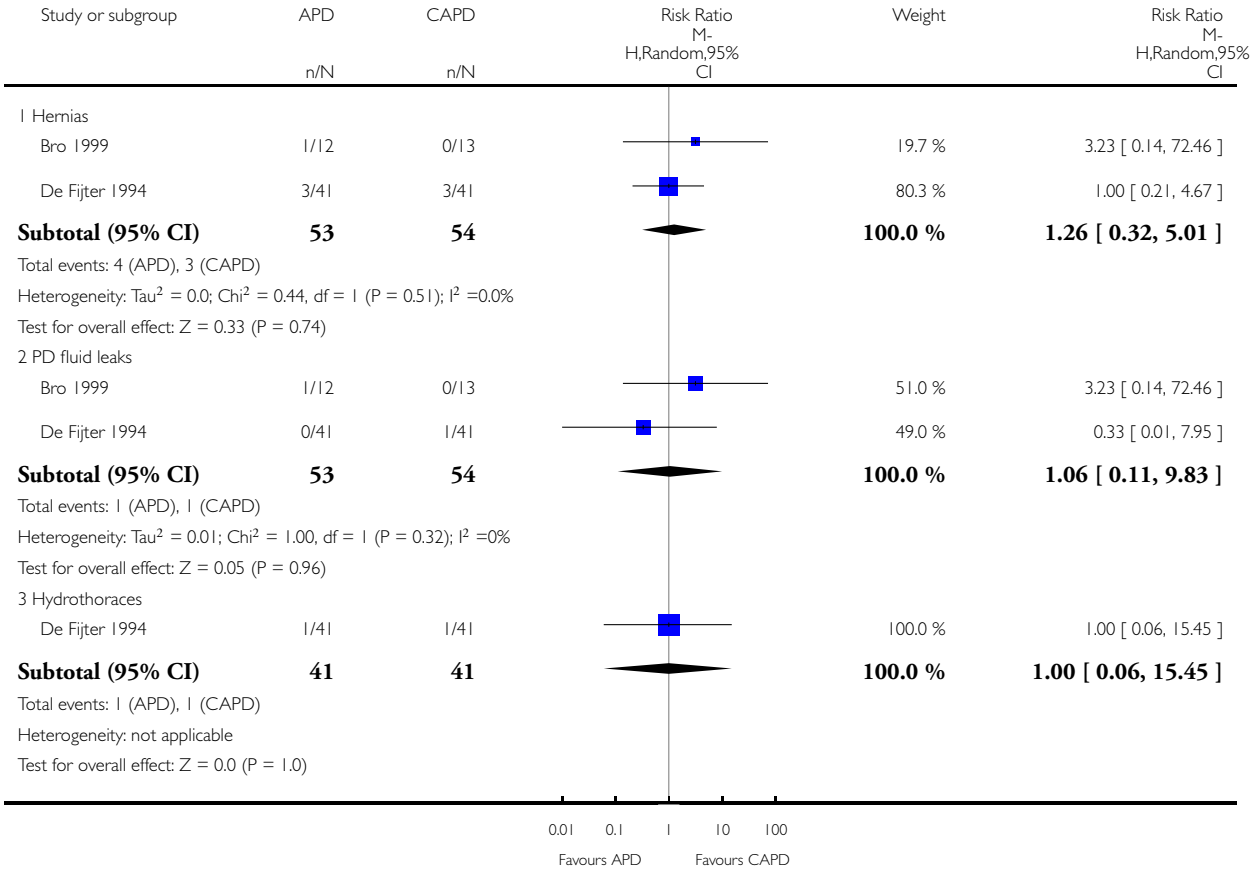


Analysis 1.4. Comparison 1 APD versus CAPD, Outcome 4 Mechanical complications.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 4 Mechanical complications

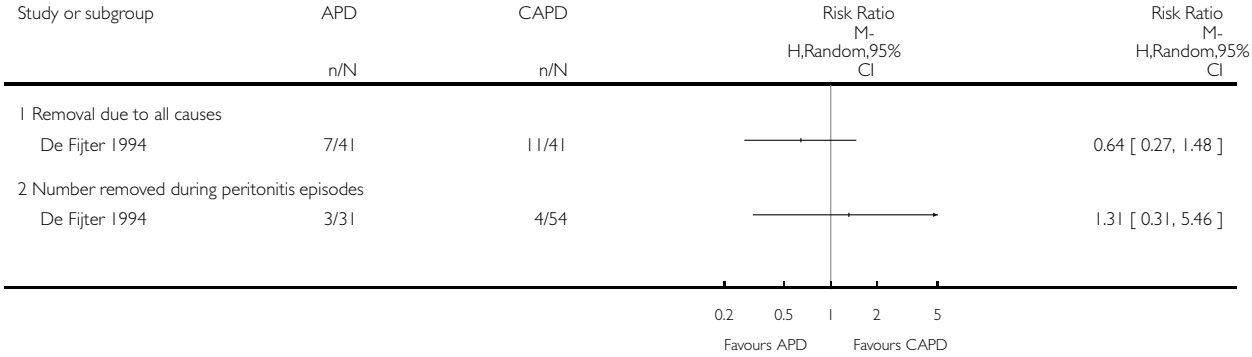


Analysis 1.5. Comparison 1 APD versus CAPD, Outcome 5 PD catheter removal.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 5 PD catheter removal

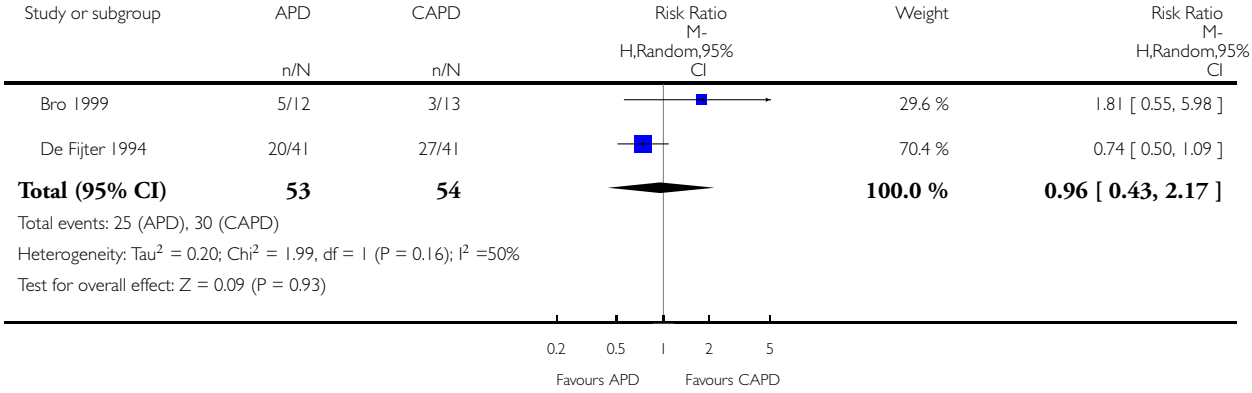


Analysis 1.6. Comparison 1 APD versus CAPD, Outcome 6 Hospital admissions.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 6 Hospital admissions

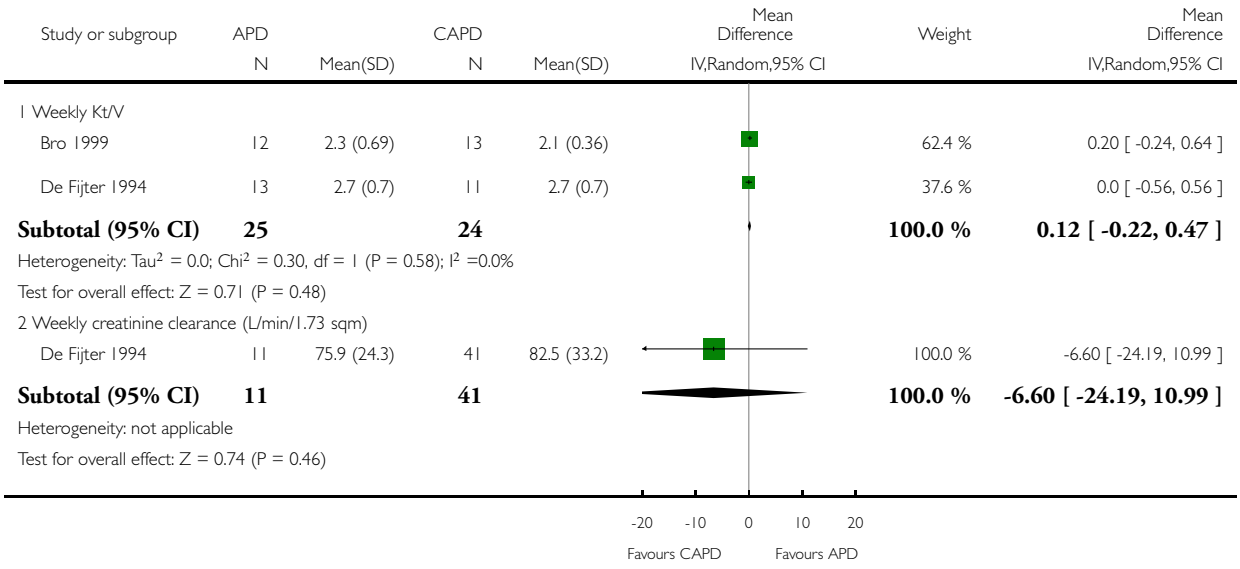


Analysis 1.7. Comparison 1 APD versus CAPD, Outcome 7 Dialysis adequacy measures.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 7 Dialysis adequacy measures



Analysis 1.8. Comparison 1 APD versus CAPD, Outcome 8 Residual renal function.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 8 Residual renal function

Study or subgroup	APD N	Mean(SD)	CAPD N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 End of study creatinine clearance							
Bro 1999	12	3 (2.42)	13	3.5 (2.52)		58.9 %	-0.50 [-2.44, 1.44]
De Fijter 1994	13	2.1 (2.3)	11	1.8 (3.3)		41.1 %	0.30 [-2.02, 2.62]
Subtotal (95% CI)	**25**		**24**			**100.0 %**	**-0.17 [-1.66, 1.32]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.27$, df = 1 (P = 0.60); $I^2 = 0.0\%$

Test for overall effect: Z = 0.23 (P = 0.82)

Analysis 1.9. Comparison 1 APD versus CAPD, Outcome 9 Quality of life.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 9 Quality of life

Study or subgroup	APD N	Mean(SD)	CAPD N	Mean(SD)	Mean Difference IV,Random,95% CI	Mean Difference IV,Random,95% CI
1 Karnofsky score						
De Fijter 1994	13	83 (8)	11	77 (7)		6.00 [0.00, 12.00]

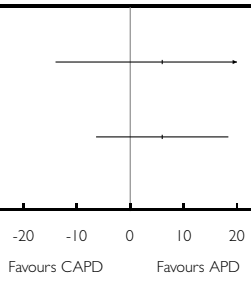
Analysis 1.10. Comparison 1 APD versus CAPD, Outcome 10 Blood pressure.

Review: Continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis for end-stage renal disease

Comparison: 1 APD versus CAPD

Outcome: 10 Blood pressure

Study or subgroup	APD N	Mean(SD)	CAPD N	Mean(SD)	Mean Difference IV,Random,95% CI	Mean Difference IV,Random,95% CI
1 Systolic blood pressure (mmHg)						
Bro 1999	12	147 (31)	13	141 (18)		6.00 [-14.08, 26.08]
2 Diastolic blood pressure (mmHg)						
Bro 1999	12	92 (21)	13	86 (7)		6.00 [-6.48, 18.48]



APPENDICES

Appendix 1. Electronic search strategies

Database	Search terms
MEDLINE	1. controlled clinical trial.pt. 2. randomized controlled trial.pt. 3. randomized controlled trials/ 4. random allocation/ 5. double blind method/ 6. single blind method/ 7. clinical trial.pt. 8. exp clinical trials/ 9. placebos/ 10. placebo$.tw. 11. random$.tw. 12. research design/ 13. volunteer$.tw. 14. (clin$ adj25 trial$).tw. 15. ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).tw. 16. factorial.tw.

(*Continued*)

	17. cross-over studies/ 18. crossover.tw. 19. latin square.tw. 20. (balance$ adj2 block$).tw. 21. (animals not human).sh. 22. or/1-20 23. 22 not 21 24. exp Peritoneal Dialysis, Continuous Ambulatory/ 25. continuous ambulatory peritoneal dialysis.tw. 26. CAPD.tw. 27. (APD or CCPD or CFPD or NPD or NIPD or TPD or TVPD).tw. 28. ((automated or continuous cycli$ or continuous-cycli$ or continuous flow or continuous-flow or night$ or nocturnal or tidal) adj3 (peritoneal dialysis or PD)).tw. 29. 24 or 25 or 26 30. 27 or 28 31. 23 and 29 and 30
EMBASE	1. Randomized Controlled Trial/ 2. controlled study/ 3. clinical study/ 4. major clinical study/ 5. prospective study/ 6. meta analysis/ 7. exp clinical trial/ 8. randomization/ 9. crossover procedure/ or double blind procedure/ or parallel design/ or single blind procedure/ 10. Placebo/ 11. latin square design/ 12. exp comparative study/ 13. follow up/ 14. pilot study/ 15. family study/ or feasibility study/ or pilot study/ or study/ 16. placebo$.tw. 17. random$.tw. 18. (clin$ adj25 trial$).tw. 19. ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).tw. 20. factorial.tw. 21. crossover.tw. 22. latin square.tw. 23. (balance$ adj2 block$).tw. 24. or/1-23 25. (nonhuman not human).sh. 26. 24 not 25 27. exp Continuous Ambulatory Peritoneal Dialysis/ 28. Continuous Ambulatory Peritoneal Dialysis.tw. 29. CAPD.tw. 30. (APD or CCPD or CFPD or NPD or NIPD or TPD or TVPD or TIPD).tw. 31. ((automated or continuous cycli$ or continuous-cycli$ or continuous flow or continuous-flow or night$ or nocturnal or tidal) adj3 (peritoneal dialysis or PD)).tw.

(*Continued*)

	32. or/27-29 33. 30 or 31 34. 26 and 32 and 33

WHAT'S NEW

Date	Event	Description
12 May 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

KSR: Develop search strategy, screen search titles, select studies, data extraction and analysis, writing review

JA: Data extraction

TZA: Screening abstracts and writing the review

AMM: Design and writing the review

CD: Designing and writing the review

JC: Design and writing the review

SW: Develop search strategy

LV: Design and writing the review

DECLARATIONS OF INTEREST

None declared

INDEX TERMS

Medical Subject Headings (MeSH)

Kidney Failure, Chronic [*therapy]; Peritoneal Dialysis [*methods]; Peritoneal Dialysis, Continuous Ambulatory; Randomized Controlled Trials as Topic

MeSH check words

Humans