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Efficacy of antibiotic therapy for peritoneal dialysis-associated peritonitis: a proportional meta-analysis

Pasqual Barretti*, João Vitor Pereira Doles, Douglas Gonçalves Pinotti and Regina El Dib

Abstract

Background: The choice of antimicrobials for initial treatment of peritoneal dialysis (PD)-related peritonitis is crucial for a favorable outcome. There is no consensus about the best therapy; few prospective controlled studies have been published, and the only published systematic reviews did not report superiority of any class of antimicrobials. The objective of this review was to analyze the results of PD peritonitis treatment in adult patients by employing a new methodology, the proportional meta-analysis.

Methods: A review of the literature was conducted. There was no language restriction. Studies were obtained from MEDLINE, EMBASE, and LILACS. The inclusion criteria were: (a) case series and RCTs with the number of reported patients in each study greater than five, (b) use of any antibiotic therapy for initial treatment (e.g., cefazolin plus gentamicin or vancomycin plus gentamicin), for Gram-positive (e.g., vancomycin or a first generation cephalosporin), or for Gram-negative rods (e.g., gentamicin, ceftazidime, and fluoroquinolone), (c) patients with PD-related peritonitis, and (d) studies specifying the rates of resolution. A proportional meta-analysis was performed on outcomes using a random-effects model, and the pooled resolution rates were calculated.

Results: A total of 64 studies (32 for initial treatment and negative culture, 28 reporting treatment for Gram-positive rods and 24 reporting treatment for Gram-negative rods) and 21 RCTs met all inclusion criteria (14 for initial treatment and negative culture, 8 reporting treatment for Gram-positive rods and 8 reporting treatment for Gram-negative rods). The pooled resolution rate of ceftazidime plus glycopeptide as initial treatment (pooled proportion = 86% [95% CI 0.82–0.89]) was significantly higher than first generation cephalosporin plus aminoglycosides (pooled proportion = 66% [95% CI 0.57–0.75]) and significantly higher than glycopeptides plus aminoglycosides (pooled proportion = 75% [95% CI 0.69–0.80]. Other comparisons of regimens used for either initial treatment, treatment for Gram-positive rods or Gram-negative rods did not show statistically significant differences.

Conclusion: We showed that the association of a glycopeptide plus ceftazidime is superior to other regimens for initial treatment of PD peritonitis. This result should be carefully analyzed and does not exclude the necessity of monitoring the local microbiologic profile in each dialysis center to choice the initial therapeutic protocol.

Keywords: Peritonitis, Peritoneal dialysis, Treatment, Meta-analysis

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Background

Although continuous peritoneal dialysis (PD) was introduced almost four decades ago, its application continues to be hindered by peritonitis, despite the large reduction of peritonitis incidence due to advances in connectology and widespread use of antibiotic prophylaxis. Peritonitis remains as a serious complication influencing patients' mortality, and is the most frequent cause of PD failure [1].

The choice of antimicrobial therapy for initial treatment is a crucial determinant for a favorable clinical course and outcome. Historically, this choice has been based on the recommendations of the International Society for Peritoneal Dialysis (ISPD), which has published six documents between 1989 and 2010 [2-7]. According to these guidelines, the initial treatment of peritonitis (prior to the results of microbiological tests) should be based on associations of drugs for coverage of Gram-positive cocci and Gram-negative bacilli. The recommendations about the class of antimicrobials have varied over time. In general, for coverage of Gram-positive cocci the use of a first generation cephalosporin or vancomycin has been proposed, while for Gram-negative bacilli an aminoglycoside or ceftazidime have been recommended. However, based on the available literature there is no consensus about the best antimicrobial therapy for the initial treatment of these infections, and few prospective and controlled studies have been published.

A systematic review with a meta-analysis of randomized controlled trials, published by Wiggins et al. [8], included 36 studies published between 1985 and 2006, and did not report superiority of any class of antimicrobials. One limitation of the study was the exclusion of a large number of publications with a high number of patients and episodes of peritonitis. Most of these excluded studies were case series. Thus, the present study aimed to analyze the clinical results of PD related peritonitis treatment reported in both, randomized controlled trials (RCTs) and case series studies employing an alternative methodology, the proportional meta-analysis, and to examine possible differences among therapeutic protocols.

Methods

Literature search and studies selection

A review of case series and RCTs containing the treatment of PD-related peritonitis was performed. There was no language restriction. Studies were obtained from the following sources: US National Library of Medicine (PUBMED; 1966–2013), Excerpta Medica database (EMBASE; 1980–2013) and Literatura Latino-Americana and Caribe em Ciências da Saúde (LILACS; 1982–2013). The last search date was 11th January, 2013.

The databases were examined using a comprehensive search strategy for PD-related peritonitis and antibiotic therapy, along with MeSH and text words, including a list of synonyms (Appendix). The search strategy was adapted for each database in order to maximize the ability to identify eligible studies. The bibliographic references in relevant articles were also examined for eligible studies.

The following inclusion criteria were used: (a) RCTs and case series studies with a number of reported patients greater than five, (b) use of any antibiotic therapy, regardless of whether it was used for initial treatment (e.g., cefazolin plus gentamicin or vancomycin plus gentamicin), for Gram-positive rods (e.g., vancomycin or a first generation cephalosporin), or for Gram-negative rods (e.g., gentamicin, ceftazidime, and fluoroquinolone), (c) patients with PD-related peritonitis, and (d) studies specifying the rates of peritonitis resolution. The data from RCTs were incorporated in the analysis as discrete data sets. Studies in pediatric patients and those with incomplete data were excluded from the review.

Peritonitis diagnosis was based on at least two of the following: abdominal pain or cloudy dialysate, dialysate white cell count >100/μL with at least 50% neutrophilic cells, and positive culture of dialysate [6,7]. We defined peritonitis resolution based on the following definitions used by authors of the included studies: disappearance of signs and symptoms within 96 h after the beginning of antibiotic therapy and a negative peritoneal fluid culture at least 28 days after treatment completion; an episode of peritonitis where the catheter remained *in situ* and symptoms and signs resolved; initial response to antibiotic therapy combined with no need to remove the PD catheter; complete resolution of peritonitis without relapse for 30 days following initial therapy completion; absence of symptoms of peritonitis and clear dialysate effluent 5 days after start of antibiotic therapy; sterilization of the dialysate with no relapse within 4 weeks after treatment; no relapse within 2 weeks after ceasing treatment; cure without altering either of the empirical antibiotics to second-line antibiotics; resolution of abdominal pain, clearing of dialysate, and dialysate neutrophil count less than 100/μL on day 10; complete resolution of peritonitis by antibiotics alone without relapse or recurrence within 4 weeks of completion of therapy; PD fluid became clear, patient survived the period of the treatment of peritonitis and 4 weeks after treatment ceased; PD catheter did not require removal to clear the infection, and no relapse of peritonitis caused by the same organism or with negative culture results within 4 weeks post treatment of the initial episode [6,7].

Data collection

Two reviewers independently screened the titles identified by the literature search, extracted the data from the studies, and analyzed the results. Discrepancies in the results were resolved by discussion by the reviewers. A standard

Table 1 Characteristics of case series and RCT studies including in the qualitative analysis, according to treatment target (initial, gram-positive and gram-negative rods) and the patient's renal basal disease

Study	All studies	Initial treatment/Negative culture	Gram +	Gram -
Total of studies (case series and RCTs)	84 [15-98]	44 [15-24,26,28,34, 40,55,57,60-87]	36 [15,18,20-25,29,30, 33-37,42,44,48,50,54, 55,57,63,75,77,85,86, 88-95]	32 [15,18,20,22,23,25, ,31,32,35-37,39,41, 45-47,49,50,52,55,57, 63,69,77,78,86,91,93, 96-98]
No. of patients/No. of episodes	9.268/16.109	4.411/7.315	3,526/6,259	2,549/4,925
Basal renal disease				
Branchio-oto-renal syndrome	1	0	0	0
Chronic tubulointerstitial disease	2	1	1	0
Diabetes	51	16	14	10
Glomerulonephritis	33	12	10	6
Gouty	1	1	0	0
Hemolytic-uremic syndrome	1	0	0	0
Hypertension	21	13	8	5
IgA nephropathy	1	1	0	0
Interstitial nephritis	3	1	0	0
Systemic lupus	5	2	1	1
Malignancy	2	0	1	0
Multiple myeloma	1	0	0	0
Nephrosclerosis	2	2	2	0
Obstruction/Reflux	15	5	4	4
Others/unknown	25	11	8	3
Pyelonephritis	4	3	1	1
Policystic kidney disease	24	8	8	5
Renal artery stenosis	1	1	0	0
Renovascular	12	3	1	1
Systemic autoimmune disease	2	2	1	0
Comorbidities				
AIDS	1	1	0	0
Cerebrovascular disease	7	1	2	0
Chronic lung disease	7	1	3	1
Connective tissue disorder	1	1	1	0
Congestive heart failure	2	1	1	0
Coronary heart disease	9	1	4	1
Current smoker	4	0	1	0
Dementia	2	1	1	0
Diabetes	16	6	8	5
Hemiplegia	2	1	1	0
Mild liver disease	2	1	1	0
Moderate or severe liver disease	3	2	1	0
Peptic ulcer disease	2	1	1	0
Peripheral vascular disease	9	1	2	0
Secondary hyperparathyroidism	1	0	1	1
Any Tumor, Leukemia, Lymphoma	4	2	3	1
Type of dialysis				

Table 1 Characteristics of case series and RCT studies including in the qualitative analysis, according to treatment target (initial, gram-positive and gram-negative rods) and the patient's renal basal disease *(Continued)*

CAPD	50	32	24	23
APD	11	7	7	7
Not reported	37	9	11	9
Any change from APD to CAPD	NR	NR	NR	NR
Mean age (years)	57,36	55,65	58,44	56,53

NR = not reported; CAPD = continuous ambulatory peritoneal dialysis; APD = automated peritoneal dialysis; RCT = randomized clinical trial.

form was used to extract the following information: authors and year of publication, country, number of participants and peritonitis episodes, patients' mean age, basal renal disease, comorbidities, PD modality (continuous ambulatory peritoneal dialysis [CAPD] or automated peritoneal dialysis [APD]), initial peritonitis treatment protocol and its adjustments, and outcomes.

We used the risk of bias approach for Cochrane Reviews to assess the RCT quality [9] as we are used to critical appraise RCT with this tool. Please, find below the reference. We have included one figure entitled Risk of bias summary: review authors' judgments about each risk of bias item for each RCT included.

Statistical analysis

The outcomes were treated as a dichotomous variable (peritonitis resolution versus no resolution) with respective 95% confidence intervals (CI). Statistical heterogeneity was assessed with the I^2 statistic, and significance was assumed when the I^2 was greater than 50%. The I^2 statistic illustrates the percentage of the variability in effect estimates resulting from heterogeneity rather than sampling error [10,11]. Because of the clear differences among the included studies and several uncontrolled variables, we used a random-effect model [12] to perform a proportional meta-analysis of case series studies [13,14]. The software used to plot the studies in the meta-analysis was StatsDirect.

For first generation cephalosporins, we included: cefazolin, cephalotin, cefamezin and cephaloridine. The only third generation cephalosporin we analyzed was ceftazidime. For aminoglycosides we included gentamicin, amikacin, netilmicin and tobramycin. Vancomycin and teicoplanin were considered in the analysis as glycopeptides. Finally, ciprofloxacin, levofloxacin and ofloxacin were the fluoroquinolones included.

A statistically significant difference between interventions was defined when their combined 95% CIs did not overlap [13,14]. We considered $p < 0.05$ as statistically significant.

Results

The literature search was conducted through January 2013, and 6,743 titles had been identified. After the screening by title and abstract, we obtained full paper copies of 140 studies reporting antibiotic therapy for PD-related peritonitis that were eligible for inclusion. However, 56 of these studies were either cohort or off-topic. Hence, only a total of 64 case series studies (32 reporting initial treatment and negative culture, 28 reporting treatment for Gram-positive rods and 24 reporting treatment for Gram-negative rods) and 20 RCTs met all inclusion criteria (14 for initial treatment and negative culture, eight reporting treatment for Gram-positive rods and eight reporting treatment for Gram-negative rods). These studies included 9.268 patients with 16.109 episodes of peritonitis. A total of 4.411 patients (7.315 episodes) were reported for the initial treatment and negative culture, 3.526 patients (6.259) were reported for the Gram-positive group, and 2.549 (4.925) were reported for the Gram-negative group (Table 1).

However, from these total, 38 case series [15-52] were not included in the meta-analysis due to the lack of data. Methodological aspects of five RCT studies [53-57] had a risk of introducing bias, with inadequate blinding of participants, random sequence generation and incomplete outcome, and three RCTs was excluded from the quantitative analysis due to lack of data [53,56,58]. In this way, proportional meta-analysis was performed from 43 studies (Figure 1). We have summarized the risk of bias of RCT included studies in Figure 2.

Comparisons for initial treatment or culture negative episodes

Ceftazidme plus a glycopeptide as initial treatment was used in five studies [59-63] with 443 episodes; the pooled resolution rate was 86% (95% CI 0.82–0.89). This resolution rate was significant higher than initial treatment with a first generation cephalosporin plus aminoglycosides (pooled proportion of 66%, 95% CI 0.57–0.75) from 14 included studies [57,61,64-75] with 1,438 total episodes (Figure 3). Initial treatment with ceftazidime plus a glycopeptide also showed a higher resolution rate than a glycopeptide plus aminoglycosides (pooled proportion of 75%, 95% CI 0.69–0.80) that were used in 16 included studies [55,66-68,75-86] with 574 episodes (Figure 4).

The following comparisons did not show statistically significant differences because their CIs overlapped: a first generation cephalosporin plus aminoglycosides (resolution rate = 66%, 95% CI 0.57–0.75) versus glycopeptides plus

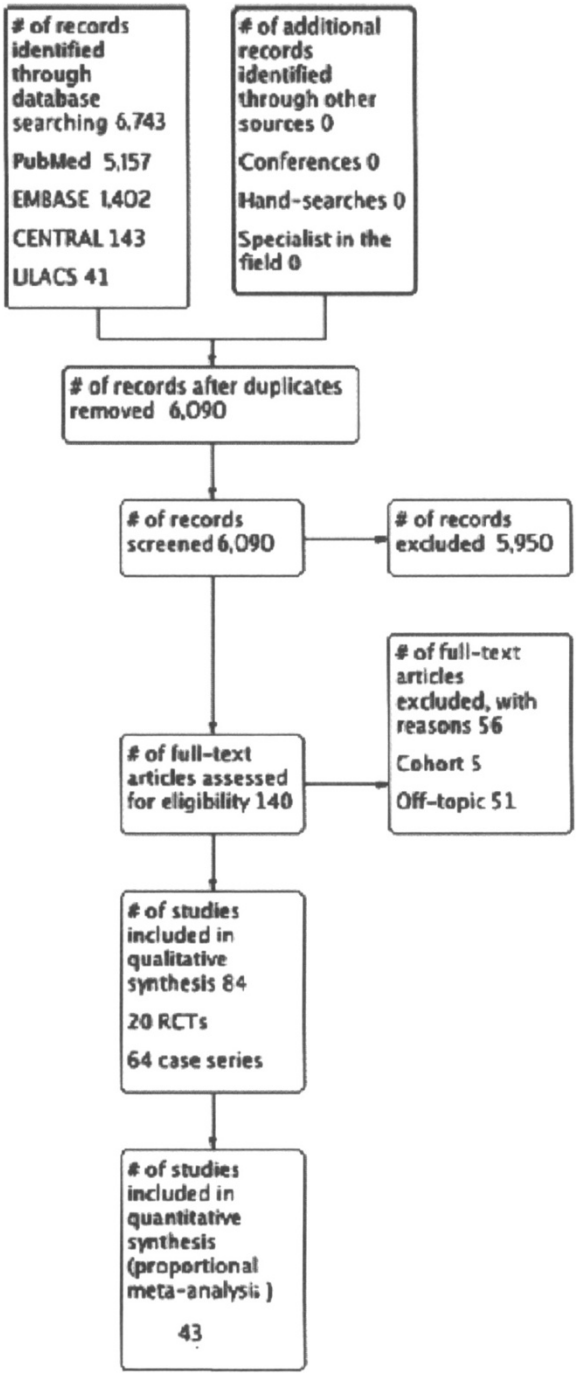

Figure 1 Study flow diagram.

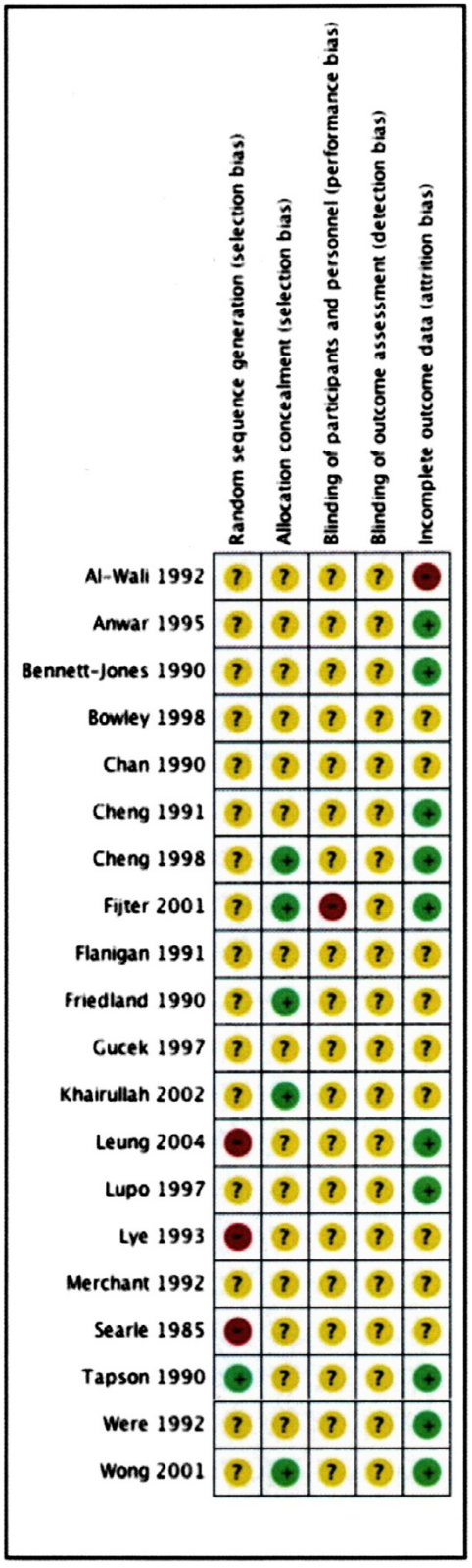

Figure 2 Risk of bias summary of randomized control trials: review authors' judgments about each risk of bias item for each included study.

aminoglycosides (resolution rate = 75%, 95% CI 0.69–0.80); a first generation cephalosporin plus aminoglycosides (resolution rate = 66%, 95% CI 0.57–0.75) versus a first generation cephalosporin plus ceftazidime (resolution rate = 59%, 95% CI 0.32–0.83); glycopeptides plus aminoglycosides (resolution rate = 75%, 95% CI 0.69–0.80) versus first generation cephalosporin plus ceftazidime (resolution rate = 59%, 95% CI 0.32–0.83), and a first

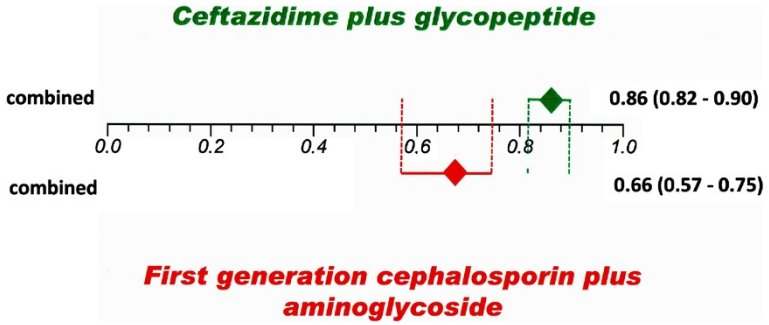

Figure 3 Combined resolution rate with 95% CIs of studies of initial treatment with ceftazidime plus a glycopeptide versus a first generation cephalosporin plus an aminoglycoside.

generation cephalosporin plus ceftazidime (resolution rate = 59%, 95% CI 0.32–0.83) versus ceftazidime plus a glycopeptide (resolution rate = 86%, 95% CI 0.82–0.89).

There was significant heterogeneity among studies for three of the initial treatment used (ceftazidme plus glycopeptide I^2 = 91.5%; first generation cephalosporin plus third generation cephalosporin, I^2 = 94.8%; third generation cephalosporin plus glycopeptide, I^2 = 8,02E-02% .

Comparisons for episodes due to gram-positive rods

For treatment of episodes due to Gram-positive rods, the pooled resolution rate from 13 studies [54,55,62,76,84,85,87-93] with 917 episodes was 78% (95% CI 0.66–0.88) for a glycopeptide, while from five studies [57,74,88,93,94] with 532 episodes for a first generation cephalosporin it was 73% (95% CI 0.55–0.88). There was no significant difference between the schemes.

There was significant heterogeneity among studies for both first generation cephalosporin and glycopeptide: I^2 = 94.6% and 94%, respectively.

Comparisons for episodes due to gram-negative rods

The pooled proportion resolution rate from nine studies [55,76,85,92,95-98] with 138 episodes was 68% (95% CI 0.50–0.85) for a quinolone (Figure 5). For ceftazidime, the resolution rate was 61% (95% CI 0.53–0.70) from three studies [68,56,98] with 117 episodes (Figure 6), and for aminoglycosides it was 65% (95% CI 0.51–0.77) from nine studies [55,57,62,68,76,85,90,97,98] with 211 episodes (Figure 7). There were no significant differences among the three drugs because their CIs overlapped.

There was significant heterogeneity among studies for both of the two drugs: I^2 value was 79.3% for quinolone, and 71.1% for aminoglycosides.

Discussion

The choice of initial treatment of PD-related peritonitis remains a challenge to nephrologists who perform PD, particularly because of the absence of evidence to indicate superiority of particular recommended therapeutic protocols. Although the only available systematic review with meta-analysis of randomized clinical trials [8], and its recent update [99] did not show superiority of a specific class of antimicrobials a review of therapeutic protocols proposed by ISPD guidelines used in case series studies (which are typically excluded from meta-analyses) could potentially show differences in outcomes among antimicrobial regimens. In addition, the possibility of performing randomized clinical trials with a sufficient number of

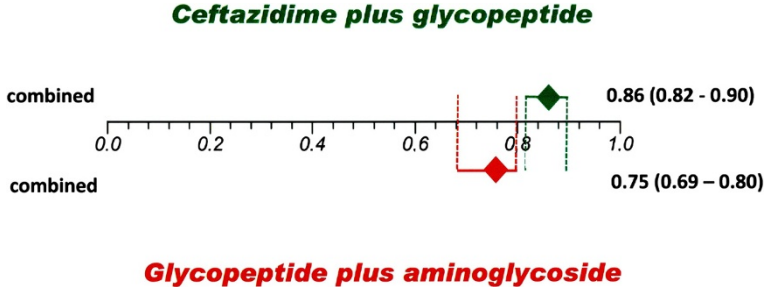

Figure 4 Combined resolution rate with 95% CIs of studies of initial treatment with ceftazidime plus a glycopeptide compared to a glycopeptide plus an aminoglycoside.

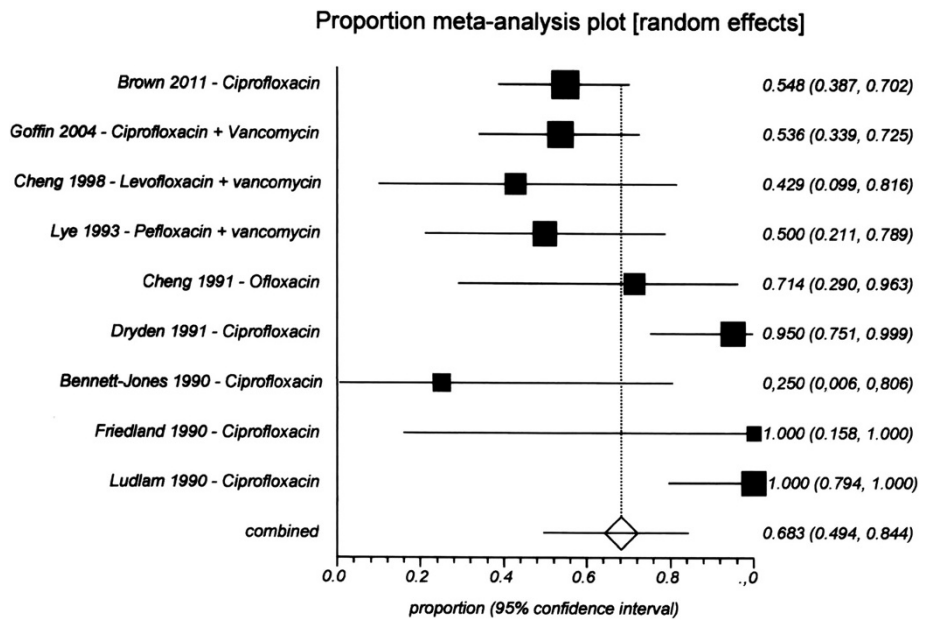

Figure 5 Proportional meta-analysis of studies of the resolution rate of quinolone treatment for gram-negative peritonitis.

patients has become more remote because of the current low incidence of PD-related peritonitis.

A narrative review of antimicrobial treatment of patients with PD-related peritonitis published in 1991 [100] concluded that the optimal empirical treatment was weekly vancomycin plus ceftazidime. Interestingly, the present study using proportional meta-analysis of case series was able to identify the superiority of the combination of glycopeptides plus ceftazidime in the initial treatment of PD-related peritonitis, when compared with a glycopeptide plus an aminoglycoside and when compared with a first generation cephalosporin plus aminoglycosides. This result strongly suggests that the differences found may be related to a better coverage of Gram-negative bacilli of

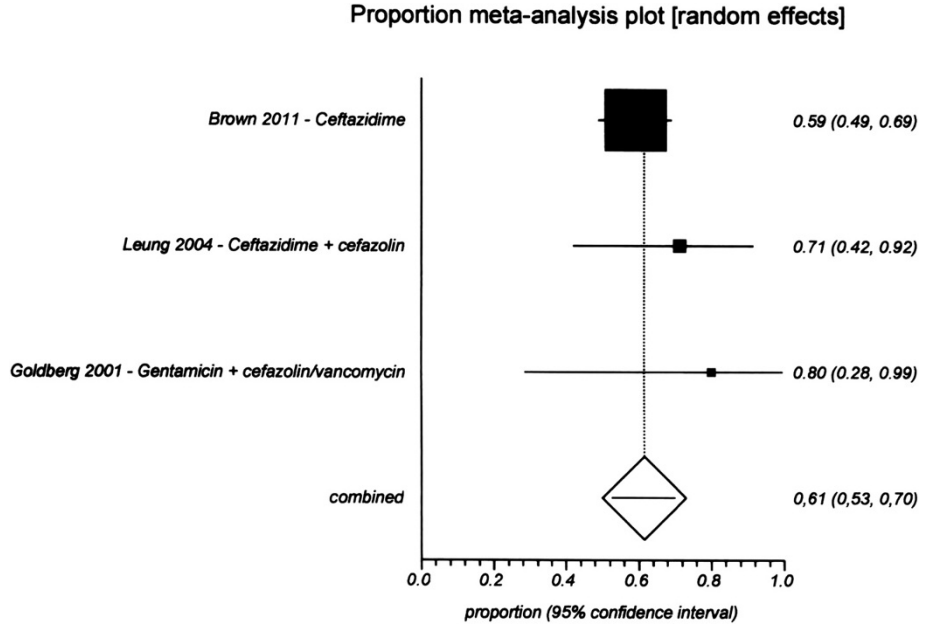

Figure 6 Proportional meta-analysis of studies of the resolution rate of ceftazidime treatment for gram-negative peritonitis.

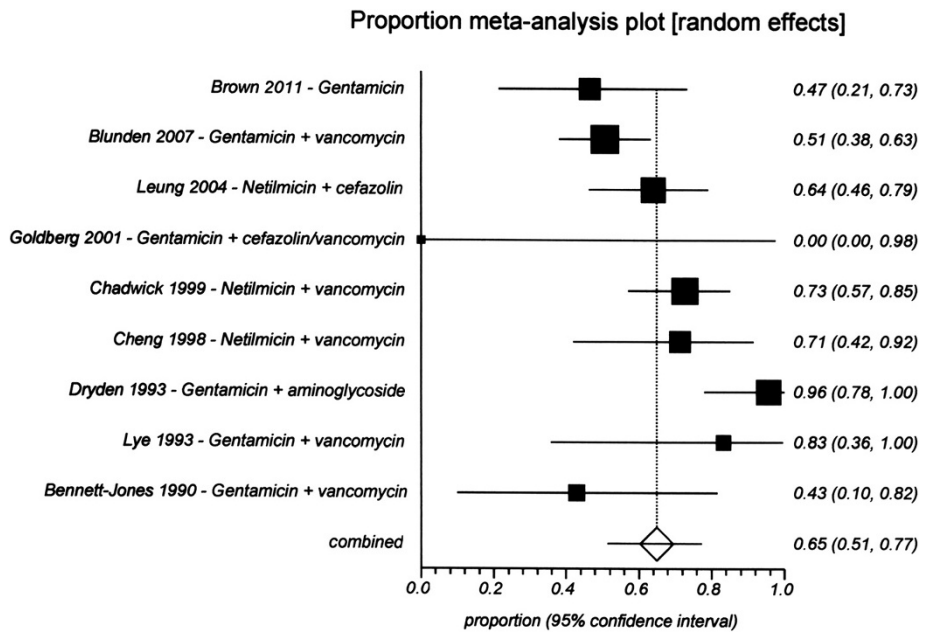

Figure 7 Proportional meta-analysis of studies of the resolution rate of aminoglycosides treatment for gram-negative peritonitis.

third generation cephalosporin compared with aminoglycosides. Bacterial resistance of Gram-negative bacilli, particularly *Pseudomonas* species, to commonly prescribed antimicrobials has been reported in recent years [101]; this may explain the superiority of the protocols employing ceftazidime. We found a low-resolution rate associated with regimens based on aminoglycosides for treatment of episodes caused by Gram-negatives. It was noticeable that papers of the decade 90 presenter higher resolution rate than those published after 2000, which could result of a temporal increase of bacterial resistance to these antibiotics. In agreement, low and decreasing susceptibility rate of *Pseudomonas spp* to gentamycin was reported in our center where only 40% of strains were susceptible in the same period period [101]. The set of these data suggests the bacterial resistance may explains the outcome of Gram-negative episodes treated with aminoglycosides.

The superiority observed with a glycopeptide plus ceftazidime must be carefully examined, because only 443 peritonitis episodes, in four case series [60-63] and only one RCT [59] were given this treatment. In addition, the comparisons among aminoglycosides, ceftazidime and fluoroquinolones used for the treatment of Gram-negative bacilli showed no differences in the resolution rates. Although the majority of these studies did not report the description of the bacterial resistance profile, differences in resistance may have influenced the outcome.

The present study confirms previous findings that showed no differences between vancomycin and first generation cephalosporins for the treatment of Gram-positive cocci. However, it should be considered that an increase in methicillin-resistant coagulase negative staphylococci as causal agents of PD-related peritonitis has been reported by several authors [75,102], and that the results of this review may reflect conditions associated with the era or specific characteristics of each center.

This review has several limitations. The most important is the lower evidence level of case studies compared with the study designs of studies included in traditional systematic reviews. In addition, our analysis shows that there is significant heterogeneity in resolution rate. Finally, the studies differed considerably in their patient selection, baseline renal diseases, number of subjects, antibiotic administration routes, and other aspects. In conclusion, this review showed that the protocol of a glycopeptide plus ceftazidime could be a promising initial therapy in patients with PD-related peritonitis. This result should be carefully analyzed, and an emphasis should be placed on the necessity of monitoring the local microbiologic profile in each center regarding the initial therapeutic choice.

Conclusion

The association of a glycopeptide plus ceftazidime was superior to other regimens for initial treatment of PD peritonitis. This result should be carefully analyzed and does not exclude the necessity of monitoring the local microbiologic profile in each dialysis center to choice the initial therapeutic protocol.

Appendix

Summary of the bibliographic search strategies for type of clinical situation and intervention of interest.

[(Primary Peritonitis) OR (Secondary Peritonitis) OR (Peritoneal Dialyses) OR (Peritoneal Dialyses) OR CAPD OR (Continuous Ambulatory Peritoneal Dialysis) OR APD OR (Automated Peritoneal Dialysis)] AND [(Anti Bacterial Agents) OR (Antibacterial Agents) OR (Anti-Mycobacterial Agents) OR (Anti Mycobacterial Agents) OR (Antimycobacterial Agents) OR Antibiotic OR Antibiotics OR (Bactericidal Agents) OR Bactericides).

Competing interests

The authors declare that they have no competing interests.

Authors' contribution

JVPD extracted the data. DGP helped extract the data. RED designed the research, carried out the analysis, and wrote the initial draft of the paper. PB has conceived the study and reviewed the draft of the paper. All authors read and approved the final manuscript.

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References

1. Davenport A: **Peritonitis remains the major clinical complication of peritoneal dialysis: the London, UK, peritonitis audit 2002–2003.** *Perit Dial Int* 2009, **29:**297–302.
2. Keane WF, Everett ED, Fine RN, Golper TA, Vas S, Peterson PK, Gokal R, Matzke GR: **Continuous ambulatory peritoneal dialysis (CAPD) peritonitis treatment recommendations: 1989 update.** *Perit Dial Int* 1989, **9:**247–256.
3. Keane WF, Everett ED, Golper TA, Gokal R, Halstenson C, Kawaguchi Y, Riella M, Vas S, Verbrugh HA: **Peritoneal dialysis-related peritonitis treatment recommendations: 1993 update.** *Perit Dial Int* 1993, **13:**14–28.
4. Keane WF, Alexander SR, Bailie GR, Boeschoten E, Gokal R, Golper TA, Holmes CJ, Huang CC, Kawaguchi Y, Piraino B, Riella M, Schaefer F, Vas S: **Peritoneal dialysis related peritonitis treatment recommendations: 1996 update.** *Perit Dial Int* 1996, **16:**557–573.
5. Keane WF, Bailie GR, Boeschoten E, Gokal R, Golper TA, Holmes CJ, Kawaguchi Y, Piraino B, Riella M, Vas S: **Adult peritoneal dialysis-related peritonitis recommendations: 2000 update.** *Perit Dial Int* 2000, **20:**396–411.
6. Piraino B, Bailie GR, Bernardini J, Boeschoten E, Gupta A, Holmes C, Kuijper EJ, Li PK, Lye WC, Mujais S, Paterson DL, Fontan MP, Ramos A, Schaefer F, Uttley L: **ISPD Ad Hoc Advisory Committee. Peritoneal dialysis-related infections recommendations: 2005 update.** *Perit Dial Int* 2005, **25:**107–131.
7. Li PK, Szeto CC, Piraino B, Bernardini J, Figueiredo AE, Gupta A, Johnson DW, Kuijper EJ, Lye WC, Salzer W, Schaefer F, Struijk DG: **International Society for Peritoneal Dialysis. Peritoneal dialysis-related infections recommendations: 2010 update.** *Perit Dial Int* 2010, **30:**393–423.
8. Wiggins KJ, Johnson DW, Craig JC, Strippoli GF: **Treatment of peritoneal dialysis-associated peritonitis: a systematic review of randomized controlled trials.** *Am J Kidney Dis* 2007, **50:**967–988.
9. Higgins JPT, Green S (Eds): *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0. [updated March 2011].* The Cochrane Collaboration; 2011. Available from http://handbook.cochrane.org.
10. Higgins JPT, Green S: *Assessment of study quality. Cochrane Reviewers' Handbook 4.2.5. The Cochrane Library, Issue 3.* 2005th edition. Chichester: John Wiley & Sons, Ltd; 2005.
11. Higgins JP, Thompson SG, Deeks JJ, Altman DG: **Measuring inconsistency in meta-analysis.** *BMJ* 2003, **3:**557–560.
12. Der Simonian R, Laird N: **Meta-analysis in clinical trials.** *Control Clin Trials* 1986, **7:**177–188.
13. El Dib R, Touma NJ, Kapoor A: **Cryoablation versus Radiofrequency Ablation for the Treatment of Renal Cell Carcinoma: a meta-analysis of case series studies.** *BJU Int* 2012, **110:**510–516.
14. El Dib R, Touma N, Kapoor A: *A new approach to deal with the absence of clinical trials in systematic reviews: a meta-analysis of case series studies.* New Zealand, Australia: 20th Cochrane Colloquium; 2012b.
15. Hyams PJ, Smithivas T, Matalon R, Katz L, Simberkoff MS, Rahal JJ Jr: **The use of gentamicin in peritoneal dialysis. II. Microbiologic and clinical results.** *J Infect Dis* 1971, **124**(Suppl 124):84–89.
16. Gray HH, Goulding S, Eykyn SJ: **Intraperitoneal vancomycin and ceftazidime in the treatment of CAPD peritonitis.** *Clin Nephrol* 1985, **23:**81–84.
17. Ryckelynck JP, Hurault de Ligny B, Vergnaud M, Dapogny C, Batho JM, Landru I: **[Intraperitoneal ceftazime as treatment for peritonitis in patients on continuous ambulatory peritoneal dialysis].** *Therapie* 1987, **42:**37–39.
18. Boeschoten EW, Kuijper EJ, Speelman P, Struijk DG, Krediet RT, Arisz L: **Oral treatment of CAPD-peritonitis with ciprofloxacin.** *Adv Perit Dial* 1990, **6:**126–129.
19. Dratwa M, Glupczynski Y, Lameire N, Matthys D, Verschraegen G, Vaneechoutte M, Boelaert J, Schurgers M, Van Landuyt H, Verbeelen D, Lawers S: **Treatment of gram-negative peritonitis with aztreonam in patients undergoing continuous ambulatory peritoneal dialysis.** *Rev Infect Dis* 1991, **13**(Suppl 7):S645–S647.
20. Dryden MS, Wing AJ, Phillips I: **Low dose intraperitoneal ciprofloxacin for the treatment of peritonitis in patients receiving continuous ambulatory peritoneal dialysis (CAPD).** *J Antimicrob Chemother* 1991, **28:**131–139.
21. Nye KJ, Gibson SP, Nwosu AC, Manji MR, Robinson BHB, Hawkins JB: **Single-Dose intraperitoneal vancomycin and oral ciprofloxacin for the treatment of peritonitis in CAPD patients: Preliminary report.** *Perit Dial Int* 1993, **13:**59–60.
22. Guerra EMM, D'Avila R, Rodrigues CIS, Cadaval RAM, Fernandes FA, Almeida FA: **Tratamento de peritonites por bactérias Gram-negativas com aztreonam em pacientes submetidos a diálise peritoneal/Treatment of peritonitis by Gram-negative bacteria with aztreonam in patients submitted to peritoneal dialysis.** *Arq Bras Med* 1994, **68:**43–46.
23. Lui S-F, Cheng AB, Leung C-B, Wong K-C, Li PKT, Lai K-N: **Imipenem/cilastatin sodium in the treatment of continuous ambulatory peritoneal dialysis-associated peritonitis.** *Am J Nephrol* 1994, **14:**182–186.
24. Brulez HF, Moncasi EP, Posthuma N, Choy K, ter Wee PM: **The efficacy of intraperitoneally administered gentamicin and rifampin as initial treatment of peritoneal dialysis-related peritonitis.** *Adv Perit Dial* 1995, **11:**182–186.
25. Goffin E, Pouthier D, Vandercam B, Gigi J: **IV vancomycin-oral ciprofloxacin: a safe and efficient therapeutic protocol for CAPD peritonitis (preliminary report).** *Perit Dial Int* 1996, **6:**174–177.
26. Shemin D, Maaz D: **Gram-negative peritonitis in peritoneal dialysis: Improved outcome with intraperitoneal ceftazidime.** *Perit Dial Int* 1996, **16:**637–640.
27. Szeto CC, Chow VC, Chow KM, Lai RW, Chung KY, Leung CB, Kwan BC, Li PK: **Enterobacteriaceae peritonitis complicating peritoneal dialysis: a review of 210 consecutive cases.** *Kidney Int* 2006, **69:**1245–1252.
28. Yorioka N, Taniguchi Y, Ito T, Katsutani M, Amimoto D, Masaki T, Nishida Y, Kushihata S, Oda H, Yamakido M: **Vancomycin therapy for treatment of peritonitis in outpatients on peritoneal dialysis.** *Hiroshima J Med Sci* 1998, **47:**105–107.
29. Lévesque R, Lemieux C, Laverdiere M, Pichette V: **Treatment of gram-positive peritonitis in peritoneal dialysis patients:cefazolin or vancomycin?** *Perit Dial Int* 2003, **23:**599–601.
30. Kobayashi K, Nakamoto H, Okada S, Hoshitani K, Uchida K, Arima H, Shoda J, Takane Y, Ikeda N, Sugahara S, Okada H, Suzuki H: **Efficacy and safety of meropenem plus tobramycin followed by meropenem plus vancomycin for treating peritonitis in patients on continuous ambulatory peritoneal dialysis.** *Adv Perit Dial* 2006, **22:**65–68.
31. Leppänen H, Metsärinne KP, Nikoskelainen J, Tertti R: **Three-year analysis of microbial aetiology and antimicrobial susceptibilities of PD peritonitis.** *Scand J Infect Dis* 2006, **38:**645–649.
32. Shukla A, Abreu Z, Bargman JM: **Streptococcal PD peritonitis–a 10-year review of one centre's experience.** *Nephrol Dial Transplant* 2006, **21:**3545–3549.
33. Brown F, Liu WJ, Kotsanas D, Korman TM, Atkins RC: **A quarter of a century of adult peritoneal dialysis-related peritonitis at an Australian medical center.** *Perit Dial Int* 2007, **27:**565–574.

34. Lima RCS, Barreira A, Cardoso FL, Lima MHS, Leite M Jr: **Ciprofloxacin and cefazolin as a combination for empirical initial therapy of peritoneal dialysis-related peritonitis: Five-year follow-up.** *Perit Dial Int* 2007, **27:**56–60.
35. Kabat-Koperska J, Golembiewska E, Ciechanowski K: **Peritoneal dialysis-related peritonitis in the years 2005–2007 among patients of the Peritoneal Dialysis Clinic of the Department of Nephrology, Transplantology and Internal Medicine, Pomeranian Medical University in Szczecin.** *Pol Arch Med Wewn* 2008, **118:**694–699.
36. Santoianni JE, Predari SC, Veron D, Zucchini A, De Paulis AN: **A 15 year-review of peritoneal dialysis-related peritonitis: Microbiological trends and patterns of infection in a teaching hospital in Argentina.** *Rev Argent Microbiol* 2008, **40:**17–23.
37. Fontán MP, Cambre HD, Rodríguez-Carmona A, Muñiz AL, Falcón TG: **Treatment of peritoneal dialysis-related peritonitis with ciprofloxacin monotherapy: clinical outcomes and bacterial susceptibility over two decades.** *Perit Dial Int* 2009, **29:**310–318.
38. O'Shea S, Hawley CM, McDonald SP, Brown FG, Rosman JB, Wiggins KJ, Bannister KM, Johnson DW: **Streptococcal peritonitis in Australian peritoneal dialysis patients: predictors, treatment and outcomes in 287 cases.** *BMC Nephrol* 2009, **26:**10–19.
39. Szeto CC, Kwan BC, Chow KM, Law MC, Pang WF, Chung KY, Leung CB, Li PK: **Recurrent and relapsing peritonitis: causative organisms and response to treatment.** *Am J Kidney Dis* 2009, **54:**702–710.
40. Barraclough K, Hawley CM, McDonald SP, Brown FG, Rosman JB, Wiggins KJ, Bannister KM, Johnson DW: **Polymicrobial peritonitis in peritoneal dialysis patients in Australia:predictors, treatment, and outcomes.** *Am J Kidney Dis* 2010, **55:**121–131.
41. Edey M, Hawley CM, McDonald SP, Brown FG, Rosman JB, Wiggins KJ, Bannister KM, Johnson DW: **Enterococcal peritonitis in Australian peritoneal dialysis patients: predictors, treatment and outcomes in 116 cases.** *Nephrol Dial Transplant* 2010, **25:**1272–1278.
42. Fahim M, Hawley CM, McDonald SP, Brown FG, Rosman JB, Wiggins KJ, Bannister KM, Johnson DW: **Culture-negative peritonitis in peritoneal dialysis patients in Australia:predictors, treatment, and outcomes in 435 cases.** *Am J Kidney Dis* 2010, **55:**690–697.
43. Fahim M, Hawley CM, McDonald SP, Brown FG, Rosman JB, Wiggins KJ, Bannister KM, Johnson DW: **Coagulase-negative staphylococcal peritonitis in Australian peritoneal dialysis patients: predictors, treatment and outcomes in 936 cases.** *Nephrol Dial Transplant* 2010, **25:**3386–3392.
44. Govindarajulu S, Hawley CM, McDonald SP, Brown FG, Rosman JB, Wiggins KJ, Bannister KM, Johnson DW: **Staphylococcus aureus peritonitis in Australian peritoneal dialysis patients:predictors, treatment, and outcomes in 503 cases.** *Perit Dial Int* 2010, **30:**311–319.
45. Heywood A, Bargman JM: **Coagulase-negative staphylococcal peritonitis: outcomes of cephalosporin-resistant strains.** *Adv Perit Dial* 2010, **26:**34–36.
46. Kofteridis DP, Valachis A, Perakis K, Maraki S, Daphnis E, Samonis G: **Peritoneal dialysis-associated peritonitis: clinical features and predictors of outcome.** *Int J Infect Dis* 2010, **14:**e489–e493.
47. Noone D, Edwards L, Boyle S, Kinlough M, Riordan M, Awan A: **Low rate of peritonitis in children on peritoneal dialysis, 5 year review from a single-centre.** *Pediatr Nephrol* 2010, **25:**1834.
48. Ghali JR, Bannister KM, Brown FG, Rosman JB, Wiggins KJ, Johnson DW, McDonald SP: **Microbiology and outcomes of peritonitis in Australian peritoneal dialysis patients.** *Perit Dial Int* 2011, **31:**651–662.
49. Peres LAB, Matsuo T, Ann HK, Camargo MTA, Rohde NRS, Uscocovich VSM, Litchteneker K, Frederico SAM: **Peritonites em diálise peritoneal ambulatorial contínua/Peritonitis in continuous ambulatory peritoneal dialysis.** *Rev Soc Bras Clín Méd* 2011, **9:**5.
50. Szeto CC, Kwan BC, Chow KM, Lau MF, Law MC, Chung KY, Leung CB, Li PK: **Repeat peritonitis in peritoneal dialysis: Retrospective review of 181 consecutive cases.** *Clin J Am Soc Nephrol* 2011, **6:**827–833.
51. Yip T, Tse KC, Ng F, Hung I, Lam MF, Tang S, Lui SL, Lai KN, Chan TM, Lo WK: **Clinical course and outcomes of single-organism Enterococcus peritonitis inperitoneal dialysis patients.** *Perit Dial Int* 2011, **31:**522–528.
52. Yap DYH, To KKW, Yip TPS, Lui SL, Chan TM, Lai KN, Lo WK: **Streptococcus bovis peritonitis complicating peritoneal dialysis-a review of 10 years' experience.** *Perit Dials Int* 2012, **32:**55–59.
53. Searle M, Raman GV: **Oral treatment of peritonitis complicating continuous ambulatory peritoneal dialysis.** *Clin Nephrol* 1985, **23:**241–244.
54. Al-Wali W, Baillod RA, Brumfitt W, Hamilton-Miller JMT: **Teicoplanin in the treatment of peritonitis in patients receiving continuous ambulatory peritoneal dialysis: A comparative trial against vancomycin.** *Int J Antimicrob Agents* 1992, **1:**S1–S6.
55. Lye WC, Lee EJ, van der Straaten J: **Intraperitoneal vancomycin/oral pefloxacin versus intraperitoneal vancomycin/gentamicin in the treatment of continuous ambulatory peritoneal dialysis peritonitis.** *Perit Dial Int* 1993, **13:**S348–S350.
56. Fijter CW, ter Wee PM, Oe LP, Verbrugh HÁ: **Intraperitoneal ciprofloxacin and rifampicin versus cephradine as initial treatment of (C)APD-related peritonitis: a prospective randomized multicenter comparison (CIPPER trial).** *Perit Dial Int* 2001, **21:**480–486.
57. Leung CB, Szeto CC, Chow KM, Kwan BC, Wang AY, Lui SF, Li PK: **Cefazolin plus ceftazidime versus imipenem/cilastatin monotherapy for treatment of CAPD peritonitis–a randomized controlled trial.** *Perit Dial Int* 2004, **24:**440–446.
58. Khairullah Q, Provenzano R, Tayeb J, Ahmad A, Balakrishnan R, Morrison L: **Comparison of vancomycin versus cefazolin as initial therapy for peritonitis in peritoneal dialysis patients.** *Perit Dial Int* 2002, **22:**339–344.
59. Ludlam HA, Price TN, Berry AJ, Phillips I: **Laboratory diagnosis of peritonitis in patients on continuous ambulatory peritoneal dialysis.** *J Clin Microbiol* 1988, **26:**1757–1762.
60. Beaman M, Solaro L, McGonigle RJ, Michael J, Adu D: **Vancomycin and ceftazidime in the treatment of CAPD peritonitis.** *Nephron* 1989, **51:**51–55.
61. Gucek A, Bren AF, Hergouth V, Lindic J: **Cefazolin and netilmycin versus vancomycin and ceftazidime in the treatment of CAPD peritonitis.** *Adv Perit Dial* 1997, **13:**218–220.
62. Blunden M, Zeitlin D, Ashman N, Fan SL-S: **Single UK centre experience on the treatment of PD peritonitis - Antibiotic levels and outcomes.** *Nephrol Dial Transplant* 2007, **22:**1714–1719.
63. Lartundo JAQ, Palomar R, Dominguez-Diez A, Salas C, Ruiz-Criado J, Rodrigo E, Martinez De Francisco AL, Arias M: **Microbiological profile of peritoneal dialysis peritonitis and predictors of hospitalization.** *Adv Perit Dial* 2011, **27:**38–42.
64. Chan MK, Cheng IK, Ng WS: **A randomized prospective trial of three different regimens of treatment of peritonitis in patients on continuous ambulatory peritoneal dialysis.** *Am J Kidney Dis* 1990, **15:**155–159.
65. Weber J, Kuhlmann U: **Intraperitoneal cefazolin and gentamicin in the management of CAPD-related peritonitis.** *Contrib Nephrol* 1991, **89:**108.
66. Lupo A, Rugiu C, Bernich P, Laudon A, Marcantoni C, Mosconi G, Cantaluppi MC, Maschio G: **A prospective randomized trial of two antibiotic regimens in the treatment of peritonitis in CAPD patients: teicoplanin plus tobramycin versus cephalotin plus tobramycin.** *J Antimicrob Chemother* 1997, 729–732.
67. Vas S, Bargman J, Oreopoulos D: **Treatment in PD patients of peritonitis caused by gram-positive organisms with single daily dose of antibiotics.** *Perit Dial Int* 1997, **17:**91–94.
68. Goldberg L, Clemenger M, Azadian B, Brown EA: **Initial treatment of peritoneal dialysis peritonitis without vancomycin with a once-daily cefazolin-based regimen.** *Am J Kidney Dis* 2001, **37:**49–55.
69. Silva MM, Pecoits-Filho R, Rocha CS, Stinghen AE, Pachaly MA, Nascimento MM, Campos RP, Sauthier S, Fuerbringer R, Riella MC: **The recommendations from the International Society for Peritoneal Dialysis for Peritonitis Treatment: a single-center historical comparison.** *Adv Perit Dial* 2004, **20:**74–77.
70. Toussaint N, Mullins K, Snider J, Murphy B, Langham R, Gock H: **Efficacy of a non-vancomycin-based peritoneal dialysis peritonitis protocol.** *Nephrology (Carlton)* 2005, **10:**142–146.
71. Chen KH, Chang CT, Weng SM, Yu CC, Fang JT, Huang JY, Yang CW, Hung CC: **Culture-negative peritonitis: a fifteen-year review.** *Ren Fail* 2007, **29:**177–181.
72. Barretti P, Montelli AC, Batalha JE, Caramori JC, Cunha Mde L: **The role of virulence factors in the outcome of staphylococcal peritonitis in CAPD patients.** *BMC Infect Dis* 2009, **9:**212.
73. Lee CC, Sun CY, Chang KC, Wu MS: **Positive dialysate gram stain predicts outcome of empirical antibiotic therapy for peritoneal dialysis-associated peritonitis.** *Ther Apher Dial* 2010, **14:**201–218.
74. Huang S-T, Chuang Y-W, Cheng C-H, Wu M-J, Chen C-H, Yu T-M, Shu K-H: **Evolution of microbiological trends and treatment outcomes in peritoneal dialysis-related peritonitis.** *Clin Nephrol* 2011, **75:**416–425.
75. Oliveira LG, Luengo J, Caramori JC, Montelli AC, Cunha MD, Barretti P: **Peritonitis in recent years: clinical findings and predictors of treatmentresponse of 170 episodes at a single Brazilian center.** *Int Urol Nephrol* 2012, **44:**1529–1537.

76. Bennett-Jones DN, Russell GI, Barrett A: **A comparison between oral ciprofloxacin and intra-peritoneal vancomycin and gentamicin in the treatment of CAPD peritonitis.** *J Antimicrob Chemother* 1990, **26:**F73–F76.
77. Friedland JS, Iveson TJ, Fraise AP, Winearls CG, Selkon JB, Oliver DO: **A comparison between intraperitoneal ciprofloxacin and intraperitoneal vancomycin and gentamicin in the treatment of peritonitis associated with continuous ambulatory peritoneal dialysis (CAPD).** *J Antimicrob Chemother* 1990, **26:**F77–F81.
78. Tapson JS, Orr KE, George JC, Stansfield E, Bint AJ, Ward MK: **A comparison between oral ciprofloxacin and intraperitoneal vancomycin and netilmicin in CAPD peritonitis.** *J Antimicrob Chemother* 1990, **26:**F63–F71.
79. Merchant MR, Anwar N, Were A, Uttley L, Tooth JA, Gokal R: **Imipenem versus netilmicin and vancomycin in the treatment of CAPD peritonitis.** *Adv Perit Dial* 1992, **8:**234–247.
80. Were AJ, Marsden A, Tooth A, Ramsden R, Mistry CD, Gokal R: **Netilmycin and vancomycin in the treatment of peritonitis in CAPD patients.** *Clin Nephrol* 1992, **37:**209–213.
81. Anwar N, Merchant M, Were T, Tooth A, Uttley L, Gokal R: **A prospective, randomized study of the comparative safety and efficacy of intraperitoneal imipenem versus vancomycin and netilmicin in the treatment of peritonitis on CAPD.** *Perit Dial Int* 1995, **15:**167–171.
82. Guest SS, Erickson LJ: **Combination therapy involving ciprofloxacin for peritonitis.** *Perit Dial Int* 1996, **16:**316–318.
83. Lai MN, Kao MT, Chen CC, Cheung SY, Chung WK: **Intraperitoneal once-daily dose of cefazolin and gentamicin for treating CAPD peritonitis.** *Perit Dial Int* 1997, **17:**87–89.
84. Bowley JA, Pickering SJ, Scantlebury AJ, Ackrill P, Jones DM: **Intraperitoneal teicoplanin in the treatment of peritonitis associated with continuous ambulatory peritoneal dialysis.** *J Antimicrob Chemother* 1988, **21:**A133–A139.
85. Cheng IK, Fang GX, Chau PY, Chan TM, Tong KL, Wong AK, Li CS, Lo WK, Cheung KO, Kumana CR: **A randomized prospective comparison of oral levofloxacin plus intraperitoneal (IP) vancomycin and IP netromycin plus IP vancomycin as primary treatment of peritonitis complicating CAPD.** *Perit Dial Int* 1998, **18:**371–375.
86. Wong KM, Chan YH, Cheung CY, Wai LC, Choi KS, Leung SH, Leung J, Ka Foon C, Tsang DNC, Li CS: **Cefepime versus vancomycin plus netilmicin therapy for continuous ambulatory peritoneal dialysis-associated peritonitis. Am. J.** *Kidney Dis* 2001, **38:**127–131.
87. Vargemezis V, Pasadakis P, Thodis H, Coucudis P, Peihaberis P, Jafer H, Jara F, Kartali S: **Vancomycin therapy for gram-positive peritonitis in patients on CAPD.** *Adv Perit Dial* 1989, **5:**128–129.
88. Flanigan MJ, Lim VS: **Initial treatment of dialysis associated peritonitis: a controlled trial of vancomycin versus cefazolin.** *Perit Dial Int* 1991, **11:**31–37.
89. Bailie GR, Haqqie SS, Eisele G, Gorman T, Low CL: **Effectiveness of once-weekly vancomycin and once-daily gentamicin, intraperitoneally, for CAPD peritonitis.** *Perit Dial Int* 1995, **15:**269–271.
90. Chadwick DH, Agarwal S, Vora BJ, Hair M, McKewan A, Gokal R: **Outcome of peritonitis treated with intraperitoneal (i.p.) weekly vancomycin and i.p. daily netilmicin.** *J Nephrol* 1999, **12:**318–321.
91. Li PK, Ip M, Law MC, Szeto CC, Leung CB, Wong TY, Ho KK, Wang AY, Lui SF, Yu AW, Lyon DJ, Cheng AF, Lai KN: **Use of intraperitoneal cefepime as monotherapy in treatment of CAPD peritonitis.** *Perit Dial Int* 2000, **20:**232–234.
92. Goffin E, Herbiet L, Pouthier D, Pochet JM, Lafontaine JJ, Christophe JL, Gigi J, Vandercam B: **Vancomycin and ciprofloxacin: systemic antibiotic administration for peritoneal dialysis-associated peritonitis.** *Perit Dial Int* 2004, **24:**433–439.
93. Szeto CC, Kwan BC, Chow KM, Lau MF, Law MC, Chung KY, Leung CB, Li PK: **Coagulase negative staphylococcal peritonitis in peritoneal dialysis patients: review of 232 consecutive cases.** *Clin J Am Soc Nephrol* 2008, **3:**91–97.
94. Percival A, Cohen SL: **The treatment of peritoneal infections in patients on peritoneal dialysis.** *Postgrad Med J* 1967, **43**(Suppl):160–165.
95. Ludlam HA, Barton I, White L, McMullin C, King A, Phillips I: **Intraperitoneal ciprofloxacin for the treatment of peritonitis in patients receiving continuous ambulatory peritoneal dialysis (CAPD).** *J Antimicrob Chemother* 1990, **25:**843–851.
96. Cheng IK, Chan CY, Wong WT: **A randomised prospective comparison of oral ofloxacin and intraperitoneal vancomycin plus aztreonam in the treatment of bacterial peritonitis complicating continuous ambulatory peritoneal dialysis (CAPD).** *Perit Dial Int* 1991, **11:**27–30.
97. Dryden M, Eykyn SJ: **Short-course gentamicin in gram-negative CAPD peritonitis.** *Lancet* 1993, **341**(8843):8497.
98. Brown MC, Simpson K, Kerssens JJ: **Mactier R.A Peritoneal dialysis-associated peritonitis rates and outcomes in a national cohort are not improving in the post-millennium (2000–2007).** *Perit Dial Int* 2011, **31:**639–650.
99. Ballinger AE, Palmer SC, Wiggins KJ, Craig JC, Johnson DW, Cross NB, Strippoli GFM: **Treatment for peritoneal dialysis-associated peritonitis.** *Cochrane Database Syst Rev* 2014, **26;4:**CD005284. doi: 10.1002/14651858.
100. Milikin SMG, Keane WF: **Antimicrobial treatment of peritonitis associated with continuous ambulatory peritoneal dialysis.** *Perit Dial Int* 1991, **11:**252–260.
101. Barretti P, Pereira D, Brasil MA, de Lourdes CM, Caramori J, Montelli A: **Evolution of gram-negative bacilli susceptibility in peritoneal dialysis-related peritonitis in Brazil: a single center's experience over nine years.** *Perit Dial Int* 2009, **29:**230–233.
102. Kim DK, Yoo TH, Ryu DR, Xu ZG, Kim HJ, Choi KH, Lee HY, Han DS, Kang SW: **Changes in causative organisms and their antimicrobial susceptibilities in CAPD peritonitis: a single center's experience over one decade.** *Perit Dial Int* 2004, **24:**424–432.

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