Review Article

# Continuous Ambulatory Peritoneal Dialysis Peritonitis Guidelines – Consensus Statement of Peritoneal Dialysis Society of India - 2020

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**Preamble**

Continuous ambulatory peritoneal dialysis (CAPD) related peritonitis is a major cause of technique failure, morbidity, and mortality in patients on CAPD. Its prevention and management is key to success of CAPD program. Due to variability in practice, microbiological trends and sensitivity towards antibiotics, there is a need for customized guidelines for management of CAPD related peritonitis (CAPDRP) in India. With this need, Peritoneal Dialysis Society of India (PDSI) organized a structured meeting to discuss various aspects of management of CAPDRP and formulated a consensus agreement which will help in management of patients with CAPDRP.

**Keywords:** *Guidelines, peritoneal dialysis, peritoneal dialysis related peritonitis*

## Introduction

It has been observed that the practice patterns of management of continuous ambulatory peritoneal dialysis related peritonitis (CAPDRP) is highly variable in India. Culture positive rates in India are also variable and mostly below the acceptable recommendations.[1] We know that microbiological information is critical in optimal management of CAPDRP and is an important determinant of clinical outcome. A working group with representation from all zones of the country came together to formulate guidelines for treatment of CAPDRP after review of published literature and exhaustive debate on the subject.

This guideline for treatment of CAPDRP is intended to help practicing nephrologists in decision making while treating patients with CAPDRP. It does not define a standard of care of CAPDRP and the group acknowledges the variations in practice based on individual patients' needs, available resources, and limitations faced by clinicians. The working group also acknowledges the lack of high quality evidence on this issue from our country and hence the guideline is based on recommendations of International Society of Peritoneal dialysis (ISPD)[2] with modifications suitable and applicable for India.

### Nomenclature and Description for rating guideline recommendations

We have used the terminology similar to Kidney Disease Improving Global Outcomes (KDIGO) guidelines [Table 1]. In view of paucity of literature from India, further subdivision into A, B, C and D is avoided.

## Summary of Recommendations and Suggestions

Keys to successful PD program are dedicated team, appropriate training of patient and/or care giver, preventive measures for infection, appropriate culture methods, appropriate empiric antibiotics, preservation of peritoneum and periodic auditing. The selection of patient is also important, as utilization of PD as a last resort after failure of other modalities have compromised outcomes. CAPDRP is the most important and preventable cause of morbidity and mortality in peritoneal dialysis (PD) patients. High peritonitis rates can be a severe setback to any CAPD program.[3]

This guideline is aimed to serve as a quick recap in the management of CAPDRP and is based on evidence-based recommendations

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of International Society of Peritoneal Dialysis guidelines for peritonitis, suggestions and expert consensus statements available in literature.

## Overview of the guidelines

### *Prevention of CAPDRP*

- We recommend that systemic prophylactic antibiotic should be given prior to catheter insertion
- We recommend that the disconnect system with 'flush before fill' bags should be used for continuous ambulatory peritoneal dialysis (CAPD)
- We recommend that PD training should be conducted by a qualified nurse, preferably at the center, and reviewed for each patient by the nephrologist before certified to be complete
- We suggest that prophylactic antibiotic should be given to all PD patients before any invasive procedure like dental, gynecological or intestinal
- We recommend that topical antibiotic cream or ointment should be applied to the catheter exit site daily after bath
- We recommend that catheter exit site or tunnel infections should be treated adequately so as to prevent subsequent peritonitis
- We recommend that antifungal prophylaxis should be given whenever antibiotics are given to a CAPD patient to decrease fungal peritonitis.

### *Initial presentation and management of peritonitis*

- We recommend that peritonitis should be diagnosed when at least 2 of the 3 features are present:
  1. Clinical features consistent with peritonitis like abdominal pain, cloudy dialysis effluent;
  2. Dialysis effluent white cell count >100/μL (after a dwell time of at least 2 hours), with >50% polymorphonuclear leucocytes; and
  3. Positive dialysis effluent culture.
- We recommend that all cloudy effluent should be considered peritonitis and treated accordingly till excluded.
- We suggest sending the entire bag to the microbiology laboratory for analysis.
- We recommend that PD effluent, when suspected of peritonitis, should be tested for total cell count, differential cell count, Gram stain, and culture.
- We suggest initial testing for bacterial and fungal culture and if possible, in suspected, or in non-responding cases for mycobacterial cultures.

### *Empiric Antibiotic selection*

- We recommend that empiric antibiotic should be started as soon as possible when peritonitis is suspected, preferably after sending effluent for testing
- We recommend that the choice of empiric antibiotic should be to cover both Gram positive and negative organism and better guided by local antibiogram
- We recommend that Gram positive organism should be covered by Vancomycin and Gram negative by Piperacillin-Tazobactam or Aminoglycoside, unless local antibiogram suggest other antibiotics susceptibility
- We recommend that preferred route of antibiotic administration should be intra-peritoneal (IP), unless there is evidence of severe systemic sepsis
- We recommend that antibiotic should be deescalated once the antibiotic sensitivity pattern is available
- We recommend that PD catheter should be removed in cases of refractory peritonitis, defined by failure of the PD effluent to clear up after 5 days of appropriate antibiotics
- We suggest that peritonitis should be treated depending upon the bacteria isolated, at least for 2-3 weeks with appropriate antibiotic

**Table 1: Nomenclature of guideline statements**

| Statement | Implication for patients | Implications for clinicians |
|---|---|---|
| "We recommend" | Most people in this situation would want the recommended course of action and only a small proportion would not | Most patients should receive the recommended course of action |
| "We suggest" | The majority of people in this situation would want the suggested course of action, but many would not | Different choices will be appropriate for different patients. Each patient needs help to arrive at a management decision consistent with their values and preferences |

- We suggest that coagulase-negative Staphylococci should be treated for 2 weeks with appropriate antibiotics
- We suggest Enterococcal peritonitis should be treated for 3 weeks. We also suggest adding an Aminoglycoside for severe infection. For Vancomycin Resistant Enterococci (VRE), we suggest 3 weeks of IP Ampicillin if it is sensitive or Linezolid, Daptomycin or Teicoplanin as per sensitivity, if ampicillin resistant
- We suggest that Streptococcal peritonitis should be treated for 2 weeks
- We suggest that Staphylococcus aureus peritonitis should be treated for 3 weeks
- We suggest that Corynebacterial peritonitis should be treated for 3 weeks
- We suggest that Pseudomonas peritonitis should be treated for 3 weeks with 2 susceptible antibiotics
- We suggest that non-Pseudomonas Gram negative peritonitis should be treated for 3 weeks
- We suggest that peritonitis associated with exit site and/or tunnel infection should be managed with catheter removal
- We suggest that polymicrobial Gram negative peritonitis should be managed with surgical evaluation and antibiotics for 3 weeks
- We suggest that culture negative peritonitis, if responding within 3 days, should be continued with same antibiotics, for 2 weeks. If no response, special culture techniques should be resorted to
- We suggest that catheter should be removed for fungal peritonitis and anti-fungals to be given for 2 weeks
- We suggest that tuberculous peritonitis should be treated appropriately with anti-Tuberculous drugs and catheter removal is suggested if there is no response.

### *Catheter removal and re-insertion*

- We recommend that PD catheter should be removed for refractory, relapsing and fungal peritonitis. Catheter should also be removed for non-tuberculous mycobacterial infections and individualized for tuberculous peritonitis
- We suggest that re-insertion of catheter can be considered after 2-4 weeks of bacterial and 4-6 weeks of fungal peritonitis along with complete resolution of peritoneal symptoms
- We recommend that each PD center should have a continuous quality improvement (CQI) program to reduce the rates of peritonitis.

## Guidelines for CAPD related peritonitis

### *Prevention of PDRP*

- We recommend that one dose of systemic prophylactic antibiotic should be given just prior to catheter insertion. Every center should determine the choice of antibiotic as per their spectrum of sensitivity towards skin and soft tissue antibiogram. Three randomized controlled trials (RCTs) showed reduction in early peritonitis with use of perioperative antibiotic.[4-6] One trial showed no benefit.[7] Systematic review of these trials shows benefit of prophylactic antibiotic.[8]
- We recommend that the disconnect system with 'flush before fill' bags should be used for continuous ambulatory peritoneal dialysis (CAPD).
  The risk of developing peritonitis is reduced to 1/3rd with the use of Y system.[9,10] Also, there is no difference between the double bag or the Y system. There are conflicting results of comparison of peritonitis rates between CAPD and APD and peritonitis rate cannot be the basis of choice of any of these two modalities.
- We recommend that PD training should be conducted by a qualified trainer, preferably at the center, and reviewed for each patient by the nephrologist before certified to be complete.
  Training has great influence on incidence of peritonitis.[11-22] Though strong evidence is lacking on who should be the trainer,[22] a well-trained nurse can dedicate time enough to train and monitor the exchange process. It is suggested to ensure proper training before making them independent, which can be done by the nephrologist (or other trained nurse, preferably not the same trainer). It is also suggested that retraining should be done periodically and after each episode of peritonitis.[17,19]
- We suggest that single dose prophylactic antibiotic should be given to all PD patients before any invasive procedure like dental, gynecological or intestinal.
  Invasive procedure like colonoscopy has been shown to increase the risk of peritonitis.[23] Prophylactic antibiotic before an invasive procedure except upper gastroscopy, reduces the risk of peritonitis.[24] However, the choice of prophylactic antibiotic has not been studied and is left to the discretion of the local physician.
- We recommend that topical antibiotic cream or ointment should be applied to the catheter exit site daily after bath.
- We recommend that catheter exit site or tunnel infections should be treated adequately so as to prevent subsequent peritonitis.
  There is an association between exit site infection (ESI) and subsequent peritonitis and hence appropriate management will reduce the risk of peritonitis.[25-27] Though one of the systematic review did not show benefit of topical povidone-iodine in reducing peritonitis,[28] another meta-analysis showed that topical mupirocin reduced rates of overall S. aureus infection by 72% and S. aureus peritonitis by 40%.[29] Mupirocin resistance is of concern but is reported more with intermittent rather than daily use.[30-33] With extensive use of mupirocin ointment to reduce S aureus infections, Pseudomonas infection rates increased as a cause of catheter infections.[34] An RCT showed topical

gentamicin cream to the exit site was effective in reducing ESIs caused by Pseudomonas species as well as S aureus.[35] However, other studies showed increased ESIs by Enterobacteriaceae, Pseudomonas species and non-tuberculous mycobacteria with use of gentamicin cream.[36,37] It is believed that topical gentamicin, however, is an acceptable alternative to mupirocin.

No definite anti-microbial guidelines are available for non-Tuberculous mycobacteria infections, but consensus is to treat with multiple antibiotics and remove the catheter.

- We recommend that antifungal prophylaxis should be given whenever antibiotics are given to a PD patient to decrease fungal peritonitis. Antifungal prophylaxis should be continued for a week beyond antibiotics.

  Fungal peritonitis is increased after antibiotic courses.[38-40] Two randomized trials[41,42] and a systematic review[8] showed benefits of prophylactic anti-fungals during antibiotic course in preventing subsequent fungal peritonitis.

### *Initial presentation and management of peritonitis*

- We recommend that peritonitis should be diagnosed when at least 2 of the 3 features are present:
  1. Clinical features consistent with peritonitis like abdominal pain, cloudy dialysis effluent;
  2. Dialysis effluent white cell count >100/µL (after a dwell time of at least 2 hours), with >50% polymorphonuclear leucocytes; and
  3. Positive dialysis effluent culture.
- We recommend that all cloudy effluent should be considered peritonitis and treated accordingly till excluded.
- We recommend that PD effluent, when suspected of peritonitis, should be tested for total and differential cell count, Gram stain, and culture.

Cloudy effluent should be treated as peritonitis unless proven otherwise. There are non infectious causes of cloudy effluent which should be considered in non classical presentations [Table 2].[43] Patients presenting with abdominal pain should also be evaluated for peritonitis even when effluent is clear.

When peritonitis is suspected, dialysis effluent should be drained, inspected for cloudiness, and sent for total and differential cell count, Gram stain, and culture.[44] An effluent cell count with white blood cells (WBC) >100/µL (after a dwell time of at least 2 hours), with >50% PMN, is highly suggestive of peritonitis.[45] Appropriate antibiotic therapy (see below) should be initiated once the dialysis effluent specimens have been collected for analysis, without waiting for the results of laboratory testing. For patients on APD, percentage of PMN rather than the absolute WBC count should be used to diagnose peritonitis and a proportion above 50% PMN is strong evidence of peritonitis, even if the absolute WBC count is less than 100/µL.[45]

**Table 2: Differential diagnosis of cloudy effluent**

| |
|---|
| Culture positive peritonitis |
| Culture negative infectious peritonitis |
| Chemical peritonitis |
| Calcium channel blockers |
| Eosinophilia of the peritoneum |
| Hemoperitoneum |
| Malignancy (rare) |
| Chylous effluent (rare) |
| Specimen taken from ‘dry abdomen’ |

Adapted and modified from Li PKT *et al*. Perit Dial Int 2016; 36(5): 481-508

For patients in remote areas, they can keep the effluent bag refrigerated till they bring the bag for analysis and start intra peritoneal antibiotics as soon as possible. If possible, specimen should be processed within 6 hours of collection. Alternatively, they can send the effluent for analysis at local center or, if trained and available can inoculate into blood culture bottles, which should be provided to them. The inoculated culture bottles should be incubated at 37°C.

Gram stain of PD effluent should be performed, preferably after centrifugation. Appropriate culture method is a key to positive results. After collection, 50 ml of effluent should be centrifuged at 3000 g for 15 minutes, followed by resuspension of the sediment in 3-5 ml supernatant and inoculation on solid culture media or standard blood culture media. If cultures remain negative after 3-5 days, PD effluent should be sent for repeat cell count, fungal and mycobacterial cultures.

A number of novel diagnostic techniques have been explored for the early diagnosis of peritonitis, including leukocyte esterase reagent strips, biomarker assays (matrix metalloproteinase-8 and -9, neutrophil gelatinase-associated lipocalin and procalcitonin), polymerase chain reaction (PCR) for bacterial-derived DNA fragments, 16S rRNA gene sequencing, matrix-assisted laser desorption ionization-time of flight (MALDI-TOF), and pathogen-specific “immune fingerprints”.[46-58] However, none of them has been proved to be superior to conventional culture techniques.

### *Empiric Antibiotic selection*

- We recommend that empiric antibiotic should be started as soon as possible when peritonitis is suspected, preferably after sending effluent for testing.
- We recommend that the choice of empiric antibiotic should be to cover both Gram positive and negative organism and better guided by local antibiogram.
- We recommend that Gram positive organism should be covered by Vancomycin and Gram negative by Piperacillin-Tazobactam or Aminoglycosides unless local antibiogram suggest other susceptibility.

  In the recent data analysis, gram-positive organisms are more commonly encountered across the country

but almost close to gram-negative organisms.[2] However, center wise difference have also been noted. It is suggested to start with antibiotics covering for both positive and negative organisms. In a meta-analysis,[55] the combination of a glycopeptide (vancomycin or teicoplanin) and ceftazidime was superior to other regimens. However, the sensitivity pattern across all zones in India suggest resistance towards cephalosporins and better sensitivity to piperacillin-tazobactam. Cefepime or imipenem/cilastatin can be used as monotherapy. Once the culture results are available, antibiotics can be adjusted and deescalated to avoid future antibiotic resistance.

- We recommend that preferred route of antibiotic administration should be intra-peritoneal (IP), unless there is evidence of severe systemic sepsis.
- We recommend that antibiotic should be deescalated once the antibiotic sensitivity pattern is available.

  Intraperitoneal dosing results in high IP drug levels and is preferable to IV administration. Intraperitoneal antibiotics can be given as continuous (in each exchange) or intermittent dosing (once daily).[59-64] In intermittent dosing, the antibiotic-containing dialysis solution must be allowed to dwell for at least six hours to allow adequate absorption. The role of monitoring serum vancomycin levels is controversial.[65,66] In general, a dosing interval of every 4 to 5 days would keep serum trough levels above 15 µg/mL, but there is substantial inter-individual variability.[65,67] Re-dosing is probably appropriate when serum vancomycin levels are below 15 µg/mL.[67-69] There is no firm evidence that monitoring aminoglycoside levels mitigates toxicity risk or enhances efficacy.[69]

  Antibiotic dosing in APD is of concern because of rapid exchanges. However, intermittent dosing given at long day dwell is effective. Alternatively, if possible, patients may switch to CAPD till completion of the treatment. The recommended dosage of antibiotics for the treatment of PD related peritonitis is summarized in Tables 3 and 4.[2]
- We recommend that PD catheter should be removed in cases of refractory peritonitis.

  Refractory peritonitis is defined as failure of the PD effluent to clear up after 5 days of appropriate antibiotics. If there is failure to respond to empiric antibiotic in culture negative or to susceptible antibiotic in culture positive peritonitis in 3 days, a trial of higher / susceptible antibiotic is recommended for another 2 days before labelling it as refractory. Catheter removal is indicated in cases of refractory peritonitis. Delay in catheter removal leads to extended hospital stay, peritoneal membrane damage, increased risk of fungal peritonitis and excessive mortality.[70] Catheter should also be removed if patient's condition is deteriorating.
- We suggest that coagulase-negative Staphylococci (CONS) should be treated for 2 weeks with appropriate antibiotics.

  CONS is mostly due to touch contamination. Intraperitoneal vancomycin or cephalosporins can be advised for 2 weeks. Relapsing CONS peritonitis suggests colonization and bio-film formation, when catheter removal may be considered.
- We suggest Enterococcal peritonitis should be treated for 3 weeks. We also suggest adding an Aminoglycoside for severe infection. For Vancomycin Resistant Enterococci (VRE), we suggest 3 weeks of IP Ampicillin if it is sensitive or Linezolid, Daptomycin or Teicoplanin as per sensitivity, if ampicillin resistant.

  Enterococci infection suggests intra-abdominal source of infection. Identification of species is important as many are resistant to penicillins and carbapenems.
- We suggest that Streptococcal peritonitis should be treated for 2 weeks.

  Streptococci frequently originate from the mouth,[71] although S bovis comes from the colon.[72] Streptococcus viridans are more likely to be refractory.
- We suggest that Staphylococcus aureus peritonitis should be treated for 3 weeks.

  S aureus is often secondary to touch contamination, exit site or tunnel infection. Data suggests 3 weeks treatment[73,74] with appropriate antibiotic. Concomitant exit site or tunnel infection may need catheter removal.
- We suggest that Corynebacterial peritonitis should be treated for 3 weeks.
- We suggest that Pseudomonas peritonitis should be treated for 3 weeks with 2 susceptible antibiotics.

  Pseudomonas peritonitis is associated with higher rates of hospitalizations, catheter removal and transfer to hemodialysis. The outcome is reported to be better with 2 anti-pseudomonal antibiotics.[75]
- We suggest that non Pseudomonas Gram negative peritonitis should be treated for 3 weeks.

  The SPICE organisms (Serratia, Pseudomonas, indole positive organisms like Proteus and Providentia, Citrobacter, and Enterobacter) have amp C beta lactamases which can inactivate cephalosporins and have an increased risk of relapse. There are observational studies which shows treatment with 2 antibiotics for 3 to 4 weeks have better results.[76]
- We suggest that peritonitis associated with exit site and/or tunnel infection should be managed with catheter removal.

  It is believed that peritonitis associated with ESI or tunnel infection is because of peri-catheter translocation of bacteria. The outcome of such infections are poor and catheter removal with appropriate antibiotic helps in decreasing the morbidity.
- We suggest that polymicrobial Gram negative peritonitis should be managed with surgical evaluation and antibiotics for 3 weeks.

  When multiple enteric organisms are isolated, intra-abdominal pathology is a possibility and

**Table 3: Intraperitoneal Antibiotic Dosing Recommendations for Treatment of Peritonitis**

| | Intermittent (1 exchange daily) | Continuous (all exchanges) |
|---|---|---|
| **Aminoglycosides** | | |
| Amikacin | 2 mg/kg daily | LD 25 mg/L, MD 12 mg/L |
| Gentamicin | 0.6 mg/kg daily | LD 8 mg/L, MD 4 mg/L |
| Netilmicin | 0.6 mg/kg daily | MD 10 mg/L |
| Tobramycin | 0.6 mg/kg daily | LD 3 mg/kg, MD 0.3 mg/kg |
| Cephalosporins | | |
| Cefazolin | 15-20 mg/kg daily | LD 500 mg/L, MD 125 mg/L |
| Cefepime | 1,000 mg daily | LD 250-500 mg/L, MD 100-125 mg/L |
| Cefoperazone | no data | LD 500 mg/L, MD 62.5-125 mg/L |
| Cefotaxime | 500-1,000 mg daily | no data |
| Ceftazidime | 1,000-1,500 mg daily | LD 500 mg/L, MD 125 mg/L |
| Ceftriaxone | 1,000 mg daily | no data |
| **Penicillins** | | |
| Penicillin G | no data | LD 50,000 unit/L, MD 25,000 unit/L |
| Amoxicillin | no data | MD 150 mg/L |
| Ampicillin | no data | MD 125 mg/L |
| Ampicillin/Sulbactam | 2 gm/1 gm every 12 hours | LD 750-100 mg/L, MD 100 mg/L |
| Piperacillin/Tazobactam | no data | LD 4 gm/0.5 gm, MD 1 gm/0.125 gm |
| **Others** | | |
| Aztreonam | 2 gm daily | LD 1,000 mg/L, MD 250 mg/L |
| Ciprofloxacin | no data | MD 50 mg/L |
| Clindamycin | no data | MD 600 mg/bag |
| Daptomycin | no data | LD 100 mg/L, MD 20 mg/L |
| Imipenem/Cilastatin | 500 mg in alternate exchange | LD 250 mg/L, MD 50 mg/L |
| Ofloxacin | no data | LD 200 mg, MD 25 mg/L |
| Polymyxin B | no data | MD 300,000 unit (30 mg)/bag |
| Meropenem | 1 gm daily | 125 mg/L (case report) |
| Teicoplanin | 15 mg/kg every 5 days | LD 400 mg/bag, MD 20 mg/bag |
| Vancomycin | 15-30 mg/kg every 5-7 days (Supplement doses for APD patients) | LD 30 mg/kg, MD 1.5 mg/kg/bag |
| **Antifungals** | | |
| Fluconazole | IP 200 mg every 24 to 48 hours | no data |
| Voriconazole | IP 2.5 mg/kg daily | no data |

LD = Loading dose in mg; MD = Maintenance dose in mg; IP = Intraperitoneal; APD = Automated peritoneal dialysis. Adapted and modified from Li PKT *et al*. Perit Dial Int 2016; 36(5): 481-508

should be evaluated. The choice of antibiotic becomes metronidazole with vancomycin with cephalosporin or aminoglycoside. Carbapenems or piperacillin/tazobactam are an alternative.

- We suggest that culture negative peritonitis, if responding within 3 days, should be treated with same antibiotics for 2 weeks. Early response usually is due to CONS, but several centers have reported equal or higher incidence of gram negative organisms and the consensus was to continue both the empiric antibiotics for 2 weeks. If no response within 5 days, special culture techniques should be resorted to.

  Inappropriate culture technique is the most common cause of 'culture negative' peritonitis. Recent antibiotic usage also leads to culture negative peritonitis. Predominantly, these are due to gram positive organisms and hence, if responded within 3 days, should be managed for 2 weeks.[77-79]
- We suggest that catheter should be removed for fungal peritonitis and anti-fungals to be given for 2 weeks.

  Fungal peritonitis is associated with higher rates of hospitalization, transfer to hemodialysis, and death.[80-83] Catheter removal is suggested once diagnosis is confirmed to reduce mortality and preserve the peritoneum. Anti-fungal agents are continued for 2 weeks after catheter removal. The choice of anti-fungals are a combination of amphotericin B and flucytosine. However, IP amphotericin may cause chemical peritonitis and IV has poor peritoneal bioavailability. Flucytosine is not widely available. Other agents include fluconazole (for Candida and cryptococcus), echinocandins (for Aspergillus and non-albicans Candida), posconazole, and voriconazole (for filamentous fungi).
- We suggest that Tuberculous peritonitis should be treated appropriately with anti-tuberculous drugs and catheter removal is considered if there is no response.

**Table 4: Systemic Antibiotic Dosing Recommendations for Treatment of Peritonitis**

| Drug | Dosing |
|---|---|
| **Anti-bacterials** | |
| Ciprofloxacin | Oral 250 mg BD (500 mg BD, if residual renal function > 5 ml/min) |
| Colistin | IV 300 mg loading, then 150-200 mg daily (expressed as Colistin Base Activity, CBA) |
| Ertapenem | IV 500 mg daily |
| Levofloxacin | Oral 250 mg daily |
| Linezolid | IV or oral 600 mg BD |
| Moxifloxacin | Oral 400 mg daily |
| Rifampicin | 450 mg daily for BW <50;600 mg daily for BW ≥50 kg |
| Trimethoprim/Sulfamethoxazole | Oral 160 mg / 800 mg BD |
| **Anti-fungals** | |
| Amphotericin | IV test dose 1 mg; starting dose 0.1 mg/kg/day over 6 hours; increased to target dose 0.75 1.0 mg/kg/day over 4 days |
| Caspofungin | IV 70 mg loading, then 50 mg daily |
| Fluconazole | Oral 200 mg loading, then 50-100 mg daily |
| Posaconazole | IV 400 mg every 12 hours |
| Voriconazole | Oral 200 mg every 12 hours |

BD = Twice a day; IV = Intravenous; BW = Body weight. Adapted and modified from Li PKT *et al*. Perit Dial Int 2016; 36(5): 481-508

Patient with refractory or relapsing peritonitis with negative bacterial cultures should be suspected of tuberculous peritonitis. Routine testing for tuberculosis like Ziehl Neelsen stain or conventional culture are not sufficiently sensitive. Culture in fluid medium like MGIT or BactAlert or mycobacterial DNA PCR (Gene Xpert) can be better in diagnosing tuberculous peritonitis. Laproscopic peritoneal or omental biopsy can be diagnostic in suspicious cases.[84] Catheter removal is required only if patient is sick or is non-responding to drug therapy.

### *Catheter removal and re-insertion*

- We recommend that PD catheter should be removed for refractory, relapsing and fungal peritonitis. Catheter should also be removed for non-tuberculous mycobacterial infections and individualized for tuberculous peritonitis.
- We suggest that re-insertion of catheter can be considered after 2-4 weeks of bacterial and 4-6 weeks of fungal peritonitis along with complete resolution of peritoneal symptoms.
  There is enough evidence of poor outcome while salvaging catheters in refractory, relapsing and fungal peritonitis. However, for non-tuberculous mycobacterial infections, there are case reports and series which suggest catheter removal[85] along with multi-agent antibiotic therapy.
- We recommend that each PD center should have a continuous quality improvement (CQI) program to reduce the rates of peritonitis. Satellite centers may strengthen the patient management and the PD program. Monitoring of peritonitis rates and outcomes annually gives an insight on culture negative peritonitis rates, incidence of peritonitis and its outcome. This may reveal the cause of failure of cultures and measures to improve culture positive rates. Incidence rates may also help establish the lacunae in training or re-training needs of patients. Comparing the incidence and outcome of peritonitis and discussions with other centers may help improving the overall outcome of PD patients.

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## Conflicts of interest

There are no conflicts of interest.

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