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ARTICLE

Prescribing and peritoneal dialysis

SUMMARY

Peritoneal dialysis is a home-based therapy for patients with end-stage kidney disease. It is less efficient in removing solutes and fluid than haemodialysis but offers more flexibility and independence.

Peritoneal transport characteristics affect the dialysis prescription. The timing of drug administration is independent of the dialysis process except for the administration of intraperitoneal antibiotics. Dose reductions should follow current recommendations for patients with kidney disease.

Fluid overload is common in patients undergoing peritoneal dialysis. Residual kidney function can ameliorate this problem and needs to be preserved. Dialysis solutions with high glucose concentrations contribute to adverse metabolic effects.

Peritoneal dialysis-related catheter complications and infections may require patients to transition to haemodialysis. Antifungal prophylaxis needs to be co-administered for the duration of antibiotic courses for any indication to reduce the risk of fungal peritonitis.

Close communication with the patient's supervising dialysis unit is required.

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Introduction

Peritoneal dialysis is a home-based treatment modality for end-stage kidney disease. Like haemodialysis, it aids solute and water clearance. Haemodialysis achieves this in four to five hours three times per week, whereas peritoneal dialysis takes longer.[1] However, the health-related quality of life of patients undergoing peritoneal dialysis is comparable to that of patients having haemodialysis.[2]

The elimination of uraemic toxins and excess water is important for successful peritoneal dialysis. However, increasing emphasis is placed on the patient's symptoms, burden of therapy, nutrition and quality of life.[3,4] Shared decision-making can facilitate sufficient treatment and enable patients to achieve their life goals. While patients receive specialist management from dialysis units, primary healthcare providers are essential for ongoing care.

Adult patients usually have comorbidities and polypharmacy is almost universal.[5] Prescribing generally follows the principles applied to other patients with end-stage kidney disease.[6] Doses of renally cleared drugs are reduced or their intervals extended, and prescribing resources should be consulted. Therapeutic drug monitoring is available for selected drugs with a narrow therapeutic index.[7]

Peritoneal dialysis principles

In peritoneal dialysis, a dialysis solution (dialysate) is instilled into the peritoneal cavity via a catheter tunnelled through the abdominal wall. In an exchange, the solution is left to dwell for several hours and then replaced with fresh dialysate.

The peritoneal membrane allows movement of solutes and water between the vascular and peritoneal space. Its transport characteristics are assessed through an equilibration test and can be classified as low, low-average, high-average or high.[8] Patients who are low transporters require longer dwell times, while high transporters usually need shorter dwells. Transport characteristics can change over time, and the process often fails eventually.

Dialysates

Dialysis solutions generate the diffusion and osmotic gradients required for solute and water transport. Their glucose contents are high (1.5%, 2.5% and 4.25%) and contribute to hyperglycaemia, hyperinsulinaemia and dyslipidaemia.[9] Solutions with higher glucose concentrations remove more fluid, but their use should be minimised.[10]

Glucose-sparing dialysates contain icodextrin, a starch-derived polymer. However, it is metabolised to maltose which is absorbed and causes falsely elevated blood glucose concentrations in monitors that are not specific for measuring glucose.[11]

More physiological dialysis solutions contain bicarbonate instead of lactate as a buffer. Their neutral pH can reduce inflow pain and preserve residual kidney function.[1,3] Dialysates containing amino acids may be adjuncts in the treatment of malnutrition.[12] However, higher costs limit their use.

Treatment modalities

Peritoneal dialysis can be performed either continuously or intermittently. In continuous ambulatory peritoneal dialysis, the dialysate is exchanged manually about every four hours during the day with a longer dwell overnight. In automated peritoneal dialysis, a cycler performs shorter exchanges while the patient is asleep, but a day dwell may be included. Medicines are given irrespective of when peritoneal dialysis is performed, as its effect on drug clearance is not clinically relevant.[6]

Home therapy

Peritoneal dialysis is performed by patients or carers in the community. They are trained in aseptic techniques, when to adjust therapy and how to troubleshoot.[13] A clean environment and appropriate storage of consumables are prerequisites. The supervising dialysis unit provides support and should be contacted early when problems arise.

Compared to undergoing haemodialysis in a healthcare facility, patients performing peritoneal dialysis need appropriate cognitive capacity and manual dexterity. However, the benefits include relative independence and flexibility regarding the location and timing of treatment.

Showering and swimming are permissible with an intact catheter exit site. Before strenuous exercise, the dialysate should be drained and the catheter extension line secured.[14]

Fluid management

The patient's hydration needs to be assessed regularly to achieve a normal volume status.[10] The supervising dialysis unit provides the patient with an action plan in relation to changes from an ideal dry weight. Fluid intake should match losses, and dietary salt intake generally needs to be restricted.[9]

While dehydration may be characterised by muscle cramping and hypotension, fluid overload is more common. Overload can be addressed with oral fluid restriction, additional exchanges with icodextrin or temporary use of higher glucose dialysate. Loop diuretics can be very effective in larger doses (e.g. up to 250 mg oral furosemide daily).[10]

Residual kidney function

In end-stage kidney disease, residual kidney function is associated with better patient outcomes.[4] It declines more slowly with peritoneal dialysis than with haemodialysis but nevertheless diminishes over time.[9] Additional measures to preserve residual kidney function include good control of blood pressure (especially with ACE inhibitors or angiotensin receptor antagonists), use of diuretics and glucose-sparing dialysates. Nephrotoxic drugs and volume depletion should be avoided.

Residual kidney function can be measured with a 24-hour urine volume and creatinine clearance.[10]

Complications

Non-infectious and infectious complications of peritoneal dialysis can lead to treatment failure. Close attention needs to be given to their prevention and effective management.

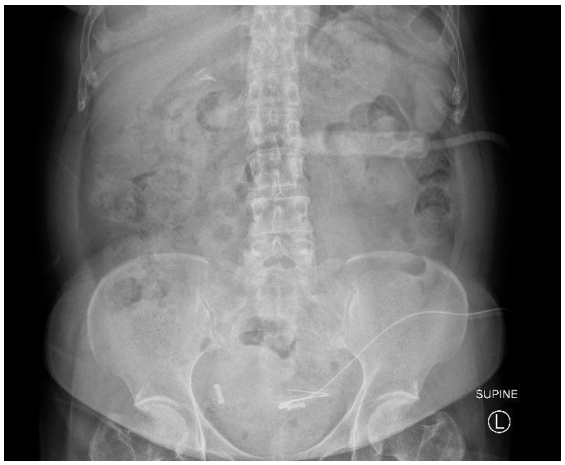
When prescribing an antibiotic for any indication, patients also need to be given antifungal prophylaxis for the duration of the antibiotic therapy to prevent fungal peritonitis.[15] Nystatin (tablets or capsules) 500,000 units orally four times a day is suitable. Fluconazole 200 mg taken orally every 48 hours is an alternative but is associated with drug interactions and prolongation of the QT interval on the ECG.[16]

Constipation can lead to catheter malfunction including displacement of its tip, and peritonitis.[17] Daily soft bowel motions can be achieved with sufficient dietary fibre intake as well as laxatives. Stool softeners and osmotic agents are preferred over stimulant laxatives.[18] Enemas with a high sodium and phosphate content should be avoided.

Catheter malfunction

Exchanges of dialysate are best achieved with the catheter tip located in the pelvis. This can be confirmed by abdominal radiographs (see Fig.).

Fig. **Abdominal X-ray showing peritoneal dialysis catheter**



Abdominal X-ray showing the tip of the peritoneal dialysis catheter (radiopaque line) correctly positioned in the pelvis. The cylindrical shape projected over the mid-abdomen is the connector of the extension line. The bowel is faecally loaded.

Image courtesy of Department of Radiology, John Hunter Hospital, Newcastle, NSW

Peritoneal dialysis catheters can remain in place for years, but their patency may diminish over time or during episodes of peritonitis. Fibrin strands in the effluent can be reduced by adding heparin to the dialysate (500 units/L). Unblocking a catheter with irrigation or a fibrinolytic drug should occur under the guidance of the supervising dialysis unit.[12]

Infections

Peritoneal dialysis-related infections are a major contributor to patient morbidity and treatment failure. Their prevention requires good hand hygiene and aseptic technique during exchanges.

The catheter exit site should be cleaned at least twice a week and after it becomes soiled or wet.[19] Suitable antiseptics include chlorhexidine 2% or povidone-iodine 10%. Drainage of the peritoneal fluid and antibiotic prophylaxis are recommended before colonoscopy and invasive gynaecological procedures.

All contaminations and episodes of infection need to be discussed with the dialysis unit. When infections are suspected, samples should be collected for culture and sensitivities before starting empirical antibiotics. Skin commensals, such as coagulase-negative staphylococci and corynebacteria, can be pathogenic.[19]

Fungal infections as well as those caused by methicillin-resistant *Staphylococcus aureus* and *Pseudomonas aeruginosa* are more difficult to treat and require specialist input. Severe, unresolving or recurrent infections are indications for catheter removal.

Catheter-related infections

Infections involving the catheter are a major risk factor for peritonitis. They require early treatment.[19] Exit-site infections are associated with local inflammation and purulent discharge from which skin swabs should be taken.[19] They often respond to treatment with oral antibiotics for a minimum duration of two weeks (with antifungal prophylaxis). Topical anti-infectives may also be applied daily during exit-site care. Antibacterial honey is an alternative to mupirocin ointment except in patients with diabetes, in whom it appears to be ineffective.[20]

Tunnel infections present with inflammation along the catheter tract, and a collection may be evident. These are treated with oral, intravenous or intraperitoneal antibiotics. Surgical drainage may be needed.

Peritonitis

Risk factors for peritonitis include constipation, enteritis, gastrointestinal bleeding, persistent hypokalaemia, and gastric acid suppression especially with H_2 antagonists.[16]

Peritoneal dialysis-related peritonitis is diagnosed when two of the following are present:

- abdominal pain or cloudy effluent (mild cloudiness can be detected by an inability to read a printed sheet of paper through the effluent bag)
- effluent leukocyte count greater than 100/microlitre with more than 50% polymorphonuclear cells
- positive effluent culture.[16]

In addition to skin and environmental organisms, enteric pathogens from a surgical cause may be responsible. When peritonitis occurs, the exchange technique needs to be re-assessed.

Unlike other causes, peritoneal dialysis-related peritonitis frequently has a more subtle presentation. It can often be managed outside hospital. Empirical treatment covers Gram-positive and Gram-negative organisms and often consists of intraperitoneal cefazolin 15 mg/kg or vancomycin 15 mg/kg, with gentamicin 0.6 mg/kg. These can be mixed into one dialysate bag and left to dwell in the patient for six hours once a day. Treatment is adjusted when the organism is identified and continued for 14 days. The exceptions are intermittent vancomycin dosing based on serum concentrations, and the treatment of organisms such as *Staphylococcus aureus*, *Enterococcus* and *Pseudomonas* for 21 days.[16]

Close liaison with the dialysis unit is required. If the patient has features of systemic sepsis, intravenous antibiotics are added. Insufficient improvement after five days of therapy or the presence of fungal peritonitis requires surgical removal of the peritoneal dialysis catheter and transition to haemodialysis.

Diabetes mellitus

Hyperglycaemia increases the risk of catheter-related infections and contributes to fluid retention. Glucose-lowering therapies may need to be increased when dialysis solutions with high glucose concentrations are used regularly.[19] In end-stage kidney disease, the use of metformin is not recommended and insulin effects are more pronounced.[10] Glycaemic targets should be individualised.[9]

Conclusion

Peritoneal dialysis enables patients to undergo kidney replacement therapy outside of healthcare facilities and can be adjusted to suit individual needs. While

SELF-TEST QUESTIONS

True or false?

1. If antibiotics are given for a chest infection in a patient undergoing peritoneal dialysis, an antifungal drug should always be co-prescribed.

2. H_2 antagonists are a risk factor of peritonitis in patients having peritoneal dialysis.

Answers on page 19

the technique is simple, adverse metabolic effects from glucose-containing dialysis solutions need to be minimised. Complications may require patients to transition to haemodialysis, with infections being a particular threat. Polypharmacy is common and judicious prescribing is required. With appropriate support, patients can live with kidney failure and enjoy a good quality of life. <

Conflicts of interest: none to declare

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