Peritoneal Dialysis

This is a form of renal replacement therapy. It involves instilling dialysis fluid into the peritoneal cavity via a dialysis catheter.

Indications for dialysis

To correct uraemia associated with:[1]

- Severe metabolic acidosis.
- Hyperkalaemia.
- Pericarditis.
- Encephalopathy.
- Intractable volume overload.
- Failure to thrive and malnutrition.
- Peripheral neuropathy.
- Intractable gastrointestinal symptoms.
- Glomerular filtration rate (GFR) less than 10 mL/min, ie stage 5 chronic kidney disease (CKD).[2] [3]

Peritoneal dialysis versus haemodialysis

The decision for peritoneal dialysis (PD) versus haemodialysis (HD) depends on various factors including:[3]

- Patient age, choice and lifestyle:
  - PD is often self-administered at home (see 'Continuous ambulatory peritoneal dialysis', below).
  - PD is the choice of renal replacement therapy in children aged two years and younger.
- Presence of residual renal function - PD is the choice.
- Absence of other comorbidities - PD is favoured.

Patients and their carers should be involved in the decision-making process and the National Institute for Health and Clinical Excellence (NICE) lists factors that should be discussed.[3]

Mechanism

Dialysis takes place by diffusion of uraemic toxins through the patient's peritoneal capillaries, down a concentration gradient into the dialysis fluid. Water is removed from the circulation by varying the concentration of osmotic agents (normally glucose) in the dialysis fluid to draw water through the capillary membranes. The fluid is repeatedly removed and replaced with fresh solution.

A catheter is implanted into the abdomen by a minor surgical procedure. Peritoneal dialysis (PD) may be performed manually or by using a machine to perform the dialysis at night. About 2 to 3 litres of dialysis fluid are infused into the abdominal cavity through this catheter. The fluid is allowed to dwell for two to several hours before being drained, taking these unwanted wastes and water with it. The process of draining and filling is called an exchange and takes about 30 to 40 minutes. The period the dialysis solution is in the abdomen is called the dwell time. A typical schedule calls for four exchanges a day, each with a dwell time of 4 to 6 hours. Different types of PD have different schedules of daily exchanges.[4]

Advantages of peritoneal dialysis

- Peritoneal dialysis (PD) offers much more freedom compared to haemodialysis (HD), as patients do not need to go to a dialysis centre for their treatment.
- Many normal activities can be performed whilst undergoing treatment. It may be the preferable therapy for children.
- Most patients are candidates for both HD and PD.
- There are few differences in outcomes between the two procedures. [5]

Prevalence

- 15-20% of all patients on chronic dialysis worldwide receive peritoneal dialysis (PD).
- 500-600 per million population are on renal replacement therapy. [6]

Management

Dialysis solutions

Contain glucose as osmotic agent together with balanced electrolyte solutions and lactate to correct acidosis. However, because of their low pH and hyperosmolality they may cause long-term damage to the membrane, with mesothelial cell loss and glycation of the membrane. Newer solutions contain bicarbonate/lactate as a buffer, glucose polymer and amino acids to help correct hypoalbuminaemia and malnutrition.

Catheters

- A variety of designs exist, with no clear advantages for any of them.
- The catheter is left in place on a semi-permanent basis, with the subcutaneous portion providing anchorage and a barrier to infection.
- The catheter can be inserted either percutaneously with a trochar and cannula, or via a laparoscope or with a mini-laparotomy. [7]
- The wound needs time to heal before starting dialysis.

Testing membrane function

The patient's peritoneal capillary membrane has varying permeability to both uraemic toxins and glucose. This needs to be assessed using the Peritoneal Equilibration Test:

- 2.27% glucose-based dialysis solution is instilled into the peritoneal cavity and membrane transport characteristics are classified as low, average or high by measuring glucose and creatinine concentrations in both blood and dialysate.
- Those with high transporter status will allow rapid removal of uraemic toxins, but will not be able to maintain the glucose gradient essential for adequate fluid removal.
- Similarly, those with low transporter status will have adequate fluid removal but may not be able to remove the solute load, resulting in under-dialysis. In this way, the proper prescription for peritoneal dialysis (PD) can be made.

Continuous ambulatory peritoneal dialysis

- Continuous ambulatory peritoneal dialysis (CAPD) is a technique where patients manually drain and replace the fluid content of their peritoneal cavity several times a day, using bags of solution supplied to them. It doesn't require a machine.
- Standard prescription is 4 x 1.5-2 L exchanges per day. However, this takes no account of bodyweight, membrane function or residual renal function. Standard prescription may be adequate in early stages of dialysis when there is some degree of residual renal function that may eliminate 25-30% of solutes.
- After 2-3 years it is very important to individualise the patient's prescription, with those with a low transporter function requiring higher volume exchanges, and those with high transporter membranes needing short, frequent exchanges if they are to remain oedema-free.
- If adequate dialysis is not achievable, then transfer to haemodialysis (HD) may be required.

Continuous cycler-assisted peritoneal dialysis or automated peritoneal dialysis

Continuous cycler-assisted peritoneal dialysis (CCPD) uses an automated cycler to perform three to five exchanges during the night while the patient is asleep. In the morning, one exchange begins with a dwell time that lasts the entire day. It is also sometimes called automated peritoneal dialysis (APD). It may be particularly suitable for the young still at work or school. Initially, when there is still residual renal function, it may use relatively low, small volumes of dialysis fluid but, as this declines, larger fill volumes and longer overnight dwells are needed.

Monitoring patients

- Monitoring of urea and creatinine clearance needs to be at least yearly.
- Change the dialysis prescription if it is inadequate.
- Patients commonly suffer from malnutrition due to appetite suppression and peritoneal protein loss. They may need specialist dietary advice.[7] Studies have shown that treatment with 1.1% amino acid-based dialysis solution is safe and may improve protein malnutrition in continuous ambulatory peritoneal dialysis (CAPD) patients with low protein intake.[8]
- Cardiovascular status: up to half of all deaths from peritoneal dialysis are from this cause and particular attention should be given to controlling risk factors, eg smoking, exercise, hypertension, hyperlipidaemia.
- Anaemia: treated with recombinant human erythropoietin (EPO) and oral/intravenous iron.

Renal transplantation

Patients can be transplanted in safety with evidence of lower incidences of delayed graft function and early rejection. If necessary, the catheter may be used after transplantation, providing the peritoneum has not been breached. The catheter can be removed 2-3 months later when the risk of graft failure has reduced.

Complications

- The catheter exit site frequently becomes infected and may cause peritonitis and/or necessitate catheter removal unless properly treated.
- The most common organisms are *Staphylococcus aureus* or *Staphylococcus epidermidis* and, occasionally, Gram-negative bacteria.
- Meticulous care of site is needed with regular cleaning with antiseptics and local application of mupirocin to eradicate *S. aureus*.
- If infection develops, broad-spectrum antibiotics are needed and, if necessary, removal and replacement.

Peritonitis

- This is a major complication and may require transfer to haemodialysis (HD).
- Infecting organisms are similar to those at the catheter wound site.
- Diagnosis is on presence of cloudy dialysate fluid ± abdominal pain.
- Treat on clinical suspicion, using intraperitoneal gentamicin and vancomycin plus an oral quinolone, eg ciprofloxacin (but see local guidelines). Change therapy to match culture results. It should be possible to achieve one episode of peritonitis every two years with >85% cure rate without catheter removal.

Further reading & references

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Original Author: Dr Hayley Willacy
Current Version: Dr Gurvinder Rull
Peer Reviewer: Dr Adrian Bonsall

Last Checked: 19/10/2011
Document ID: 2599 Version: 23