The unwell patient on peritoneal dialysis: what you need to know on an acute medical take

Introduction

Chronic kidney disease is common and its prevalence is increasing. Acceptance of patients onto renal replacement therapies is also increasing and currently it is estimated that around 640 people per million are on some form of renal replacement therapies (Renal Association, 2005), of whom 25% are over the age of 75 years. Annually, the acceptance rate for renal replacement therapy in adults is just over 100 people per million. Chronic kidney disease is associated with a heavy burden of co-morbidities, especially cardiovascular, where there is around a 10–20-fold increased incidence than in the general population (Foley et al, 1998).

Renal replacement therapies can be provided in three main ways: renal transplantation, haemodialysis and peritoneal dialysis. Transplantation provides the best outcome in terms of survival, morbidity and quality of life but less than 50% are suitable for listing. Haemodialysis and peritoneal dialysis have similar outcomes in terms of morbidity and mortality.

Peritoneal dialysis

Peritoneal dialysis is generally performed at home and is associated with greater personal freedom. Patient choice of dialysis modality is very important and the majority of patients are medically suitable for peritoneal dialysis. There may be technical difficulties precluding peritoneal dialysis in a minority of patients, such as in those with previous complicated abdominal surgery. Any abdominal hernias need to be corrected surgically before commencing peritoneal dialysis. Patients with physical or mental disabilities may not be able to perform peritoneal dialysis exchanges which require a certain level of strength, manual dexterity and cognitive function. In some cases a trained carer or family member may be available.

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Access to the peritoneum is via a peritoneal dialysis catheter, most commonly a Tenckhoff catheter. This consists of an intra-abdominal segment with multiple holes which is ideally positioned within the pelvis. The mid-portion is implanted and tunnelled within the wall of the abdomen and the extra-abdominal segment exits the abdominal wall, lateral to the midline (*Figure 1*).

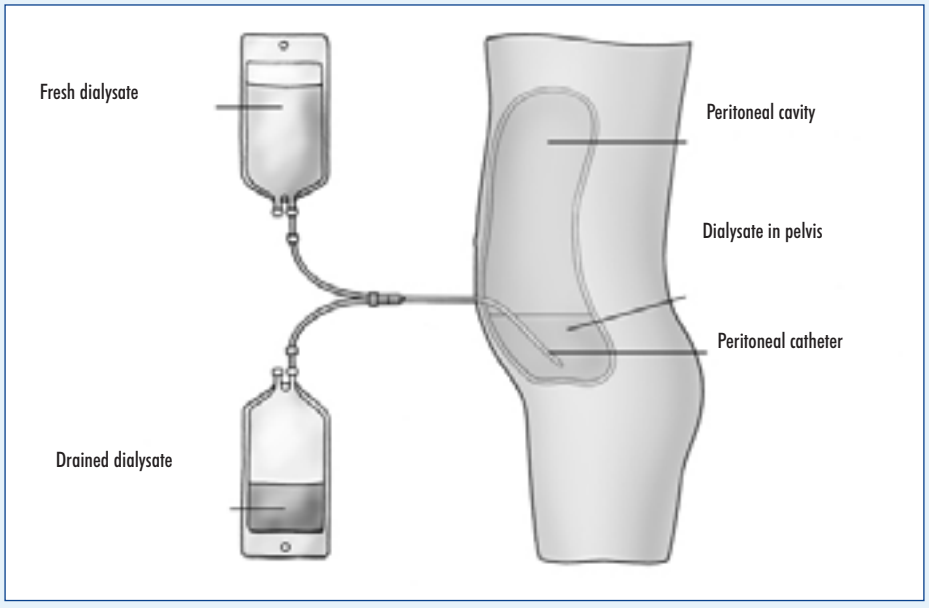
Continuous ambulatory peritoneal dialysis involves several 'manual' exchanges during the day followed by an 'overnight dwell' (*Figure 2*). The daytime exchanges involve leaving peritoneal dialysis fluid within the peritoneal cavity for 3–5 hours. The longer overnight dwell fluid may be in situ for up to 10 or 12 hours.

Automated peritoneal dialysis generally involves a long daytime dwell and multiple cycles overnight, performed by a programmable machine while the patient sleeps, typically for 8–9 hours. All exchanges and connections are performed aseptically by the patient, trained member of the family or carer. Any contamination or procedure errors may require a set change (change of connectors), a sample of peritoneal dialysis fluid to be sent for culture and possibly the administration of prophylactic antibiotics.

There are several commercially available peritoneal dialysis solutions (dialysate). The constituents can be broadly divided into osmotic agents, buffers, and electrolytes. Fluid removal is induced by the osmotic gradient. Generally glucose, or sometimes for longer dwells a glucose polymer, is used to produce this osmotic effect. Solute transport across the peritoneum occurs via diffusion down a con-

Figure 1. Tenckhoff catheter exit site.

Figure 2. The principle of continuous ambulatory peritoneal dialysis. Used dialysate is drained out and replaced with fresh dialysate via a sterile set of connectors and tubing. After dialysate is drained in, the tubes are disconnected and the connector capped off aseptically.



centration gradient (e.g. high urea concentration in blood *vs* none in the dialysate) or convection (solute drag occurring with water transport induced by the osmotic gradient). Dialysis, however, is equivalent to only a small proportion of normal renal clearance and does not correct certain endocrine functions such as erythropoietin production, vitamin D metabolism and parathyroid hormone control.

A typical patient on dialysis will be on multiple medications to address issues such as hypertension, cardiovascular disease, salt and water retention, renal anaemia, renal bone disease, dyslipidaemias, vitamin deficiencies and commonly treatment for the underlying disease which ultimately led to end-stage renal failure, e.g. diabetes. Peritoneal dialysis patients will also be on fluid and dietary restrictions including salt, phosphate and sometimes potassium-containing foods.

Management of the peritoneal dialysis patient

General issues

Fluid balance

It should be ascertained in the history whether there is any residual kidney function and the volume of urine produced daily. This is important, not only for managing fluid balance but also when considering which drugs can be used (or avoided). Any fluid restrictions should be determined.

The patient should be examined for 'volume status' in the normal way, looking at the jugular venous pressure, skin turgur, mucous membranes, signs of peripheral oedema, hypertension, postural hypotension and for the presence of pulmonary oedema or effusions. For a euvolaemic patient a general guide to daily fluid requirements should include the daily urine output plus insensible losses and any other significant losses (e.g. diarrhoea or vomiting). Generally in the non-septic anuric patient, a 1 litre fluid restriction per day is appropriate. It is very important that he/she also receives a salt-restricted diet.

If a patient is dehydrated then resuscitation with intravenous fluids will require regular reassessment of volume status, ideally after each 0.5–1.0 litre of fluid given. A urinary catheter is unhelpful in monitoring fluid balance and should be avoided as a possible source of sepsis.

There are always patients in whom fluid status is difficult to assess, especially if they have co-existing heart, lung or liver disease. These patients require closer monitoring, more cautious filling and more regular assessments. Central venous pressure monitoring can be a useful guide to adequate filling in cardiovascularly unstable patients; however, this is invasive and generally best carried out on a unit with experience.

If a patient is admitted with signs of fluid overload, assessing whether he/she normally has a urine output is important when considering treatment options. If a patient is able to perform his/her peritoneal dialysis as normal, then increasing the hypertonicity (osmotic strength) of the dialysate and shortening the length of exchanges will increase fluid removal. This may be difficult if the patient is admitted to a hospital without a renal unit or staff trained in peritoneal dialysis, and the patient is too unwell to perform it him-/herself. Clearly such patients should be fluid restricted.

If a daily urine output exceeds 0.5 litre then diuretics may be beneficial. Generally the dose required to produce a diuresis is much higher than in normal renal function. If a diuresis is not achieved and there are signs of pulmonary oedema, intravenous nitrates can help 'offload' the heart and lungs. This, however, is commonly only a temporizing measure to improve clinical stability until fluid removal is achieved by dialysis.

Drug prescribing

There are several considerations which need to be taken into account including drug clearance, altered effectiveness of the drug and effects on residual renal function.

In renal failure there is reduced clearance of numerous drugs and this can lead to accumulation of the drug and its metabolites, which can result in unwanted side effects and occasionally severe toxicity. There are several important classes of drugs which require special attention. It is good practice to always check, before prescribing any new drug, whether or not its dose and/or frequency of administration should be reduced in renal failure (Ashley and Currie, 2004; Mehta, 2006). Assume patients on peritoneal dialysis or haemodialysis have a glomerular filtration rate of under 10 ml/min. Any residual renal function is very important, not only from the benefit urine production provides to overall fluid balance, but also in terms of treatment success on peritoneal dialysis and overall survival, and so should be protected.

Analgesics: Once again it is important to enquire about residual renal function particularly when considering non-steroidal anti-inflammatory drugs. These should generally be avoided if there is a measurable urine output. Non-steroidal anti-inflammatory drugs may be given to the oligo-anuric patient, but consideration must be given to the increased risk of peptic ulceration already present in this population.

If stronger analgesia is required then caution must also be taken with opiate analgesics. The drug and pharmacologically active metabolites can accumulate in end-stage renal failure and lead to unwanted side effects, especially constipation, drowsiness and respiratory depression. Generally a dose reduction of at least 50% for oral and parenteral opiates should be used with close monitoring for signs of opiate toxicity. If these were to occur, then further reduction or indeed cessation of the drug is indicated. Opiate antagonism with naloxone should be considered if conscious level or respiratory rate is compromised.

Antibiotics: Special precaution should especially be taken with aminoglycosides (e.g. gentamicin) as they are all nephrotoxic and ototoxic at higher doses. There is a dose and frequency reduction required, with regular pre-dose trough level measurements to avoid accumulation and toxic side effects. In practice, gentamicin typically requires a single dose of around 1 mg/kg every couple of days to maintain adequate systemic levels. Prophylactic antibiotics are required for certain procedures to reduce the risk of peritoneal dialysis peritonitis including cystoscopy, endoscopy, colonoscopy and gynaecological procedures. Peritoneal dialysis fluid should be drained out before all such procedures. Prophylactic antibiotic policy should be checked with the local renal department.

Peritoneal dialysis-related problems

Problems related to the peritoneal dialysis machine or the dialysis itself should be discussed directly with the local peritoneal dialysis specialist nurse or renal unit.

Abdominal pain is a frequent complaint and several of the more common reasons are listed in *Table 1*. Any peritoneal dialysis patient presenting with abdominal pain should have a sample of dialysate sent for analysis. It is important not to overlook other possible acute intra-abdominal pathologies not related to peritoneal dialysis. An open mind, a good history and a thorough examination is required. Other less common causes of abdominal pain include intestinal perforation and mesenteric ischaemia.

Peritoneal dialysis peritonitis

Peritoneal dialysis-related infections are an important complication of this type of dialysis (Piraino et al, 2005). Recurrent or severe peritoneal dialysis peritonitis is a major cause of peritoneal dialysis treatment failure which may necessitate a switch to haemodialysis. It commonly presents with cloudy dialysate, abdominal pain and occasionally systemic upset. The diagnosis is confirmed by a peritoneal dialysis dialysate white cell count greater than 0.1×10^9/litre, with at least 50% polymorphonuclear leukocytes (neutrophils). Common gram-positive organisms include coagulase-negative staphylococcus and *Staphylococcus aureus*, usually from contamination or infected exit sites and tunnels. Gram-negative organisms are less common. Multiple organisms including anaerobes usually indicate a perforated viscus and require urgent surgical exploration.

Treatment involves the administration of antibiotics with both gram-negative and gram-positive cover (until the organism and sensitivities are known). Antibiotics are commonly administered intraperitoneally. Response to treatment can then be assessed with monitoring of the peritoneal dialysis fluid white cell count.

Table 1. Common causes of abdominal pain in peritoneal dialysis patients

Cause of pain	Presentation
Peritoneal dialysis peritonitis	Cloudy peritoneal dialysis fluid ± pain ± pyrexia
Constipation	Common cause of ultrafiltration failure
Catheter tip position	Local irritation within peritoneum (sometimes pain radiating to shoulder if diaphragm involved)
Dialysate fluid effect	Pain on draining in/out – usually improves with time or changing the type of dialysate fluid
Catheter tunnel infections	Tender along subcutaneous tunnel
Primary intra-abdominal pathology	Any sign of an acute abdomen

KEY POINTS

- Regular reassessment of volume status is required when resuscitating a dry peritoneal dialysis patient, with appropriate limitation of intake once adequately filled.
- Always enquire about residual renal function and avoid nephrotoxins if a reasonable urine output is present.
- Remember to always check appropriate dose and frequency reductions of drugs in dialysis patients (glomerular filtration rate less than 10 ml/min).
- Peritoneal dialysis should not be attempted by non-trained members of staff for risk of contamination.
- All peritoneal dialysis patients presenting with abdominal pain should have a sample of fluid sent for gram stain, white cell count and culture to investigate possible peritoneal dialysis peritonitis.
- Always contact the local renal unit early for advice and commonly transfer of the patient.

Performing inpatient peritoneal dialysis

If a peritoneal dialysis patient is acutely unwell and unable to perform peritoneal dialysis, a couple of exchanges can normally be missed without significant upset. Very close attention to fluid balance and electrolytes is mandatory in these patients. Borderline hyperkalaemia can be treated 'medically' and with dietary restriction in the short term. Inpatient peritoneal dialysis should only be attempted if the patient is physically well enough to continue performing exchanges without risk of contamination or there are trained nursing staff available.

Conclusions

A patient on peritoneal dialysis may be admitted for complications originating from his/her dialysis or for a completely unrelated matter. In either case, there are general principles which require special attention including fluid balance, drug prescribing, preserving residual renal function and avoidance of contamination of the peritoneal dialysis tube.

Ultimately all patients on peritoneal dialysis, admitted acutely, should be discussed with the on-call nephrologist for advice and commonly for transfer to a renal unit, if not on site. BJHM

Conflict of interest: Dr Woodrow has previously received honoraria for performing occasional educational lectures related to peritoneal dialysis for Baxter Healthcare.

Ashley C, Currie A, eds (2004) *The Renal Drug Handbook.* Radcliffe Publishing, Oxford

Department of Health (2005) *National Service Framework for Renal Services Part Two: Chronic Kidney Disease, Acute Renal Failure and End of Life Care.* HMSO, London

Foley R, Parfrey PS, Sarnak MJ et al (1998) Clinical epidemiology of cardiovascular disease in chronic renal disease. *Am J Kidney Dis* **32:** 112–19

Mehta D, ed (2006) *British National Formulary.* Vol 52. Pharmaceutical Press, London

Piraino B, Bailie GR, Bernardini J et al (2005) Peritoneal dialysis-related infections recommendations: 2005 Update. *Perit Dial Int* **25:** 107–31

Renal Association (2005) *UK Renal Registry Eighth Annual Report.* UK Renal Registry, Bristol

Further reading

Gokal R, Khanna R, eds (2000) *Textbook of Peritoneal Dialysis.* 2nd edn. Kluwer Academic Publishers, Dordrecht, The Netherlands