Avoidance of Difficulties with Peritoneal Dialysis

H.J. GOLDSMITH, MD, FRCP
Physician, Royal Liverpool Hospital and Physician in Administrative Charge, Liverpool Regional Dialysis Service

Peritoneal dialysis (PD), though used in the treatment of acute renal failure by many non-specialised units, has acquired the reputation of being a second-best form of treatment for chronic renal failure because of the many things that can and often do go wrong. Nevertheless, in practised hands the complication rate has fallen and is now acceptable, owing to increased expertise and improved catheter design. This article deals mainly with the problems encountered with peritoneal dialysis in the treatment of acute renal failure, though much will also apply to long-term peritoneal dialysis in the treatment of chronic renal failure.

In PD more than in most forms of treatment, meticulous attention to detail pays dividends and the technique cannot be practised safely by a house physician whose knowledge is based entirely on reading rather than practical experience. If no experienced practitioner is available it may well be safer to transfer a patient with renal failure to the nearest renal unit where peritoneal dialysis will be in daily use.

The complications of PD can be divided into those of a mechanical nature, infection at the site of cannulation or within the peritoneal cavity, and those attributable to induced metabolic changes.

Techniques and Mechanical Complications

The Trocath is the most popular peritoneal catheter. It is produced by McGaw and distributed in the UK through Boots Ltd, Nottingham. Cheaper imitations have not proved as serviceable. The perforations start 19.5 cm from the proximal end of the catheter. It is, of course, essential that the whole of the perforated segment of the catheter is sited intra-abdominally and that this is done through a single peritoneal puncture, since fluid will otherwise seep into the anterior abdominal wall, resulting in progressive fluid retention, genital oedema, and infection. A common error is to place the catheter pre-peritoneally. This is avoided by advancing the catheter with stilette in situ at right angles to the abdominal wall until it is felt to penetrate the peritoneum. At this point, the stilette is withdrawn 1 cm and the direction of advance is changed towards the Pouch of Douglas. The PD catheter should now be gently advanced as far as it will go, at which point the patient may experience some pelvic discomfort which is relieved by withdrawing the catheter 1 to 3 cm. Force must not be used in introducing the catheter once it has passed through the abdominal wall and its direction must be changed if plastic resistance is encountered. The intraperitoneal advance of the catheter is helped by pre-filling the peritoneal cavity, through a small plastic cannula inserted away from the midline, with two litres of warmed dialysing solution.

The next step of immobilising the catheter by appropriate dressings is most important to the success of peritoneal dialysis. A metal disc is provided with the Trocath to prevent the catheter escaping into the abdomen, and after the disc has been sited on the catheter the projecting portion is reduced to 3 cm with a scalpel. The stump, after connecting the dialysis line, is then built up with dressings on all sides and by thorough strapping with elastoplast it should be possible to avoid all rotational, in-and-out and side-to-side movement of the cannula. The dressings are secured with liberal applications of elastoplast, sufficient to cover the abdomen between the pubis and the sternum. In restless patients it is advisable to take the elastoplast completely around the abdomen without applying much tension. Unless immobilisation of the PD catheter is complete, leakage of fluid into the anterior abdominal wall, and less frequently externally, will soon follow and probably result in infection. This cause of failure can be minimised by nicking the skin with a small curved blade prior to cannula insertion. The incision, however, must be small, so that no pursestring suture is required to fix the catheter, since suture material predisposes to infection. A loop of tubing is tethered separately from the main dressing by a strip of elastoplast (Fig. 1) so that any accidental pull on the tubing when the patient turns over in bed will not be transmitted directly to the catheter dressing.

The first peritoneal exchange will often be blood-stained, particularly in patients with advanced uraemia. As this blood may lead to early catheter blockage it is advisable to add heparin 500 IU/litre to the initial exchanges until bleeding has stopped. Occasionally, heparin may also be required to prevent blockage by fibrin.

Visceral Perforation

Bladder perforation is avoided by ensuring that the bladder is empty before PD catheter insertion. If the PD catheter has been accidentally introduced into the bladder a gratifying diuresis will follow as soon as inflow
begins; the catheter should be withdrawn from the bladder and advanced in a different direction. Provided it is drained for a few days through an indwelling urethral catheter under appropriate prophylactic antibiotic cover, the bladder will probably not require surgical repair. Bowel perforation is most likely to occur in patients who have adhesions from previous abdominal operations or in patients with ileus. Perforation of the colon may result in peritonitis and, sometimes, profuse watery diarrhoea. If a bowel perforation is suspected, the catheter should be withdrawn several centimetres and advanced in a different direction, or it may require removing and the insertion of a fresh catheter in a different place. The bowel perforation will usually close spontaneously in a short time [1] but gentamicin should be added to the fluid as soon as a bowel perforation is suspected. Continuous PD without a 'dwell' period should then limit the effects of contamination through dilution. Laparotomy is required only occasionally for this complication and also when a large mesenteric vein has been punctured by the initial insertion, and bleeding is vigorous.

The commonest difficulty encountered at this stage is failure to obtain an adequate return volume in spite of free inflow. It will take several one-litre exchanges before one can be certain on this point since the peritoneal cavity will often accommodate several litres before it allows significant return drainage. A loaded bowel is a frequent cause of difficulty in drainage and should be dealt with appropriately.

PD is not normally a painful process but warming the fluid to body temperature will increase comfort and, incidentally, improve the efficiency of dialysis. This can be accomplished by heating the bags or vats prior to use or by using a special heating bath. Intra-abdominal procaine has been used, but systemic analgesics are safer when required. Abdominal over-distension is a common cause of pain and it may persist for a day or so after the excess fluid has drained off. If there is difficulty with fluid return, check whether the line is kinked or the catheter obstructed by a blood clot or fibrin. A change of posture, elevation of the top or bottom of the bed and, in particular, induction of a bowel movement, usually improve matters. Cannula blockage by omentum is relatively common after peritonitis and de novo in infants and children. Some paediatricians therefore insert the catheter under direct vision and take the opportunity of doing a prophylactic omentectomy at the time of catheter insertion. Sometimes the catheter has to be withdrawn and a fresh cannula inserted to procure drainage but, if possible, re-insertion should be delayed for 24 hours to allow the original peritoneal puncture to heal, thus avoiding extravasation.

Rarely, an excess of air is accidentally introduced and collects in the epigastrium. This can be relieved by plunging a large intramuscular needle through the linea alba high up.

### Infective Complications

These complications can be divided into those involving the anterior abdominal wall and frank peritonitis (Table 1). Needless to say, the incidence of skin sepsis can be reduced by a scrupulous antiseptic and aseptic technique and the avoidance of sutures that are not required if the catheter is cleanly inserted, followed by its strict immobilisation. If the catheter remains in situ for longer than a week, a little superficial sepsis at the entry site will often develop, but normally it does not extend inwards unless dialysis is unduly prolonged. More serious is the presence of a bead of pus at the exit site or of local cellulitis, usually staphylococcal. This can generally be combated by full doses of systemic antibiotics without leading to frank peritonitis. If it is envisaged that PD will need to continue for more than a few days after the discovery of significant cutaneous sepsis, it may be better to withdraw the catheter for 24 to 36 hours and then insert a fresh cannula more than 2 cm away from the original site.

### Table 1. Infective complications.

| Condition / Cause | Incidence |
|-------------------|-----------|
| **Ant. Abd. Wall:** | cutaneous track infection, cellulitis |
| **Peritonitis** | fungal pyogenic |
| Fluid infected at source | | |
| Iatrogenic infection of fluid | | |
| Track infection | | |
| Visceral perforation | | |
| *Sterile peritonitis* | | |

**Peritonitis**

PD fluid should be cultured frequently, preferably daily. The best place for taking the sample is through the rubber of the drainage line, when provided, using a fine needle and iodine for disinfection. Alternatively, a 'mid-stream' sample may be taken from the drainage bag after dipping the tip into tincture of iodine. The demonstration of organisms on microscopy or culture does not necessarily presage the development of clinical peritonitis, but treatment should be started as soon as organ-
isms have been demonstrated. Frank peritonitis is characterised by abdominal pain, fever and a cloudy effluent.

Peritonitis may spring from extension of sepsis from the skin and anterior abdominal wall, from fluid infected either at source or through subsequent manipulation, or through visceral perforation. The question of whether or not bacteria can escape through the intact bowel wall or the lymphatics during peritoneal dialysis remains unanswered. Fungal infections are occasionally encountered and, rarely, the peritonitis syndrome is observed but no organisms can be grown. The possible causes of this 'sterile peritonitis' syndrome are thought to consist of chemical impurities, pyrogens or undue changes of pH in the dialysing fluid. When sterile peritonitis occurs, a whole batch of fluid may be unsatisfactory, giving rise to several concurrent cases. It is therefore wise to change to a different batch of PD fluid when this rare complication is encountered. In the early days, when 10 litre PD fluid vats were first used, fungi could often be grown from the fluid and, indeed, be seen to pass into the patient in a gelatinous mass. This is now very rare. Most cases of peritonitis that do not arise from extension of anterior abdominal wall sepsis may be traced back to lapses of aseptic or antiseptic technique while changing PD vats and this type of infection is therefore avoidable. Peritonitis used to be common when only 1-litre bags of PD solution were available. As 10-litre bags are now obtainable, 1-litre bags should be of historical interest only, since it was very difficult to insert the drainage needle aseptically into each bag.

In all cases of suspected peritonitis, Gram-stained slides of centrifuged fluid should be examined, as well as culturing the fluid. Except with the sterile variety, antibiotics should preferably be given mixed with the PD fluid in the same final concentration as the therapeutic plasma level range for the particular antibiotic used. Normally we employ gentamicin in a concentration of 60 to 80 mg/10-litre vat, which is equivalent to 6 to 8 μg/ml. This can be combined with a single initial parenteral injection of the same antibiotic in order to achieve immediate therapeutic blood levels.

Fungal peritonitis usually responds to 20 mg amphotericin B added to each 10-litre vat of PD fluid. In all cases of peritonitis heparin in a concentration of 1000 IU/litre should be added to the PD fluid to prevent clotting of the cannula. Antibiotic treatment for peritonitis is generally continued for five to ten days. Early recurrence of a staphylococcal infection strongly suggests that the source is a cannula track infection. Prophylactic antibiotics are not routinely favoured in most renal units but may be used if difficulty is experienced in cannula insertion.

Traumatic Bleeding

This often follows cannula insertion and tends to settle within a day or so. Heparin should be added to the fluid to prevent cannula clotting. Unless bleeding is very heavy and continuous, it is best to carry on with PD and to transfuse the patient if necessary. Rarely, laparotomy may be required, when the opportunity should be taken to resect the cannula under direct vision.

Repeated Cannula Blockage

This is usually due to the omentum wrapping itself around the cannula, though this never causes failure of inflow, only of fluid return. The remedy consists of using an additional cannula for outflow. Alternatively, a surgical omentectomy may be required.

Metabolic Complications

Fluid retention is important since it will aggravate the pulmonary embarrassment so often present by the time renal failure is diagnosed. When due to mechanical causes there are several possibilities: occasionally the whole cannula may have been placed extraperitoneally within the anterior abdominal wall or the catheter may have been insufficiently advanced so that some of its perforations are still draining into the substance of the anterior abdominal wall. Fluid retention may also be caused by the presence of more than one peritoneal puncture, resulting in back leakage from the peritoneal cavity, rarely through a discontinuity of the peritoneum produced surgically, or by fluid loss into the pleural cavity through a congenital communication in the diaphragm. Mechanical escape of fluid from the peritoneal cavity into the parietes reveals itself by local swelling which tends to gravitate. Treatment consists of total cannula withdrawal and restitting it after 24 hours, by which time the peritoneal puncture will have healed. When dangerous hyperkaemia prevents this interruption of treatment, dialysis with a high glucose PD fluid can be undertaken as a temporary measure, since this will compensate for fluid loss within the abdominal wall by osmotic withdrawal of more fluid from the peritoneal cavity. Insulin, however, will be required. Physiological fluid retention is associated with an excessively long intraperitoneal 'dwell' time during which the dextrose is absorbed, making the fluid relatively hypotonic with respect to body fluid. Its prevention consists of shortening or abandoning the 'dwell' time, going straight from inflow to outflow.

Dehydration

Mechanically sound PD with commercially available fluids generally results in the loss of 1 to 2 litres of fluid/24 hours. This must be allowed for by appropriate fluid replacement, preferably by mouth.

If hypertonic fluid is used, up to 10 litres a day of fluid may be removed and this can result in shock if the removal rate exceeds the rate at which oedema fluid can be reabsorbed into the vascular compartment. The risk of shock during hypertonic PD can be diminished by raising the bottom end of the bed, which encourages resorption of oedema fluid, but this must be deferred until pulmonary oedema has been cleared.

Hypernatraemia

Hypernatraemia will always result from the prolonged
use of 141 mosmol/litre sodium PD solution, especially when fluid with a high dextrose content is used. These solutions should therefore be employed only as a temporary measure to correct severe hyponatraemia with fluid overload and even then only with care and frequent observation. For routine purposes the 130 mosmol/litre sodium solution should be used.

Hyperglycaemia

Even the low dextrose fluid contains ten times as much glucose as does plasma. In elderly severely ill uremic patients, who generally have impaired carbohydrate tolerance, iatrogenic hyperglycaemia may occur and, indeed, it is invariably found when using the high dextrose (6.36 g/100 ml) fluid which should be diluted with low dextrose (1.36 g/100 ml) PD fluid. In all types of acute PD the blood sugar should be estimated at least once daily and soluble insulin added to the dialysing fluid if the blood sugar rises unduly. Between 6 and 30 units of insulin are likely to be required, well mixed with the contents of a 10-litre vat. When treating known diabetics the insulin requirements given intraperitoneally will be a little higher than the usual subcutaneous dose. On the last day of peritoneal dialysis insulin should not be added to the vat, but given subcutaneously to avoid a carry-over of intraperitoneally administered insulin after PD has stopped.

Hypoproteinaemia

It is usual to find a lowered albumin level within a few days of starting PD in acute renal failure but the trend can be minimised by early high protein feeding. Unfortunately, patients are often unable to tolerate this at the very time when their protein losses are maximal, such as with peritonitis. In this situation intravenous proteins have their use. It is not certain that in such a highly catabolic situation intravenous amino acids can be built up into protein, but the protein-sparing effect of carbohydrate should be fully utilised with 20 per cent or 50 per cent dextrose and insulin given intravenously through a central line. This regime can supply up to two-thirds of the body's caloric needs. In general, oral feeding is preferable, and homogenisation of a high protein ward diet will often help a patient to resume eating earlier than would otherwise be possible. The prolonged use of an indwelling nasogastric tube should be avoided since it tends to produce oesophagitis, with the long-term risk of stricture formation.

Plasma albumin levels below 25 g/litre must be taken seriously since they predispose to pulmonary oedema and infection. In such cases infusion of human albumin has a place.

Potassium fluctuation does not normally constitute a problem during peritoneal dialysis. The initial dangerous hyperkalaemia is usually remedied within 48 hours of starting PD but during the first 24 hours it may still be necessary to give intravenous sodium bicarbonate (8.4 per cent) at the rate of 100 to 200 m Eq/day. The addition of potassium chloride to the PD fluid usually becomes necessary after 48 hours, normally in a concentration of 3 g/10 litres, or more in the case of patients unable to eat. Supplements of the water soluble vitamins C and folic acid should be given ab initio. In prolonged PD in chronically debilitated patients, trace metal supplements by the intravenous route may also be advisable.

A few additional points that we have found useful in managing PD patients with acute renal failure are: the tendency to pulmonary atelectasis and infection can be minimised by using half to one-litre exchanges half hourly rather than two-litre exchanges hourly. This allows greater diaphragmatic excursions. Early mobilisation is desirable and is facilitated by soundly securing the PD catheter in situ.

Constant encouragement is required in the early stages to ensure an adequate food intake. Relatives are bribed into bringing in favourite dishes, and the long hospital meal gap between 6 p.m. and 8 a.m. is shortened by meat or cheese sandwiches at 10 p.m. together with a milk-based drink.

Diarrhoea, often fungal in nature, is very disabling and causes bed sores as well as secondary oliguria. The fungal variety is prevented by oral nystatin or treated with generous doses of codeine phosphate.

The aim of PD in treating acute renal failure (ARF) should be to reduce the blood urea to 35 mmol/litre and the creatinine to 1000 μmol/litre. Daily exchange volumes should be prescribed with these figures in mind. It is usually possible to reduce the exchange volumes within two to three days of the onset of a good diuresis, but the catheter should not be removed prematurely, though it may be disconnected to allow the patient full mobility. Immediately prior to its final withdrawal an antibiotic is injected into the peritoneal cavity, since the insertion track can never remain sterile. The track normally seals within 24 hours of catheter removal and then requires no further dressings.

In summary, peritoneal dialysis has become a most useful tool in the therapy of acute renal failure. Its very simplicity should not blind us to the need for care and experience in its use.

This article is based on a paper read at the Conference on Adverse Effects of Treatment held at the Royal College of Physicians in November 1979.

Reference
1. Simkin, E. P. and Wright, F. K. (1968) Lancet, 1, 64.