NEW APPLIANCES

Peritoneal Dialysis Tubing Assembly

Mr. R. W. LLOYD-DAVIES, Mr. R. H. PYNE, and Mrs. V. A. TIDY, Department of Urology and the Central Sterile Supply Department, St. Thomas's Hospital, London S.E.1, write: The essence of the technique of peritoneal dialysis is that it is a safe, inexpensive, and simple manoeuvre which may be carried out in any general ward.

There is at the present time no entirely satisfactory apparatus commercially available for delivery and drainage of peritoneal dialysis fluid.

The equipment shown here was made up as a set in the central sterile supply department of this hospital and sterilized by gamma irradiation at the radiation branch

of the United Kingdom Atomic Energy Authority at Wantage.

The assembly (see Fig.) is composed of the following items, which are costed, and takes about 10 minutes to be made up:

	s.	d.
1 Baxter solution administration set ...	5	10
36 in. (91 cm.) Portex tubing No. 10 ...		9½
1 Portex connector M/Y1 ...		10
1 Aldon drainage bag, 3-litre ...	5	9
1 Sterilwrap, 20 in. (50 cm.)		
1 Bag, code G		
1 Irradiation indicator spot		2
4 in. (10 cm.) Sellotape		
	13	4½

Peritoneal dialysis tubing assembly.

If two-litre cycles are preferred a Baxter BR.10Y double giving set may be used at an extra cost of four shillings. The Aldon three-litre bag is used, as it combines the advantages of a non-return valve at the bag entry point and also has a drainage line.

This equipment is now in standard use, together with the McGaw Trocath, for all patients receiving peritoneal dialysis. New sets are used for each day of dialysis, and routine bacteriological investigation of samples from the first and last dialysate is carried out.

Low-cost System of Peritoneal Dialysis

Dr. JAMES A. RICHARDSON, Dr. PETER E. PHILBIN, and Dr. GEORGE R. HERRON, of the Research Hemodialysis Center, Public Health Service Hospital, San Francisco, California 94118, write: In recent years peritoneal dialysis has become a reliable tool for the treatment of acute renal failure. Though less satisfactory than haemodialysis for the long-term management of chronic renal failure, peritoneal dialysis is effective in allowing at least some such patients to lead reasonably active lives (Stevens *et al.*, 1964; Lasker *et al.*, 1965; Palmer *et al.*, 1966; Vertes *et al.*, 1967; Levin and Winkelstein, 1967). The procedure has also proved useful as a means of maintaining patients awaiting renal transplantation (Cohen and Percival, 1968).

Peritoneal dialysis, while less expensive than

haemodialysis, is still a major item in a hospital budget, particularly when materials marketed especially for peritoneal dialysis are used. The cost of the procedure may be reduced considerably by employing dialysis solutions prepared in the hospital pharmacy and by repeatedly reusing the amber latex rubber tubing. Faced with a limited budget and a growing number of patients who could profit by peritoneal dialysis, we began the preparation of dialysis solutions in our hospital several years ago. This report describes our low-cost method of preparing, sterilizing, and dispensing peritoneal dialysis solutions. Experience with 304 dialyses is briefly recounted.

Our procedure for peritoneal dialysis is based on the techniques developed by Boen

and associates (Boen, 1961; Boen *et al.*, 1964; Tenckhoff *et al.*, 1967), with considerable modifications to reduce costs and to adapt the methods to existing facilities.

PREPARATION OF DIALYSIS FLUID

The dialysis fluid is prepared in the hospital's pharmacy with reagent-grade sodium, calcium, and magnesium chloride and sodium acetate. The chemicals are purchased in relatively inexpensive bulk quantities, weighed in batch amounts, and mixed with distilled water in a 100-gallon (455-litre) stainless-steel tank. During the initial mixing a 5% excess of distilled water is added to compensate for the amount of water evaporated during subsequent autoclaving. Because of its greater stability, acetate, rather than bicarbonate or lactate, is used as the source of base. Sterile dextrose and potassium chloride solutions are added in amounts dictated by clinical circumstances just before dialysis is begun.

After being mixed, the fluid is pumped from the steel tank through a Millipore filter into a clean carboy. Disposable Millipore filters eliminate particulate matter and are available in several pore sizes. The 0.22-micron filter excludes the smaller bacteria but results in extremely slow flow rates. We routinely use the 0.45-micron pore size, which removes most particulate matter and provides an acceptable flow.

Pyrex carboys, 45-litre capacity, are used to store, dispense, and collect the dialysis solutions. The bottles are manufactured with vertical and horizontal seams which serve as reference points for applying a length of adhesive tape calibrated in litre increments (Fig. 1). Once a reference tape

FIG. 1.—Incubator box, its door open, containing a filled carboy. Tubing, thermometer, calibrated tape, light bulbs, and heat shields are seen.

has been carefully calibrated it is kept and used as a template for making additional tapes.

Before autoclaving, 31.5 litres of freshly mixed dialysate is filtered into each of a number of carboys. Each carboy is then capped with a standard No. 12 two-hole rubber stopper. Short lengths of glass tubing are inserted into the stopper holes and pieces of rubber tubing attached to them. This tubing allows egress of steam during autoclaving and subsequent sealing of the bottles. The filled bottles are autoclaved at 260° F. (126° C.) for two hours. After the autoclave chamber has returned to atmospheric pressure the autoclave door is opened and left slightly ajar, permitting the fluids to cool. When the solutions have cooled so that the bottles can be handled comfortably, a sample from the 30 litres of fluid now remaining is taken for determination of electrolyte concentrations. The final concentration of the autoclaved dialysate is shown in the Table. The rubber tubing is then clamped shut with haemostats. Clamping the tubing when the solutions are hot results in a vacuum capable of imploding the carboys. Polyethylene bags are then placed over the tops of the carboys and the bottles of dialysis fluid are stored for future use.

TECHNIQUE OF DIALYSIS

Throughout dialysis aseptic precautions are taken at any step involving contact with the fluid or peritoneum. Before dialysis the carboy and its contents are warmed to body temperature by applying a 600-watt infrared lamp directly to the carboy's side for approximately 45 minutes. The temperature of the dialysate is determined before dialysis by running some of the heated fluid into a small jar containing an oral thermometer.

Immediately preceding dialysis the stopper is removed from the warmed bottle and predetermined amounts of commercially prepared sterile 50% dextrose solution are poured through the carboy's wide mouth. Adding the dextrose at this time permits adjustment of dialysate osmolality based on the patient's current state of hydration, and eliminates the manipulations necessary to prevent caramelization during autoclaving (Tenckhoff *et al.*, 1967). The addition of one litre of 50% dextrose solution to 30 litres of dialysate yields a 1.6% dextrose solution, comparable to the dextrose concentration of commercial peritoneal dialysis fluids. Further additions of 500-ml. quantities of 50% dextrose result in 2.4% and 3.1% dextrose solutions, suitable for fluid removal in over-hydrated patients. Although the addition of sodium-free dextrose lowers the sodium concentration of the dialysate, hyponatraemia has not occurred in our patients.

For the occasional potassium-depleted patient commercially prepared sterile potassium chloride solution is added to the dialysate along with the dextrose. The use of potassium-free dialysis solutions and at least weekly dialyses has obviated the need for potassium exchange resins in our treatment of non-hypercatabolic renal failure.

After these additions a second two-hole rubber stopper is used to recap the bottle. Through one hole is inserted a short length of glass and preclamped rubber tubing. An 18-gauge needle inserted into the rubber portion of the tubing acts as an air vent. The

other hole of the stopper contains a 24-in. (61-cm.) length of stainless-steel tubing, so placed that its upper end projects several inches above the stopper, and its lower end, when the stopper is firmly in place, rests just above the bottom of the jar. A length of sterile rubber tubing, the inflow line, extends from the top of the steel tubing to the patient's bedside. Before the stopper is secured the steel tube is swirled around in the dialysis solution to mix the dextrose and potassium chloride.

Approximate Ion Concentration of Dialysis Fluid in mEq/l. After Autoclaving

Na+	130.0	Cl-	99.5
Ca++	3.0	Acetate	35.0
Mg++	1.5		

The dialysate must also be kept at body temperature during dialysis. To avoid the need for expensive and complicated temperature probes we constructed a large asbestos-lined wooden "incubator" to house the carboy after the initial warming (Fig. 1). A slot in the top of the box accommodates the neck of the bottle. Heat is supplied by four 100-watt light bulbs, and thin sheets of stainless steel protect the bottle from direct heat. The temperature within the box is maintained at 37° C. by an inexpensive thermostat. A thermometer, mounted inside a glass window in the door of the box, is monitored periodically during dialysis. The window also permits observation of the fluid level and calibrated tape on the carboy.

The carboy is placed in the incubator box, which is fixed about 2½ feet (76 cm.) above the patient's bed, providing the necessary height for siphonage. Siphonage is created in the inflow line by drawing the dialysis fluid through the tubing with a 50-ml. syringe and adapter. A commercial peritoneal catheter with internally fitted stylet (Trocath, McGaw Labs., Inc.) is placed in the peritoneal cavity under aseptic conditions (Weston and Roberts, 1965). The connecting tube supplied with the catheter is made into a Y configuration by removing the rubber cap from the side arm ordinarily used

for introducing drugs into the system. Into one arm of the Y is fitted the peritoneal access catheter; the inflow and outflow lines are connected to the other two arms by means of stainless-steel Luer tip adapters (Fig. 2). As quickly as possible, dialysis fluid is run into the patient's peritoneal cavity and the outflow tubing. Subsequent control of flow into and out of the peritoneal cavity is achieved by alternately releasing and clamping the inflow and outflow tubing with haemostats. The outflow fluid is collected in a calibrated carboy on the floor.

To prevent fibrin-plugging of the catheter, 1,000 units of heparin is usually injected into the sterile inflow tubing during instillation of the first two or three exchanges of fluid. We do not routinely add antibiotics to the dialysate.

Each exchange consists of 3 litres of fluid. This amount of dialysate is well tolerated by most patients, and, according to Boen (1961), provides better clearances than the 2-litre exchange volume ordinarily used. The equilibration period in the peritoneal cavity is half an hour. Since inflow requires 10 to 15 minutes and outflow 15 to 20 minutes, a complete cycle usually lasts one hour.

Nine 3-litre exchanges are obtained from each carboy. The final few litres are wasted to avoid interrupting the siphonage. When it is necessary to change carboys the stopper from the emptied bottle is prised loose and inserted into the full one. During the transfer air occasionally gets into the steel tubing, breaking the siphonage. Siphonage can be easily re-established by aspiration with a large syringe and needle inserted into the rubber inflow tubing.

EXPERIENCE

Between May 1965 and April 1968 304 peritoneal dialyses on 24 patients were performed by this method. Bacterial peritonitis, a frequent problem during chronic dialysis programmes (Ribot *et al.*, 1966; Cohen and Percival, 1968) did not occur in any of our patients. In three widely separated instances a transient rise in temperature was accompanied by moderate abdominal tenderness. Each time, cultures of peritoneal fluid were sterile, and abdominal tenderness and fever disappeared without use of antibiotics.

We do not routinely test for pyrogens or culture dialysate samples immediately after autoclaving, but instead use the autoclave temperature graph as a form of quality control. Numerous random cultures of dialysate taken at the time of use have been sterile. The infrequent occurrence of peritoneal irritation and the absence of peritonitis probably results from (1) scrupulous cleaning, rinsing, and autoclaving of re-usable items; (2) removal of particulate matter from the dialysate by Millipore filters; (3) autoclaving of solutions; (4) attention to aseptic technique in preparing and dispensing the solutions; (5) use of the Trocath catheter; and (6) employment of a relatively closed delivery system.

Nurses familiar with this procedure have been able to carry out two peritoneal dialyses simultaneously while performing other duties in the intensive care unit. Those who have previously used the commercially available solutions and tubing find our system far easier to handle. They particularly like the elimination of frequent bottle changes and the ease of monitoring fluid balances.

FIG. 2.—Diagram of placement of carboys, tubing, and peritoneal catheter.

The primary disadvantage of the system is the 75-lb. (34-kg.) weight of a carboy containing 30 litres of dialysate. To protect employees from back injuries, we have insisted that the filled bottles be lifted each time by two men.

ECONOMY OF METHOD

The cost of producing the dialysis solutions is approximately one-fourth that of proprietary dialysis fluids. This includes the

price of labour, but not that of laboratory determinations for quality control. The total price of the initial equipment such as mixing-tanks, a pump, filter holders, and a dozen carboys is about £625 (\$1,500). Many hospital pharmacies carry these items as part of their standard equipment.

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Mobile Bath for Severely Incapacitated or Completely Bedridden Patient

Dr. D. H. BLAKE, medical superintendent and specialist geriatrician, and Mr. A. H. JOHNSON, purchasing officer, of the Bendigo Home and Hospital for the Aged, Bendigo, Victoria, Australia, write: All those concerned with the care of the geriatric patient will be aware of the difficulty and sometimes complete impossibility of bathing the severely incapacitated or completely bedridden patient. The mobile bath has been designed to make possible the bathing of even the most helpless patient, and at the same time render the procedure one that can be relatively easily carried out by the nursing staff.

Hitherto, extreme difficulties have been encountered in hospitals in bathing these incapacitated patients, such bathing usually requiring manual lifting from bed to wheelchair or other carrying device, thence to a bath. Hydraulically actuated hoists are relatively expensive and are generally used in conjunction with other equipment, the patient thereby experiencing the feeling of insecurity brought about by the manner in which he must be moved. The project was therefore to provide a unit which is relatively simple and inexpensive, which is convenient to use, and which would involve the minimum of discomfort to the patient.

Description.—As can be seen from the photographs, the mobile bath is basically a wheeled trolley having a collapsible bath mounted on the top (Fig. 1). The trolley is so constructed that it can be wheeled over an island-type fixed bath in the ward bathroom. This means that, if desired, the bath can be filled from a thermostatically controlled mixer tap at the head of the fixed bath and be emptied into the fixed bath via the drain plug provided. The trolley has four braked

castors, and its top is made to standard bed height. The bath is manufactured from a heavy nylonized polyvinyl chloride material with waterproof seams. This fabric is held over a padded former and is raised by spring-loaded tubes held to the trolley frame. This former is locked in the up or down position by four synchronized shoot bolts.

bed wire from each end of the trolley. The patient can now be moved very easily from the bed to the trolley by a Masson roller, a draw sheet being used as the medium of transfer. When the patient is in the correct position on the trolley the lever at the side is released, allowing the bath to rise to its fixed position. The patient can then be

FIG. 2.—The mobile bath in position.

Method of Use.—This is quite simple. By releasing the lever at the side of the trolley the top former can be depressed to allow the sides of the bath to collapse. This gives an almost flat surface on top of the trolley, which is pushed up to the side of the patient's bed with the drain plug end at the patient's feet (Fig. 2). Safety chains are then connected to the under side of the

transported safely and by one person to the bathroom. Once the trolley is in position the patient can be undressed and bathed. We find that a temperature-controlled mixing-valve with an extended hose-shower head is very satisfactory. The plug can be left in or out as desired. Nursing staff do not have to bend, and can bath the patient from a standing position. After bathing, the whole procedure is reversed in transferring the patient back to bed.

As the patient is actually lying in the bath when it is filled, we would stress the necessity of using a thermostatically controlled mixing-valve. This is particularly necessary, as the type of patient involved may have lesions affecting the sensory system. The material used allows the inside of the bath to be quickly dried, so that once the patient has been towelled he can be dressed, while still in the bath, before transporting him back to the ward.

A prototype of the bath, for which patent is pending, has been subjected to trial in our wards and has proved to be a valuable additional nursing aid. Both patients and nursing staff have appreciated its assets. Nursing staff have easily become familiar with its use, and have employed it increasingly and for a greater variety of patients.

FIG. 1.—The mobile bath.