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Peritoneal dialysis—mechanical innovations

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THE technic of intermittent peritoneal dialysis has been generally accepted[1, 2] and is particularly suited to use in community hospitals where highly trained personnel and sophisticated dialysis equipment are not readily available. Simple and inexpensive modifications in the apparatus used for intermittent peritoneal dialysis at the Cleveland Clinic Hospital have achieved greater efficiency in nursing care and shortened the time required for a single treatment. The nurse is freed from the mechanical task of repeatedly clamping inflow and outflow tubings, and can devote full attention to other nursing duties.

At the Cleveland Clinic Hospital about 250 peritoneal dialyses are performed each year. From this experience, simple modifications of equipment and technic have evolved. The aim is to increase the nurse's skill in caring for the patient and to improve the technic for performing intermittent peritoneal dialysis in a busy intensive medical care unit. The same procedure is followed in all cases. Under local anesthesia, a specially designed metal trochar is advanced into the patient's peritoneal cavity, through which a No. 11 French plastic catheter is inserted into the most dependent portion of the peritoneal cavity. Two liters of dialyzing solution are infused and allowed to remain for a 30-minute period of equilibration. The fluids are then drained into the same bottles that had been placed on the floor beside the bed. A single dialysis usually comprises 24 such cycles.

TECHNICAL PROBLEMS

A study of the dialysis cycle reveals that the troublesome periods are near the end of the infusion of dialysis fluid, and during the collection of dialysis fluid from the peritoneal cavity. Commercially available dialysis equipment supplied in 1- or 2-liter bottles complete with infusion tubing is not designed to stop the inflow automatically after the desired volume has been reached. At that point in the process, if the inflow is not controlled, air will collect in the infusion tubing. Unless evacuated, the air will pass into the peritoneal cavity with the next 2-liter infusion. The progressive collection of air in the peritoneal cavity may produce an air lock capable of in-

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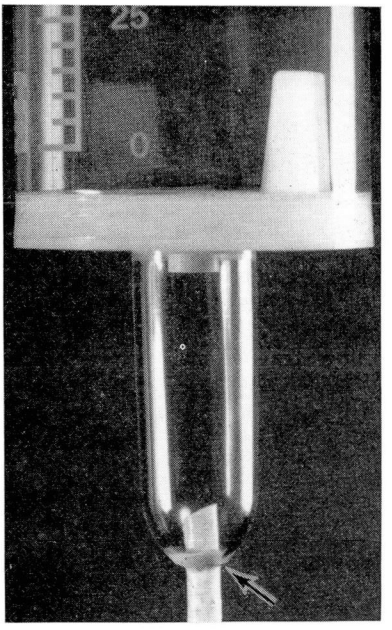

Fig. 1. Modified Soluset drip chamber with infusion set cemented in place.

terrupting the siphoning necessary for adequate drainage of dialysis fluid. Evacuation of air from the tubing is time consuming and may contaminate the system. Thus, an attendant must clamp the inflow tubing at the moment the desired volume has been reached. This is the only bedside care the patient usually needs at this stage of dialysis.

At the end of fluid collection, the nurse must again be at the patient's bedside to clamp the drainage tubing to insure accurate measurement and control of the outflow volume. If the drainage continues unchecked for long periods, the fluid reservoir within the abdominal cavity may become too small for proper immersion of the perforated catheter tip, and the siphoning will stop. Furthermore, if the outflow is not carefully monitored, the nurse must repeatedly clean up the overflow from the collection bottle.

MECHANICAL INNOVATIONS

It was difficult to design a simple and reliable valve to stop the inflow after the desired volume has been infused. The most satisfactory method in our experience has been to modify a 250-ml Soluset* to connect to a

* *Kindly supplied by Abbott Laboratories, North Chicago, Illinois.*

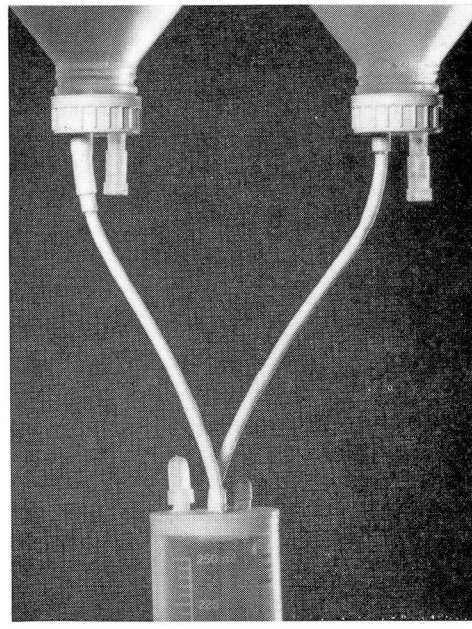

Fig. 2. Modified Soluset with second dispensing cap and sealed air vent in place.

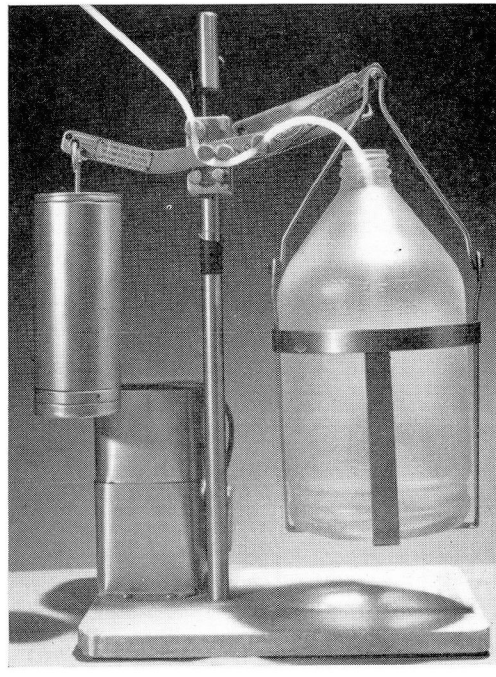

Fig. 3. Collection apparatus with basket, bottle, and counterweight in place.

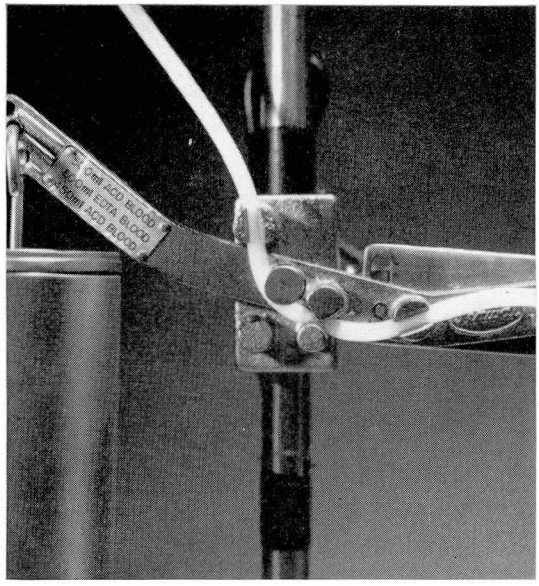

Fig. 4. Balance shown in down position with tubing pinched shut.

standard dialysis infusion set* (*Fig. 1*). This modification was accomplished by cutting away the infusion tubing from the site chamber mounted beneath the 250-ml calibrated chamber. The dialysis infusion set was then fixed to the drip chamber (see arrow, *Fig. 1*) with Tygon glue. The Soluset was further modified to accept two 1-liter bottles of dialysis solution. The air line to the dispensing cap was disconnected, and into this tubing was cemented a second dispensing cap. The air filter on the Soluset chamber was replaced with a nonperforated cap to prevent overflow from the chamber during infusion (*Fig. 2*). After gas sterilization the entire set was ready for use.

The Soluset valve closes automatically after 2 liters of dialysis solution has been delivered into the peritoneal cavity. Because most patients require a rather uniform time for infusion of fluids into the abdominal cavity, the nurse can set a laboratory timer for the inflow period plus the desired equilibration interval. At the end of this interval, the timer alerts the nurse so that she may promptly begin drainage.

An easier problem to solve than that just outlined was accurate collection of dialysis drainage. A commercially available balance† for blood bank collection was modified by hanging a standard 1-liter dialysis fluid bottle in a specially made basket from one end of the lever arm, and a counterweight

* *Kindly supplied by Abbott Laboratories, North Chicago, Illinois.*
† *Fenwall Automatic Donor Scale, B. G.-2A.*

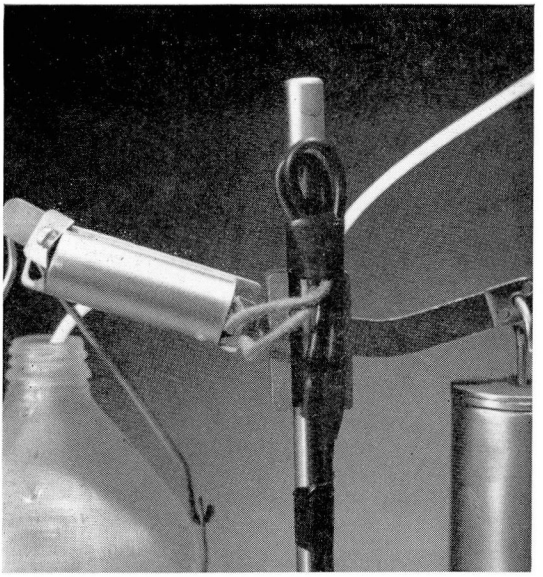

Fig. 5. Mercury-switch circuit control mounted on the balance arm.

equal to the weight of the bottle and the basket plus 1 liter of dialysis fluid (*Fig. 3*). When the bottle is full, the balance swings down to pinch shut the drainage tubing as shown in *Figure 4*. Up to 240 ml of extra fluid can be removed by adding a suitable additional counterweight. A short stout pole in a stable metal base supports the balance. A mercury-switch circuit control was mounted on the lever in such a way that a buzzer is briefly sounded when the lever arm swings down at the end of the fluid collection (*Fig. 5*). Electric current is supplied through insulated connections by a 6-v storage battery. The nurse is able to attend to other duties until the buzzer calls her attention to the dialysis patient. The use of this apparatus has reduced the total time for dialysis by eliminating the time wasted when a new cycle is not started promptly.

Thus, the nurse's attention is automatically called to the patient at the critical end points of inflow and drainage in the dialysis procedure. She is spared the need to focus on mechanical tasks and is able to spend more time in the personal care of the dialysis patients and the other patients for whom she is responsible.

COMMENT

An automatic peritoneal dialysis machine has been described[3] which may increase the efficiency of peritoneal dialysis because the machine delivers much higher dialysate flow rates than the nonautomatic equipment, and

automatically circulates the fluids. The expense of this equipment may preclude its usefulness in many institutions, and the high perfusion rates warrant supervision, especially if negative pressure is used during the drainage cycle. Boen and associates[4, 5] have described an automatic cycling system for intermittent peritoneal dialysis. Unfortunately, neither the automatic cycling equipment nor the large containers of sterile dialysate are commercially available. The simple innovations in readily available dialysis equipment currently in use at the Cleveland Clinic Hospital can be accomplished in any institution, with little effort and with minimal expense. The limiting factor in providing peritoneal dialysis for patients with renal failure frequently involves the number of nursing beds and nursing personnel available to care for such patients. The use of semiautomatic equipment such as we have described has the enthusiastic endorsement of our nurses.

SUMMARY

Simple and inexpensive mechanical modifications in commercially available equipment for clinical peritoneal dialysis allow accurate collection of drainage fluid, control of inflow volume, and better timing of dialysis cycles. The special nurses are thus freed of certain mechanical duties and have more time for the personal care of each patient.

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