Elimination of Abdominal Pain Associated with Automated Peritoneal Dialysis

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Thirteen patients have been treated with automated peritoneal dialysis at our center. Of these, three have experienced discomfort with dialysate inflow. They described rectal pain with an intense downward urge to defecate. In two, the sensation was most intense at the onset of the inflow cycle and lessened with each treatment. In both, the sensation disappeared entirely within four weeks. The third patient experienced the same downward urge, but his was associated with severe rectal pain. The intensity of the pain increased as the inflow progressed and worsened with each successive cycle. The pain was so intense that it precluded treatment with automated peritoneal dialysis equipment. The patient was therefore maintained on conventional peritoneal dialysis which was pain-free while we investigated possible causes for his symptoms.

This patient was a 60-year old white male insulin dependent diabetic with end-stage renal disease. Four years prior to his admission for chronic renal failure he had a severe myocardial infarction. He had been markedly debilitated from that time on. The patient was of slight stature and had marked peripheral edema and myocardial decompensation. His skin was pale and atrophic. There were large ulcers in both lower extremities. He was not considered a hemodialysis candidate because of his extremely poor cardiovascular status. He was well-motivated and was offered the option of entering the self-care home automated peritoneal dialysis program.

Since peritoneal dialysis at home is practical only using automated equipment, we investigated systematically a variety of potential factors to determine the cause of the patient’s pain. Tenckhoff\(^1\) has reported that low pH dialysate caused abdominal pain. To determine whether pH was a factor in the etiology of pain in this patient we measured the pH of commercial dialysate and that produced by the automated peritoneal dialysis machine. The pH of the dialysate produced by the machine was 5.9 and that of the commercially prepared solution was 5.5. The dextrose concentration of both solutions incidentally was identical at 1.5/\(\text{gm}\%\). Since the patient experienced no pain with the commercially prepared solution which had a lower pH and both were within the limits determined acceptable by Tenckhoff, pH was excluded as a pain-producing factor.

One of the most common causes of pain during dialysate inflow is catheter encasement. This is a complication of mild or asymptomatic peritonitis. A fibrin sheath forms a sack encompassing the intraperitoneal portion of the catheter. In such cases pain is the result of a rate of inflow which exceeds that at which the fluid...
escapes from the encasement. Diagnosis is confirmed by injecting a radiopaque dye into the catheter and observing the presence of a double lumen and puddling of the radiopaque material by X-ray. Catheter encasement is invariably associated with poor outflow. Although we did not radiographically examine this patient's catheter, we ruled out catheter encasement because peritoneal cultures were negative and there were never problems with dialysate drainage.

We then considered the possibility that the location of the intraperitoneal portion of the silicone rubber catheter caused the discomfort. The patient varied his position for several inflows but the pain persisted. Attempts were then made to change the positions of the catheter tip by external manipulation but the patient's symptoms remained unchanged. He experienced no discomfort associated with his catheter other than that described during inflow with automated equipment.

It occurred to us that water pretreatment for dialysate preparation by the automated peritoneal equipment might play a role in the development of pain. Tap water was pretreated with ion exchange resins to determine whether some substance was inadequately removed by the reverse osmosis membrane. Conventional water softening resins were used. This did not relieve the patient's pain.

Dialysate solution produced by the automated equipment was then pumped into a sterile 2-liter bottle and allowed to flow into the patient by gravity. He experienced no discomfort. It was then apparent that the pain resulted not from chemical differences between commercially prepared solution and that produced by automated equipment but by the way the dialysate was delivered to the peritoneal cavity.

The pump speed of the machine was changed decreasing the inflow rate from 400 ml/min to 180 ml/min, a rate equivalent to inflow by gravity. The patient again experienced pain. The single difference then was the pulsatile manner in which automated equipment delivered solution to the peritoneal cavity.

We experimented with several devices to dampen or eliminate the intermittent character of dialysate inflow. In order to cushion somewhat the irregular flow of dialysate and to prevent air from entering the peritoneal cavity, the Physio-Control* equipment contains an air trap. The addition of a second air trap to the dialysate inflow line failed to alter the pulse or eliminate the pain. The insertion of a large vented Swank CA-100** microemboli filter into the inflow line dampened the pump surge and lessened the intensity of the pain. Two such filters vented or unvented further reduced the pulsatile inflow but did not relieve the pain.

To further depress the pulsatile character of the dialysate inflow an unvented gas ballast type bubble trap (figure 1) used in the portable Belzer organ preservation system*** was placed in the dialysate inflow line. This reduced both the intermittent character of the dialysate inflow and the patient's pain. Two such bubble traps resulted in virtual continuous dialysate inflow and absence of pain.

These bubble traps are designed in such a way that fluid entering through one port is separated by an incomplete silicone rubber wall from the chamber with the exit port. The silicone rubber diaphragm between the chambers absorbs and equalizes pulsatile flow. A second complete silicone rubber partition separates a side of one chamber from a port through which pressure readings may be obtained. Fluid levels may be adjusted through injection ports at the top of the pulse dampener. Optimum dampening effects are achieved when a fluid to air ratio of 2:1 is maintained.

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Since two pulse dampeners were required to eliminate the pain, a single larger pulse dampener (figure 2) was designed specifically for this patient. Unlike the previous pulse dampener, this device contains 10 times the fluid volume. The two compartments in the larger pulse dampener are separated by an intact silicone rubber membrane. With the larger device dialysate enters and exits through the same chamber. The chamber on the side opposite to the silicone rubber membrane is filled with air by a blood pressure bulb with manometer to allow the membrane to remain in midline.

The larger device resulted in continuous flow from the automated peritoneal dialysis equipment and allowed pain-free dialysis. The manometer connected to the gas compartment showed fluctuations from 40 to 20 mm of mercury were noted in systolic and dialystolic phases of the pulsatile inflow. A disadvantage of the larger device was a collapse of the silicone rubber diaphragm during extended drainage.
The vacuum created during the outflow resulted in a reduction of pressure in the fluid side of the device. To obviate this problem and yet retain the dampening effects of the device, a plastic mesh, such as that used for support of membranes in coil dialyzers, could be placed on the fluid side of the dampener.

To demonstrate further that character of dialysate inflow was the cause of symptoms in this patient, the Drake Willock automated peritoneal delivery system**** was used. This machine uses roller pumps for dialysate delivery. The roller pumps result in a less intense pulsatile inflow. The patient experienced less rectal pain therefore with the Drake Willock equipment. A single small pulse dampener was adequate to suppress the intermittent character of dialysate inflow and eliminate pain.

Regrettably, the patient had severe vascular disease requiring bilateral amputation of his lower extremities. He died two weeks after surgery of cardiopulmonary arrest.

In summary, pain sometimes seen in patients treated with automated peritoneal dialysate delivery systems can result from the intermittent character of the dialysate inflow. Converting the pulse wave of the dialysate into a steady stream by means of pulse dampening devices can result in pain-free dialysis with such equipment. We propose to use these pulse dampening devices in any patient whose initial treatments result in pain.

**** D.W.S. Incorporated, Portland, Oregon

REFERENCES