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Complications of peritoneal dialysis

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COMPLICATIONS OF PERITONEAL DIALYSIS

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INTRODUCTION

The concept of artificial dialysis was first proposed by Abel, Rountree, and Turner[1] in 1913. In 1923 Ganter[26] first tried peritoneal dialysis. Because of technical difficulties and the high incidence of peritonitis, peritoneal dialysis was overshadowed by the interest in and the development of extra-corporeal dialysis stimulated by Kolff [16] in 1944. Treatment with the artifical kidney remained a costly and time consuming procedure requiring a team of trained personnel with elaborate equipment. This has largely limited hemodialysis to a relatively few hospitals in metropolitan areas. Peritoneal dialysis increased in popularity with the publication of Maxwell et al. in 1959[19] and with the availability of commerical dialysis solutions. The new advances made the procedure of peritoneal dialysis available in any hospital with physicians with minial training in this technique. With newer innovations in technique such as the use of tham or other agents in the dialysate accelerating the rate of dialysis[21] and the use of fat or albumin solutions to extract fat soluble or protein bound substance from the patient's circulatory system,[3] the indications for peritoneal dialysis are slowly increasing. (see Table I) As more physicians employ this procedure, the need to understand the complications which may occur become more urgent.

TABLE I

USES OF PERITONEAL DIALYSIS

I. Renal diseases

A. Acute renal failure

1. Secondary to trauma
2. Post-operative renal failure
3. Shock
4. Acute renal disease

a. Pyelonephritis
b. Glomerulonephritis

B. Chronic renal disease

1. Chronic glomerulonephritis
2. Chronic pyelonephritis
3. Kimmelstiel-Wilson disease
4. Malignant nephrosclerosis
5. Preparation for renal transplantation

II. Intoxications

A. Exogenous

1. Salicylate
2. Alcohol
3. Barbiturate
4. Glutethimide

B. Endogenous

1. Hepatic coma
2. Hyperuricemia

III. Others[8]

A. Metabolic acidosis
B. Intractable edema
C. Myasthenia Gravis
D. Electrolyte imbalance

Data

A total of 97 dialysis performed during the year 1961 to 1969 were reviewed. The dialysis were conducted on 47 patients. Thirty-one patients had one or two dialysis. The age of the 26 males and 21 females ranged between 7½ months and 81 years. The diagnoses are listed in Table II.

Many probelms are encountered in a retrospective study such as this one. Laboratory values and notations of clinical observations were often difficult to find or not found at all. There was no single standard procedure followed by all of the physicians. Different physicians seemed to emphasize different laboratory studies. Both physicians' and nurses' notes were often vague and incomplete. A few patients were treated in an intensive care area where the nurses notes were found to be more complete. These had a greater incidence of complications. The question arises whether the increased incidence was secondary to the completeness of nurses notes or whether the increase incidence represented the true frequency of the complication. Many complications occurred sparatically and without an observable pattern. The question here is, was this because of poor detail rather than frequency of complication.

TABLE II

Diagnoses	Frequency
Acute glomerulonephritis	1
Subacute glomerulonephritis	2
Chronic glomerulonephritis	17
Acute and chronic sclerosing glomerulonephritis	1
Chronic pyelonephritis	9
Acute tubular necrosis	2
Cortical necrosis	1
Malignant nephrosclerosis	1
Juvenile familial nephrophthisis of Fanconi	1
Acute renal failure following resection of abdominal aneurism	1
Infarct of the kidney	1
Kimmelstiel-Wilson disease	2
Multiple myelonoma	1
Acute intoxication: glutethimide	1
barbiturate	1
Congestive heart failure	1

Discussion

The advantages of peritoneal dialysis as compared to hemodialysis are several:

1) the procedure requires only simple inexpensive equipment and can be done in any hospital with a physician with a knowledge of paracentesis technique and hemaostasis,
2) Supervision can be carried out by a nurse,
3) Slow correction of serum electrolyte composition produces a smoother clinical course with a lesser incidence of convulsions and cardiac arrhythmia,[7]
4) An extracorporeal circulation is not required eliminating systemic anticoagulation, multiple blood transfusions and possible circulatory overload.

Table III Organisms Cultures in dialysate

Organism	frequency
Coagulase negative micrococcus	4
Escherichia intermedia	1
Escherichia Coli	6
Pseudomonas aeruginosa species	4
Pseudomonas, species not determined	5
Aerobacter aeroginosa	2
Proteus vulgarus	1
Staphylococcus aureus	2
Staphylococcus hemolytic coagulase negative	1
Staphylococcus hemolytic coagulase positive	4
Staphylococcus epidermides	1
Bacterium anitratum	6
Streptococcus enterococcus	1
Herellea	1
Staphylococcus non-hemolytic coagulas negative	1

Table IV other complications

Bleeding around catheter	3
Dehydration	6
Edema	7
Hypotension	5
Grossly bloody fluid return	3
Pleural effusion	4
Atelectasis	1
Perforation of intestine	2
Ileus	1
Subcutaneous fluid dissection	2
Error in dialysis fluid composition	1
Wound infection	3
Diarrhea	3
Convulsion	5
Cyanosis	3
Tube disconnection	3

Table V

Complication and Frequency

Complication and Frequency	Total number of cases	Diagnosis in %		Age group in %							Number of Cycles in %					
		Glomerulo-nephritis	Pyelo-nephritis	0-10	11-20	21-30	31-40	41-50	51-60	61 and older	1-10	11-20	21-30	31-40	41-50	51-156
Number of Dialysis	97	46	19	24	11	10	11	17	16	8						
Number of Patients	47	18	9	8	4	8	6	9	5	7	2	10	21	15	17	23
COMPLICATION																
Poor inflow	19	20	76	22	25	10	25	5	6	12	9	3	2	2	0	1
Poor drainage	34	24	79	54	31	10	25	10	42	25	19	5	3	4	2	1
Leakage around catheter	30	24	37	50	8	10	25	15	36	50	16	9	0	2	0	2
Pain on distention	46	50	63	54	31	50	31	46	21	37	30	9	0	2	1	3
Pain upon palpation	7	13	5	19	0	20	8	5	5	0	1	2	1	1	0	2
Pain not otherwise described	39	51	58	27	80	40	50	63	15	12	1	4	4	1	4	1
+Culture (patient received antibiotic during dialysis)	17	11	5	8	8	40	17	10	0	0	3	3	5	2	3	1
+Culture (patient received no antibiotic during dialysis)	16	20	31	23	17	0	31	15	0	25	6	2	4	2	2	0
Turbid fluid return	31	37	37	39	25	10	83	20	10	62	10	8	3	2	3	4
Pink fluid return	38	41	31	30	50	40	67	37	21	0	31	1	1	3	0	1
Patient felt chilled	26	30	16	33	17	30	60	31	5	37	9	8	3	5	1	0
Dyspnea	13	13	21								9	2	0	0	0	2
Abdominal cramping	16	20	21	8	8	30	17	20	10	25	8	2	1	3	0	2
Twitching	22	26	26	33	8	10	42	26	6	12	10	5	3	2	0	0
Fever	44	65	47	54	83	40	58	50	26	50	8	7	5	4	0	2
Vomiting	24	21	31	19	42	10	25	10	10	37	8	4	3	1	1	2

Hemorrhage, shock, recent abdominal surgery, peritonitis, and coagulation defects are no longer absolute contraindications for either method of dialysis.[4]

The disadvantages of peritoneal dialysis should also be recognized and include: 1) slow and sometimes inadequate solute extraction as in the use of intoxication, 2) abdominal wounds of recent origin may leak fluid. Additional complications will be discussed in greater detail below.

The complications of peritoneal dialysis found in the case studied were divided into three main groups: I) Mechanical, II) Metabolic, and III) Inflammatory.

I. Mechanical

Leakage and Subcutaneous fluid dissection:

Leakage of fluid around the peritoneal catheter occurs frequently, 36% of the cases in this series, and was observed by most authors.[1,11,18] Leaking fluid can lead to errors in determination of fluid balance resulting in metabolic complication. The use of purse-string sutures around the catheter often alleviates the problem. Barry et al.[3] suggest the use of a cannula with a distensible peritoneal balloon which forms a seal and provides hemostasis. The size of the original incision affects the amount of leakage observed and should, therefore, be kept as small as possible.

A related problem of scrotal edema was observed in two cases. The edema was caused by the subcutaneous dissection of fluid along Scarpe's fascia into the scrotum.[17] Subcutaneous fluid

dissection has also caused local edema of the abdominal wall.[19] This can result in the further problem of pain and infection. Deeper insertion of the catheter would minimize this problem. Recent abdominal surgery may be complicated with this problem and less fluid per cycle should be used in these patients. Hydrothorax and dyspnea have been caused by fluid dissection through a vent in the diaphragm but this has been reported only rarely.[17]

Hemorrhage. The reported incidence of hemorrhage is generally low.[17] In this series grossly bloody fluid occurred in 2% of the cases and in the first cycle. Mesenteric vein laceration resulted in one patient's death. The size of the abdominal wound is better correlated with the incidence of hemorrhage than is uremia or peritoneal catheter size.[22] Pink blood tinged fluid was not uncommon. The pink fluid described in 40% of the cases reviewed occurred early in dialysis and, therefore, was probably secondary to subcutaneous bleeding from the incision. The area of insertion of the cannula was of importance. The tissues in the midline below the umbilicus are relatively avascular, and most bleeding here is superficial and is often controlled by pressure by the tracar and cannula.[19] Purse-string sutures help provide hemostasis.

Perforation of abdominal viscera. Although encountered infrequently, perforation of an abdominal viscus is a great fear of anyone attempting a peritoneal dialysis. Of the cases reviewed, perforation of the intestine occurred twice, bladder once and

mesenteric vein once. Other abdominal viscera reported injured during peritoneal dialysis include aorta,[4] and liver[8] This complication is often fatal, the death of two of the patients in this review was the direct result of abdominal visceral perforation. The presence of abdominal adhesions greatly increases the risk of this complication. In one case reviewed, intestinal perforation was caused by the adhesion of intestine to the site of trachar insertion, and the adhesions were the complication of earlier peritoneal dialysis. Other than in cases with adhesions, infusion of fluid into the abdomen first through a spinal needle will minimize the risk of this complication.

Poor fluid flow. One of the more troublesome complications was the inadequate flow of fluid into and out of the abdominal cavity. This occurred in over half of the dialysis reviewed. Causes of poor fluid flow are many including: 1) omental blockage of the cannula, 2) fibrin clots within the cannula, 3) intraperitoneal loculation of fluid by adhesions, 4) pieces of fat plugging the cannula, 5) poor catheter placement, and 6) free air in the peritoneal cavity which disrupts the siphon effect required for proper drainage.[3] Insufficient drainage resulted in failure of two attempted peritoneal dialysis. Dyspnea has also been reported as a result of poor drainage.[17] The addition of heparin to the dialysate and the use of nonirritating catheters has diminished the problem. Increase in flow is often obtained

by simple repositioning of the patient or remanipulating the catheter. If simple procedures fail, the catheter may be flushed with sterile saline,[19] but aseptic technique must be used to prevent contamination. Ribot et al.[22] suggested re-insertion of another catheter when flow is not easily re-established.

Pain. Some discomfort related to the position of the catheter was relieved by remanipulation of the catheter. Stretching of the peritoneum, at time of trachar insertion, will cause momentary pain. Pain or distension occurred in 50% of the dialysis and was decreased in a few cases by the installation of 2 to 5 cc of a local anesthetic into the dialysate. Slowing the rate of fluid flow decreased the pain during the periods of inflow and outflow. A few patients complained of pain and restlessness and required injections of meperidine or a minor tranquilizor.

Miscellaneous mechanical complications. One patient accidently pulled out his catheter. The tubing became disconnected in the three procedures. Hypotension, observed only five times in this study, has been attributed to vaso-vagal reflexes.[23] Other complications reported by others include wound evisceration[17] and omental herniation through the catheter insertion wound.[23]

II. Metabolic Complications

Many patients reviewed had some form of uremia and the accompanying syptoms (nausea, vomiting, headache, seizures, etc.)

before the peritoneal dialysis was started. Uremic patients have intrinsic problems with electrolyte, and acid-base balance. At times one would have a difficult time in telling which complications were a direct complication of the dialysis or of the disease.

Dehydration. Dehydration occurred in 9% of the dialysis and often resulted from use of hyperosmotic dialysate. The balance of the quantity of inflow and outflow may be difficult in the presence of leakage.[13] Control of the complication lies in monitoring of blood pressure and intravenous replacement of fluid and electrolyte.

Edema. Edema may be a specific indication for dialysis. Edema noted during the dialysis occurred in 7% of the cases. Edema, because of hypoproteinemia, has been found in the chronically ill and following long-term dialysis. The use of intravenous albumin to control this complication has been suggested.[7] Pulmonary edema (found in 4 cases) may be due to the hemodynamics of the intrinsic changes in creating ascites which increased pulmonary artery pressure and decreases cardiac output.[18] Daily weights provide a rough estimate of water balance and should be routine with every dialysis procedure. In cases where cardiac reserve may be poor, one might be wise to monitor the central venous pressure.

Serum sodium abnormalities. Headache, vomiting, and convulsion can be caused by sodium abnormalities. Abnormal serum

sodium concentration seldom occurs with the use of commercially prepared dialysis solution. Hypernatremia may occur when hyperosmotic solutions are used and the cycle time shortened, resulting in a more rapid transfer of water than solute across the peritoneum.[17,22]

Potassium abnormalities. Decreased serum potassium occurred once in the series and was corrected by the use of dialysate with potassium. Cardiac patients may develop digitalis intoxication during dialysis because renal excretion of cardiac glycosides is decreased and because of a pre-dialysis hyperkalemia. Potassium abnormalities most often result from error in preparing dialysate.

Alkalosis. Respiratory alkalosis (not determined in this study) occurs early in the dialysis and is usually transient. The cause of alkalosis was the result of slower correction of intracellular acidosis than extracellular acidosis. The intracellular acidosis continues to stimulate the respiratory center and ventilation changes the extracellular acidosis into respiratory alkalosis.[22] The decrease in hydrogen ion may eventually depress respiration or may precipitate calcium and magnesium salts; but this is uncommon.[17]

Poor lactate metabolism. Anuric acidotic patients with liver failure have been reported to be unable to convert lactate into bicarbonate, which results in continued acidosis.[7] Treatment includes intravenous bicarbonate or use of a dialysate

substituting acetate for lactate.

Protein loss. Up to 50 grams of protein including many amino acids may be lost during peritoneal dialysis.[17] Albumin is lost to a greater extent.[5] Protein loss is dependent on both the duration of dialysis and the amount of fluid used. This complication occurs more in the chronically ill and in the long term dialysis patients. Intravenous albumen has been used in some cases of hypoproteinemia.[7]

Hyperglycemia and hyperosmolality. Thirst, nausea, vomiting and Cheyne-Stokes respiration may indicate a patient with hyperglycemia. Boyer et al.[6] showed that an average of 32.4 gm. of glucose were absorbed from 1.5% glucose dialysate; 131.6 gm. from 4.5% dialysate; and 201 gm. from 7% dialysate. Insulin resistence and decreased clearance of glucose are a common metabolic disturbance seen in patients with azotemia and systemic infection. High blood sugar may produce extracellular hyperosmolarity with a gradient sufficient to produce cellular dehydration and coma. One death has been reported as a direct result of hyperglycemic hyperosmolar coma occuring during a peritoneal dialysis.[13] Hyperosmolality may result in hypernatremia if dialysis is topped before blood sugars are normal and if the patient's intake of water is restricted. In this situation, the patient's sodium increased as extracellular glucose is metabolized and as extracellular water returns to the dehydrated cell. Frequent determinations of the patients blood sugar and serum osmolality

would minimize the incidence of hyperglycemia and hyperosmolality during peritoneal dialysis with 7% glucose solution.

Dialysis disequalibrium syndrome. Symptoms of the disequalibrium syndrome are headace, vomiting, coma, hypertension, EEG changes, and an occasional sudden death. In the uremic patient the extracellular urea is removed more rapidly than intracellular urea, the resulting osmotic gradient may lead to cellular edema and fatal cerebral edema. Removal of urea and possibly other substance from the cerebrospinal fluid lags behind removal of these substances from the blood. Therefore the brain may be hyperosmotic relative to the blood and imbibe water. The resulting cerebral edema is one cause of the disequlbrium syndrome. This complication is extremely uncommon during peritoneal dialysis because of the slow chemical correction.[17]

III. Inflammation

Positive cultures were obtained in 34% of the cases reviewed. Of these patients, 61% had a temperature above 99° F. 71% had some form of pain, and 49% had turbid drainage fluid. The clinical manifestation of fever, pain, and turbid fluid often did not indicate bacterial contamination. One patient developed an abdominal abscess after peritonitis from a dialysis. Some predisposing causes of peritonitis are manipulation and irrigation of a malfunctioning catheter, prolonged dialysis, and leakage.[23] As long as the dialysis continues to function well, the procedure need not be discontinued because of peritonitis. The data in this

review showed there was an increase in infection in the age group 21-30. Might one postulate that these patients have peritoneal dialysis when their state of health is worse than the other age groups? Most of the cultures yielded gram negative organisms (see tableIII). This has also been observed by others.[17,24] Some physicians believe the bacteria are from the intestinal flora, still others believe the route of infection is through the abdominal wall around the peritoneal catheter. Decrease in number of positive cultures may be achieved by 1) aseptic technique, 2) use of a closed system, 3) use of new tubing for each infusion, 4) addition of antibiotic to the dialysate, 5) use of a small bore catheter,[24] and 6) limitation of the duration of dialysis to two or three days.

The procedure followed by Cohen et al.[9] in their experiment included 1) strict asepsis, 2) sterilization for 5 minutes of involved surfaces in every disconnexion of or injection into the dialysis system, 3) adding 40% formaldehyde to the collection bottles, 4) treating the skin around the catheter with an antibiotic spray or powder, 5) bathing the patient daily in bath water with 25 ml. of 10% hexachlorphane added, and 6) dialysis being done on alternate nights from 7:00 p.m. to 6:00 a.m. Their results are remarkable. The incidence of infection was reduced from once in 32 to once in 77 days of dialysis and three patients had repeated dialysis for up to 7 months without infection.

Summary

With the increase in use of peritoneal dialysis, physicians need to be familiar with the complications of the procedure. Charts on 47 patients with a total of 97 dialysis were reviewed and the complications noted. Mechanical complications included poor inflow and drainage, leakage and bleeding around the peritoneal catheter, pain, turbid or pink-fluid returns, and abdominal visceral perforation in three cases. Some of the metabolic complications were dehydration, edema, hypotention, hypothermia, twitching, thirst, diarrhea, and convulsions. A total of 38% of the dialysis had a positive culture at some time during the dialysis. Three cases of wound infection and one abdominal abscess were found. Suggestions for reducing the number of complications were made.

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