Home therapy for kidney disease

Continuous ambulatory peritoneal dialysis and continuous cyclic peritoneal dialysis[1]

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Renewed interest in home therapy using continuous ambulatory peritoneal dialysis and/or continuous cyclic peritoneal dialysis will be sustained as both industry and researchers engage in improving understanding of the peritoneal membrane, controlling the causes of peritonitis, and creating new ways of generating dialysate. Patients on home dialysis have the potential to accept responsibility more easily, attend school, or remain gainfully employed, thereby bolstering their position in the family structure while improving their overall quality of life. In patients with diabetic nephropathy, intraperitoneal insulin administration can control blood sugar, obviating the need for subcutaneous insulin injections. Early referral for evaluation of dialysis and efforts at rehabilitation are essential to overall success. Treatment should reflect the need to address total patient care through a well-constructed patient care team.

Index terms: Home care services • Peritoneal dialysis

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Traditionally, the majority of patients with kidney failure have been treated in hemodialysis centers, regardless of the etiology (chronic glomerulonephritis, diabetic glomerulosclerosis, hypertensive renal disease, etc.). The cost of caring for patients with end-stage renal disease (ESRD) continues to escalate. Expenditures for the first 16,000 ESRD patients covered by Medicare totaled $250 million; by 1979, this figure had risen to $1 billion for 51,000 patients. The 1982 expenditures approximated $1.8 billion, and it has been estimated that by 1986, costs will reach $2.8 billion.[1]

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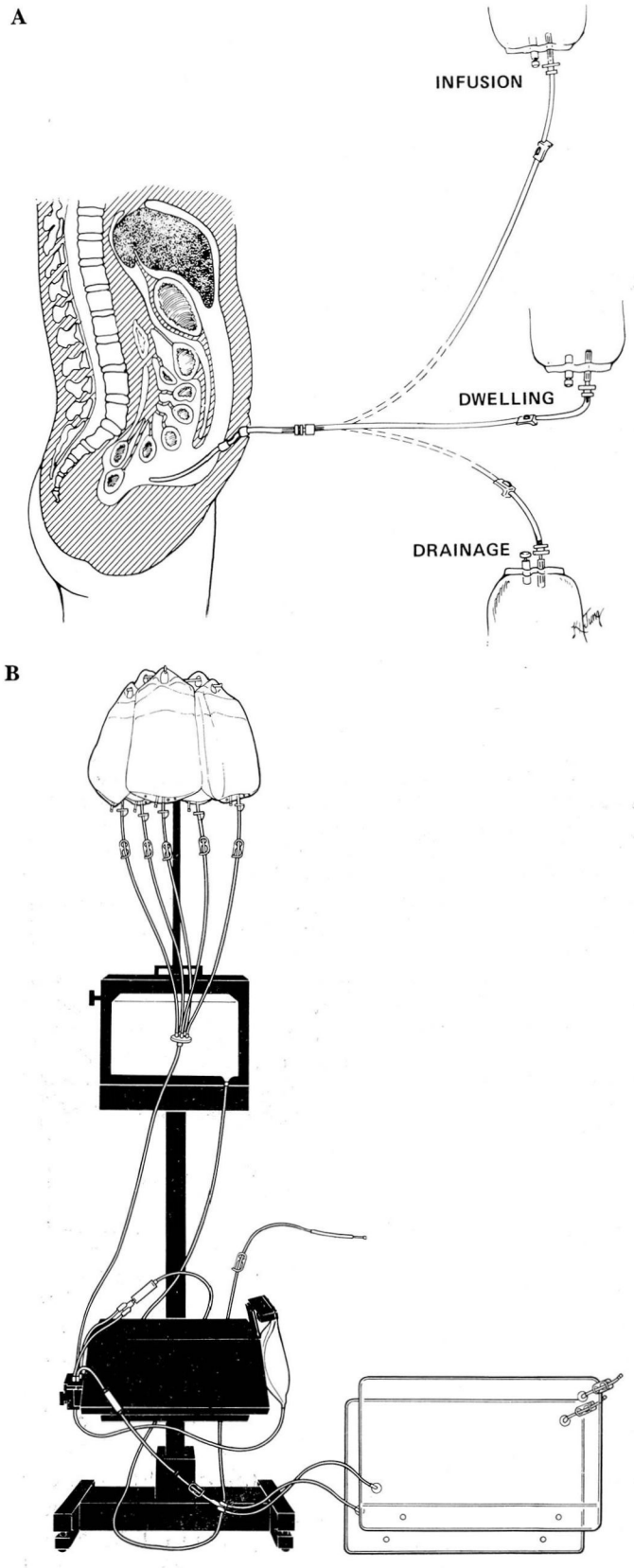

Considering the significant burden to the Medicare system, the federal government instituted prospective reimbursement for dialysis in 1982. As a result, administrators of medical centers and dialysis facilities are having to re-examine customary practices in treating ESRD patients. Because of this growing emphasis on health care costs, coupled with a greater interest in rehabilitation potential and quality of life, there has been a renewed enthusiasm for home dialysis, particularly continuous ambulatory peritoneal dialysis (CAPD). While hemodialysis has been available for many years, the need for a spouse, partner, or dialysis helper, the convenience of hemodialysis centers, and the lack of government incentives for home therapy have all contributed to the steady decline of home hemodialysis. The following paper will address the theoretical basis of both CAPD and continuous cyclic peritoneal dialysis (CCPD), program organization and patient selection, clinical consideration, and future directions in home care.

Theoretical basis

Continuous ambulatory peritoneal dialysis (CAPD) (Fig. 1A)

Since the initiation of CAPD in the United States in 1976, the number of patients treated with this modality has increased to more than 10,750, which is approximately 14% of the total undergoing dialysis at 290 centers. More than 130 patients have been trained for CAPD at The Cleveland Clinic Foundation (CCF) since 1979. Although intermittent peritoneal dialysis still exists in some centers as a form of chronic treatment, it is used mainly for acute or transient problems.

CAPD uses a physiological dialysis cycle lasting four to six hours which is capable of stabilizing serum chemistry values through multiple daily exchanges of commercially prepared dialysis solutions.[2] The underlying theoretical framework in adults has previously been described.[3,4] Within four hours of a dwell cycle, urea and other small molecules equilibrate between peritoneal and extracellular fluid; thus the total

Fig. 1. Home peritoneal dialysis modalities.
A. Continuous ambulatory peritoneal dialysis (CAPD).
B. Continuous cyclic peritoneal dialysis (CCPD).

amount of solute removed is determined simply by the product of the blood concentration and the volume of dialysate drained. Currently, solutions are available in three different concentrations (4.25, 2.5, and 1.5 g/dL dextrose); the higher the glucose content in the dialysate, the greater the degree of ultrafiltration. CAPD permits achievement of steady-state blood urea nitrogen (BUN) concentrations equal to those in patients undergoing hemodialysis. By eliminating large oscillations in weight, blood pressure, serum osmolality, and pH, CAPD has the potential to reduce dialysis morbidity.[5] Using guidelines from previous solute removal studies, CAPD regimens may be constructed to meet the individual needs of the patient with regard to protein intake, residual renal function, metabolic rate, and ultrafiltration. Altogether, the advantages of CAPD far outweigh the disadvantages (*Fig. 2*).

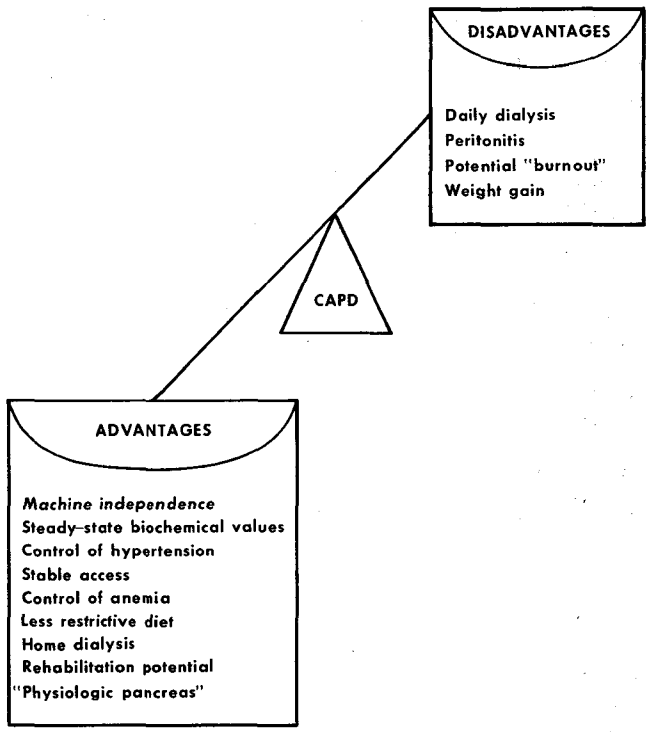

Fig. 2. Advantages and disadvantages of home peritoneal dialysis.

Continuous cyclic peritoneal dialysis (CCPD) (Fig. 1B)

CCPD provides three to five short dialysate exchanges at night, followed by a prolonged diurnal exchange.[6] All are performed automatically using a basic peritoneal dialysis cycler. This form of therapy reverses the schedule of CAPD and provides automatic delivery of dialysate to the peritoneum, usually during sleep. While a partner is still needed, his or her contribution is greatly reduced, since all technical manipulations take place early in the morning or before the patient retires. Clinical experience with the 20 patients placed on CCPD at the CCF has demonstrated adequate control of nitrogenous waste products, stabilization of acid-base balance, and favorable acceptance by both patients and families.

Individuals who are unable or unwilling to perform daily exchanges at school or in the workplace respond favorably to a CCPD program. It appears to be the optimal form of therapy when intensive involvement by parents is necessary, particularly in the case of children under eight years of age, as there is less stress on the parents with CCPD than with the four to five exchange cycles required every day with CAPD; also, young children on CCPD can avoid the embarrassment of performing dialysis during school hours, play, or study times. Recently, we have employed CCPD as a temporary mode of therapy for patients tired of performing CAPD during the "burn-out period" which occurs 18 to 24 months after beginning home therapy in some cases. Switching to CCPD for a while breaks the pattern of daily exchanges; however, because of the freedom from the machine and the desire for independence, most patients (>50%) elect to return to CAPD after this rest period.

Program organization and patient selection

The basis of a successful program is the development of a total patient care team. Each member of the "core team" has specific expertise which is essential in the long-term management of chronic disease: this includes a physician, CAPD nurses, dietitian, social worker, financial consultant, and psychiatrist.[7] All of these individuals are committed to a dedicated team approach which generates a thorough initial evaluation for selection, support, and instruction during the training period, as well as a continued interest in the needs of the patient and stress on the family after completion of the program.

Patients are referred to the CAPD unit either to initiate dialysis or for more information prior to the actual need for dialysis. The medical members of the core team work with the patient's

Table. Indications and contraindications for CAPD and CCPD in patients with end-stage renal disease

Indications
Awaiting kidney transplant
End-stage diabetic nephropathy
Patient preference for home dialysis
Distance from center
Travel or working
Already on hemodialysis with anemia, adverse symptoms, or poor vascular access
Atherosclerotic heart disease
Children with ESRD
Contraindications
Widespread abdominal wall infection
Symptomatic lumbar disk disease
Respiratory insufficiency
Noncompliance

local physician and/or nephrologist for long-term care, especially if the patient lives a considerable distance away. When the evaluation has been completed, the patient is either accepted or advised not to enter the program for reasons agreed upon by the selection committee. (Indications and contraindications for home peritoneal dialysis are listed in the *Table.*) After approval, the training period is planned and a peritoneal catheter is placed at either the CCF or the patient's local hospital. CAPD requires a five- to seven-day training period, while CCPD takes ten to twelve days of instruction. All patients are seen during the initial two weeks following training and then a visit every six weeks at the center is required. During the interim between visits, it is essential that the CAPD nurses be readily available to assess problems which may develop at home. Through a close phone dialogue with the patient, a number of potential problems can be avoided; psychosocial stress related to home therapy can be recognized early on and a solution arrived at before a crisis state is reached.

Clinical considerations

Adequacy of dialysis

It is extremely difficult to formulate specific criteria for adequacy of dialysis. Concern should arise when symptoms are coupled with a BUN >120 mg/dL and a serum creatinine level above 20 mg/dL. If a patient with a moderate protein intake (<1.5 g/kg/day) has a serum creatinine level >20 mg/dL and a BUN >100 mg/dL while carrying out the designated number of exchanges, one should suspect suboptimal peritoneal clearance; and conversely, if the patient is active, eating well, and asymptomatic, dialysis is most likely adequate.

Catheter type and placement

A properly placed functioning catheter is one of the most important components of home peritoneal dialysis. Successful implantation depends to a large extent on the technique and experience of the physician or surgeon and may also be related in part to the patient's physique. Major abdominal surgery or peritonitis does not prohibit successful catheter placement, and neither should be considered an absolute contraindication to peritoneal dialysis. Leakage, obstruction, migration, pericatheter hernia, and extrusion of the outer cuff are the main complications of home dialysis and together with peritonitis result in the greatest percentage of hospital days for patients on CAPD or CCPD. Controversy still surrounds the use of a double or single cuff, bedside versus surgical placement, and the best catheter to employ (Toronto Western, life cath, Curled Catheter, Gore-tex, Tenckhoff). Lateral catheter placement may result in increased muscular stabilization and longevity.[8] Omental obstruction may necessitate a partial omentectomy in some cases. Catheter leakage most likely results from faulty surgical technique, poor healing, early use of the catheter, and persistently high intrabdominal pressures. Double-cuff catheters may increase the likelihood of extrusion of the outer cuff, trapping bacteria in the tunnel between the two cuffs. The chemical structure of the catheter and its relationship to adherent bacteria and resistant infection deserve further study.

Peritonitis and catheter exit-site infection

Data from the NIH CAPD Registry[9] for both CAPD and CCPD indicate an average rate of approximately 1.4 episodes of peritonitis per patient per year. On the average, peritonitis occurs once every seven months. Forty percent of patients are found to have peritonitis and/or exit site infection within three months of beginning CAPD. During the first year, approximately 70% of patients will have at least one episode of peritonitis. Eighty-three percent of patients can be treated by antibiotics and do not require hospitalization.

The etiology of peritonitis has remained relatively unchanged, with gram-positive organisms responsible for 52% of episodes. Most cases are due to *Staphylococcus epidermidis* or *S aureus*[10]; gram-negative organisms account for approximately 20%, mixed infections 3%, and fungal and acid-fast bacilli about 3%. Sterile peritonitis ("no growth") accounts for 20% of all clinical peritonitis diagnosed. Most bacterial organisms are sensitive to traditional empirical therapy with one of the cephalosporines and/or aminoglycosides.[11] Conventional management of peritonitis involves intraperitoneal antibiotics alone or in combination with either intravenous or intramuscular antibiotics. Selection of appropriate doses and routes of administration are based on the type of organism involved and its sensitivity to the drug. The importance of intracellular organisms and cephalosporine-resistant infections is gaining increasing importance, affecting both the selection and length of treatment. Fortunately, improvements in patient education (early recognition, prompt treatment, compulsive exit site care) and CAPD technology (connector innovations, patient-assist devices) have led to a reduction in the incidence of peritonitis, and new culture techniques, phage typing of resistant strains, indium-labeled leukocytes, and attention to the potential immune risk factors should continue to decrease the threat of infection in the future. Peritoneal infections are potentially initiated through multiple separate routes in patients on CAPD and CCPD (*Fig. 3*). Efforts to control the incidence of peritonitis should address a multitude of different areas.

Catheter exit-site and tunnel infections

Exit site and/or tunnel infections occur approximately once every 16 months, with catheter replacement being required every 40 months as reported by the NIH Registry[9]; at the same time, variation from one hospital to another might affect overall in-center results. Treatment of catheter exit sites has proved to be somewhat disappointing despite meticulous care and several courses of either intravenous, oral, or topical antibiotics. The major concern with such infections is the possibility of subsequent peritonitis. Unroofing techniques and rerouting of catheters have achieved variable success. Persistent infection may force removal of an otherwise well-functioning catheter. Development of new catheter materials, optimal routes of placement, and a greater understanding of cell ingrowth characteristics should gradually solve catheter infection problems.

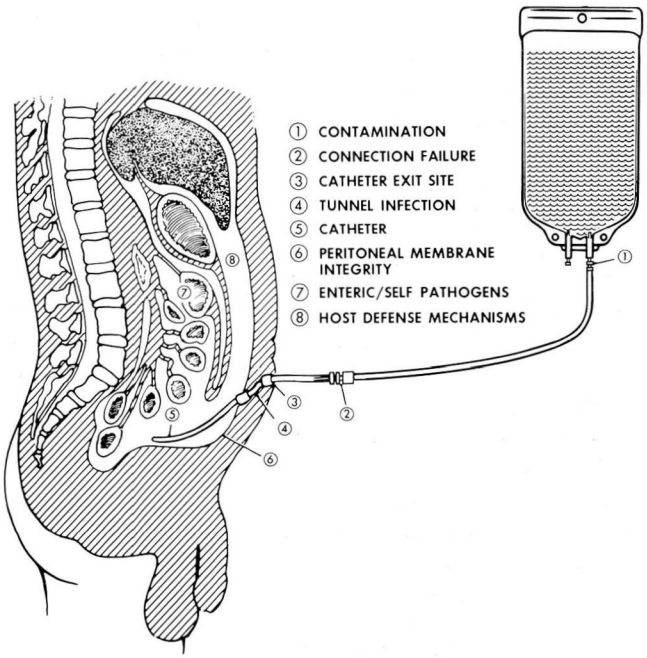

Fig. 3. Schematic diagram depicting various sites of peritoneal infection.

Nutrition

Since nitrogenous wastes are removed continuously in CAPD, patients are instructed to follow a diet of 1.2–1.5 g of protein per kg of ideal body weight with a mild phosphorus restriction, as opposed to the strict dietary restrictions prescribed for hemodialysis patients. Protein intake is adjusted as necessary based on laboratory results, arm measurements, and 24-hour diet recall sheets. While early concerns centered on daily losses of protein as leading to malnutrition in CAPD patients, this has not been the case; dietary intake of protein is capable of making up for such losses and avoiding deterioration of overall protein status.[12] Patients entering the CCF CAPD-CCPD program undergo routine nutritional assessment which includes diet, biochemical indexes and anthropometric measurements.

Psychological aspects of home therapy

The goal of home dialysis is to create a greater sense of independence with the potential for improved rehabilitation. With the responsibility of home therapy come increases in both spouse and

family stress in some situations. Understanding a patient's social support mechanisms (community involvement, closeness to family and friends, religious support, etc.), self-profile, and psychological stability is essential to evaluate home care. Being attentive to therapy-related stress and recognizing potential problems which may warrant psychiatric referral are essential early on. Coping with daily home therapy may result in a state of fatigue or hopelessness, referred to as "burn-out," which can develop after 18–24 months on CAPD in some cases. If a strong foundation for home therapy can be molded prior to dialysis, one may avoid much of the stress which can occur when home dialysis is instituted in a crisis situation. Early referral becomes particularly significant when dealing with a patient who has diabetic glomerulosclerosis or other progressive nephropathy.

Diabetes in CAPD/CCPD

Treatment of ESRD diabetics by CAPD-CCPD has been highly successful. Diabetic glomerulosclerosis accounts for the greatest percentage of patients treated with CAPD. Stable hemodynamics and an "artificial pancreas" with intraperitoneal instillation of insulin, control of blood sugar, and optimal control of blood pressure have made CAPD and CCPD attractive treatment modalities for diabetic renal failure. We have not found the incidence of peritonitis to be any higher in diabetics on CAPD-CCPD than in nondiabetic patients, nor has hyperlipidemia been a problem. While some patients have had gastric neuropathy, a significant number respond to metoclopramide (Reglan). In a recent study at the CCF, uremic diabetics experienced progressive retinopathy more often on hemodialysis than either transplantation or CAPD.[13] While uremia may affect measurement of hemoglobin A_1C, we have found this parameter to be helpful over time in examining glucose control with intraperitoneal insulin. Overall, intraperitoneal insulin is a safe and effective means of controlling blood sugar despite the high glucose loads associated with present dialysate solutions and obviates the need for subcutaneous insulin in most cases. Early referral and initiation of plans for dialysis are critical in patients whose creatinine level is 5–7 mg/dL.

Rehabilitation

CAPD and CCPD offer patients with ESRD the hope for improved total rehabilitation by restoring them to a life as close as possible to their pre-uremic state. Several factors are involved in assuring an improved quality of life as modulated by existing systemic diseases, work skills and employment status, marital relationships, family support, and the patient's own psychological adjustment to kidney disease. Through completion of such a life profile, the core team addresses those key issues in a patient's life which affect the potential for rehabilitation. Family and personal stress can necessitate aggressive psychiatric treatment in specific cases (severe depression, marital discord, "burn-out"). We strongly believe that continued monitoring and discussions with the patient and family regarding early signs of stress can help avoid critical problems. While gainful employment is a realistic option in some patients on CAPD-CCPD, the lack of government incentives, work-related disincentives, and lack of part-time or job-sharing opportunities prevent a large number of patients from returning to work. A broader definition of rehabilitation should be developed that would encompass not only survival, cost of medical care, and employment status, but also quality of life, which, though more difficult to define or measure, is extremely important to the success of home therapy.

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