RECOVERY OF RENAL FUNCTION AND THE DISCONTINUATION OF DIALYSIS IN PATIENTS TREATED WITH CONTINUOUS PERITONEAL DIALYSIS

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Objective: Previous studies have shown that patients with end-stage renal disease (ESRD) treated with continuous peritoneal dialysis (CPD) have better preservation of endogenous renal function than patients treated with hemodialysis (HD). We wondered if this better preservation of endogenous renal function seen with CPD patients translates into the improved likelihood of recovery of endogenous renal function in those patients with potentially reversible causes of renal failure.

Methods: To evaluate this question, we reviewed the records of all 1200 patients that completed CPD training at a large, freestanding peritoneal dialysis center in New Haven, Connecticut, between 1979 and 1999, and the records of all patients completing CPD training in New England between 1993 and 1998. In New Haven, about half the new patients with ESRD were started on HD compared to only 15% in New England. We then compared the chances of recovery of renal function in these two cohorts of CPD patients to the chances of recovery of renal function in two groups of HD patients. The first group consisted of all patients that started on HD in New England between 1993 and 1998. The second group consisted of all patients that started HD in our HD unit in New Haven, Connecticut, between 1993 and 1999. The data on the New England patients were provided by the ESRD Network of New England. All patients entered into the present study had to have been on dialysis for a minimum of 3 months, as in the United States Renal Data System database, and had to have recovered sufficient renal function to be able to be maintained off dialysis for a minimum of 30 days.

Results: 29 of 1200 CPD patients (2.4%) trained in New Haven recovered sufficient renal function to permit the discontinuation of dialysis for a minimum of 30 days. In comparison, only 305 of 19,032 patients (1.6%) managed with HD in New England (p < 0.05 compared to New Haven CPD patients) and 3 of 430 patients (0.7%) in our HD center (p < 0.05 compared to New Haven HD patients) recovered sufficient glomerular filtration rate (GFR) to allow the discontinuation of dialysis for at least 30 days. If only those CPD patients that initiated dialysis between 1993 and 1999 in New Haven were analyzed, 15 of 369 (4.1%) recovered sufficient GFR to allow discontinuation of dialysis for at least 30 days (p < 0.025 compared to both groups of HD patients). Of the 2924 patients completing CPD training in New England, 60 (2.1%) recovered renal function; this percentage is not significantly different from the percent of HD patients in New England recovering renal function.

Conclusion: Although the present study is a retrospective study and the actual criteria for selection of CPD and HD therapy are not controlled for, the data raise the question of whether there may be a therapeutic advantage to treating newly diagnosed ESRD patients, that have a potentially reversible cause of renal failure, with CPD.

KEY WORDS: End-stage renal disease; chronic peritoneal dialysis; recovery of renal function.

The term end-stage renal disease (ESRD) is used to describe irreversible renal failure requiring dialysis or renal allograft transplantation for patient survival. While the vast majority of patients that start dialysis require maintenance therapy to sustain life, a small percentage of patients recover sufficient renal function to permit discontinuation of dialysis treatment.

A number of studies have shown that ESRD patients treated with continuous peritoneal dialysis (CPD) have better preservation of endogenous renal function compared to patients treated with hemodialysis (HD) (1–4). This preservation of residual renal function is important since it contributes significantly to the maintenance of adequate delivery of dialysis and has been shown to have an impact on the quality of life and mortality rates in CPD patients (2,3,5). One wonders if this preservation of endogenous renal function translates, in patients with potentially reversible causes of renal failure, into the improved likelihood of recovery of endogenous renal function. After reviewing the literature, the answer to this question remains unclear. Data comparing the recovery of renal function of CPD versus HD patients have been contradic-
tory, with some studies showing a higher recovery rate on CPD, and some not (4,6–9). To more carefully address this question, we reviewed the records of all 1200 patients that completed CPD training in our facility between 1979 and 1999, as well as the records of all patients completing CPD training in New England. We then compared the chances of renal function recovery in these CPD patients to the chances of recovery in both the HD population of New England and the HD patients cared for in our HD center.

METHODS

PERITONEAL DIALYSIS (PD) AND HD UNITS

Our nephrology group refers all its patients that develop ESRD to either the New Haven CAPD unit for CPD or the St. Raphael’s Hemodialysis Center for HD. The New Haven CAPD Unit in New Haven, Connecticut, is an independent PD unit located in an inner city. The overall functioning and structure of the facility has been described previously (10). Since opening in 1979, through December 1999, 1200 patients have completed training for PD at our facility. The St. Raphael’s HD Center is located in downtown New Haven; it is a 26-station HD unit. Between January 1993 and the end of 1999, 430 new patients started HD in this facility. Accurate records prior to 1993 were not available to permit critical examination for the purposes of this study. Biocompatible membranes (polysulfone) have been used in our HD unit since 1993 to the present.

Patients with progressive renal failure in our practice are educated concerning all therapeutic options for ESRD, including CPD, HD, and renal transplantation, by a nephrology team that includes a nephrologist, a social worker, and a dialysis nurse. Patients are not directed specifically toward one therapy versus another. They make the final decision regarding their therapeutic modality and are not directed toward CPD or HD based on the etiology of ESRD. All patients with an intact abdominal cavity and a place to live, including extended care facilities, are considered candidates for CPD regardless of their age (10,11). About 50% of patients from our practice that develop ESRD choose CPD as their initial dialysis modality.

PATIENT SELECTION

The medical records of the 1200 patients that completed training for CPD between 1979 and December 1999, inclusively, were reviewed; the causes of ESRD were determined by careful chart review. In addition, data were obtained from the ESRD Network of New England concerning all patients that completed CPD training in New England from 1993 to 1998; the causes of ESRD in these patients were taken from the ICD-9-CM codes reported on Form 2728. Data for patients starting CPD in New England in 1999 were not included since computer systems changed in 1999 and it was felt that the data might not adequately capture those patients that were started on dialysis in 1999 and recovered renal function. These groups were compared to two groups of patients started on HD. The first group included all the 430 patients started on HD in the St. Raphael’s HD Center between 1 January 1993 and 31 December 1999; the causes of ESRD in these patients were determined by careful chart review. The second group included the 19,032 patients started on HD between 1 January 1993 and 31 December 1998 in New England; the causes of ESRD in these patients were taken from the ICD-9-CM codes reported on Form 2728. As with the CPD patients, patients starting HD in 1999 were not included in the study for the reasons mentioned above.

The data on the New England patients were provided by the ESRD Network of New England, which stores a complete database of all patients in the New England area that receive therapy for ESRD. Accurate information pertaining to patients started on HD prior to 1993 in both the St. Raphael’s HD Center and the New England Network could not be obtained.

Basic demographic data on the continuous ambulatory peritoneal dialysis (CAPD) patients trained between 1993 and 1999 and the new patients starting HD at the St. Raphael’s HD Center were obtained. Mean ± SD age of the CAPD patients was 61.8 ± 16 years; 52% were male, 37% had diabetes mellitus, and 55% were Caucasian. For the HD patients, mean age was 63.8 ± 14 years; 51% were male, 40% had diabetes mellitus, and 51% were Caucasian. The differences between the CAPD patients and the HD patients were not significant.

Patients were included in this analysis only if they had been managed on dialysis for a minimum of 3 months, as in the United States Renal Data System (USRDS) database. Recovery of renal function was defined as not having a renal transplant and regaining sufficient renal function to allow the discontinuation of any form of dialysis, while maintaining patient survival for at least 30 days (8). The length of recovery was defined from the date of the last dialysis to the date of resuming dialysis, death from any cause, renal transplantation, or 31 December 1999.

STATISTICAL ANALYSIS

Patient age, months on and off dialysis, and serum creatinine values are expressed as mean ± standard deviation (SD). The percentage of CPD patients that
recovered renal function was compared to the percentage of HD patients that recovered renal function, using the chi-square method. A p-value of less than 0.05 was considered statistically significant.

RESULTS (TABLES 1, 2, AND 3)

Of the 1200 patients trained by our CPD facility, 41 patients (3.4%) recovered sufficient glomerular filtration rate (GFR) to allow discontinuation of dialysis. Twelve of these patients were not included in our analysis because they did not meet inclusion criteria: 11 of these 12 patients were not managed on dialysis for at least 3 months and 1 did not remain off dialysis for at least 30 days. Twenty-nine of the 41 CPD patients (2.4% of 1200 patients) that recovered sufficient GFR to allow discontinuation of dialysis met the inclusion criteria of being maintained on CPD for a minimum of 3 months and recovering sufficient GFR to allow discontinuation of dialysis for at least 30 days. Of the 2924 patients started on CPD in New England from 1993 to 1998 and maintained on dialysis for a minimum of 3 months, 60 (2.1%) recovered sufficient renal function to permit discontinuation of dialysis. In comparison, only 305 of 19,032 patients (1.6%) managed with HD for a minimum of 3 months, 60 (2.1%) recovered sufficient renal function to permit discontinuation of dialysis. The differences between the rates of recovery of renal function in these CPD patients compared to both of the HD cohorts are statistically significant, with p-values less than 0.05. The differences between the rates of recovery of renal function in the New England CPD patients and the New England HD patients is not statistically significant. It should be noted that only 13.3% of new ESRD patients start CPD in New England, compared to 46% in our facilities.

When evaluating only CPD patients that initiated dialysis between 1993 and 1999 in our unit, 15 of 369 patients (4.1%) met the inclusion criteria of being maintained on dialysis for a minimum of 3 months and recovering sufficient GFR to allow the discontinuation of dialysis for at least 30 days. The mean age ± SD at the start of dialysis of our CPD patients that discontinued dialysis was 59.1 ± 21.2 years. There were 15 (52%) males and 14 (48%) females; 3 (10.3%) were African American, 25 (86.2%) were Caucasian, and 1 (3.4%) was Asian. These patients had a mean creatinine of 7.1 ± 2.6 mg/dL at the start of CPD, had been maintained on CPD for a mean of 12.3 ± 8.5 months at the time of discontinuation of dialysis, were managed off dialysis for a mean of 37 ± 31 months.

### TABLE 1
Total Patients Starting Dialysis and Percent Recovering Renal Function

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Patients starting dialysis (n)</td>
<td>1200</td>
<td>430</td>
<td>2924</td>
<td>19,032</td>
</tr>
<tr>
<td>Patients recovering renal function (n)</td>
<td>29 (2.4%)</td>
<td>3 (0.7%)</td>
<td>60 (2.1%)</td>
<td>305 (1.6%)</td>
</tr>
</tbody>
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CPD = continuous peritoneal dialysis; HD = hemodialysis.

### TABLE 2
Demographics of Study Patients That Recovered Renal Function

<table>
<thead>
<tr>
<th></th>
<th>New Haven CPD (n=29)</th>
<th>New Haven HD (n=3)</th>
<th>New England CPD (n=60)</th>
<th>New England HD (n=305)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at start of dialysis (years±SD)</td>
<td>59±21</td>
<td>66±7</td>
<td>61±8</td>
<td>66±7</td>
</tr>
<tr>
<td>Sex (%M/F)</td>
<td>52/48</td>
<td>33/67</td>
<td>53/47</td>
<td>57/43</td>
</tr>
<tr>
<td>Race (%C/AA/O)</td>
<td>86/10/4</td>
<td>100/0/0</td>
<td>(82/13/5)</td>
<td>92/6/2</td>
</tr>
<tr>
<td>Months on dialysis (mean±SD)a</td>
<td>12±8</td>
<td>8±6</td>
<td>8±4</td>
<td>7±4</td>
</tr>
<tr>
<td>Months off dialysis (mean±SD)b</td>
<td>37±31</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Mean creatinine at start of dialysis (mg/dL)</td>
<td>7.1±2.6</td>
<td>Unknown</td>
<td>Unknown</td>
<td>unknown</td>
</tr>
</tbody>
</table>

CPD = continuous peritoneal dialysis; HD = hemodialysis; C = Caucasian; A = African American; O = other.

*a* Time from first dialysis to discontinuation of dialysis.

*b* Time from the last dialysis to resumption of dialysis, death from any cause, or 12/31/99.
of 37.2 ± 31.3 months, and had a mean creatinine of 2.7 ± 0.8 mg/dL 1 month after the discontinuation of dialysis. The diagnoses of renal failure in these CPD patients included 11 cases (37.9%) of atheroembolic disease (2 proven by renal biopsy and 9 by clinical criteria), 3 cases (10.3%) of accelerated or malignant hypertension, 3 cases (10.3%) of glomerulonephritis, 2 cases (6.9%) of scleroderma, 2 cases (6.9%) of acute interstitial nephritis, and 8 cases (27.6%) classified as other.

Of the 29 patients treated with CPD that recovered renal function, 7 (24.1%) were lost to follow-up after having been off dialysis for at least 30 days (range 1.5–54 months). The ultimate outcome of their renal status is unknown. Three (10.3%) died from cardiovascular-related etiologies after a mean of 18.0 ± 5.6 months off dialysis, with a mean creatinine of 2.6 ± 0.1 mg/dL at the time of their death. Ten (34.5%) required reinstitution of dialysis after a mean of 31.0 ± 29.1 months. As of 1 January 2001, 9 patients (31%) with a mean creatinine of 2.7 ± 1.0 mg/dL remained stable off dialysis for a mean of 55.1 ± 34.9 months.

The mean age ± SD at the start of dialysis of the 60 CPD patients in New England that recovered renal function was 61 ± 8 years. There were 32 (53%) males and 28 (47%) females; 49 (82%) were Caucasian. The causes of renal failure included 5 (8%) with atheroembolic disease, 9 (15%) with hypertension, 8 (13%) with glomerulonephritis, and 38 (63%) with other causes. The patients had been on dialysis for a mean of 8 ± 4 months prior to discontinuation of dialysis.

The mean age ± SD at the start of dialysis of the HD patients in the New England Network that recovered renal function was 66 ± 7 years. There were 174 (57%) males and 131 (43%) females, of whom 17 (5.6%) were African American, 281 (92%) were Caucasian, and 7 (2.3%) were classified as other. These patients had been maintained on HD for a mean of 7 ± 4 months at the time of discontinuation of dialysis. The time spent off dialysis and creatinine values were not available for this HD population. The diagnoses of renal failure in these HD patients included 52 cases (17.0%) of glomerulonephritis, 46 cases (15.1%) of atheroembolic disease, 38 cases (12.5%) of accelerated or malignant hypertension, 7 cases (2.3%) of scleroderma, 6 cases (2.0%) of interstitial nephritis, and 156 cases (51.1%) classified as other.

The mean age of the 3 patients in the St. Raphael’s HD Center that discontinued dialysis was 66.3 ± 6.7 years; 2 patients were female. These patients had been maintained on HD for a mean of 8 ± 6 months before discontinuation of dialysis. The diagnoses included 1 patient with atheroembolic disease, 1 with accelerated hypertension, and 1 with an uncertain cause of renal failure.

### DISCUSSION

It has been shown that ESRD patients treated with CPD have better preservation of endogenous renal function compared to patients treated with HD (1–4). The purpose of the present study was to evaluate whether, in patients with potentially reversible causes of renal failure, this preservation of endogenous renal function translates into the improved likelihood of recovery of endogenous renal function.

Literature comparing the recovery of renal function in patients maintained on CPD to patients on HD has been contradictory. This confusion is, in part, related to the fact that different studies have used different definitions of ESRD and different criteria to define recovery of renal function.

The largest series examining recovery of renal function in patients maintained on CAPD was reported by Lindblad and Nolph (7) utilizing the US National CAPD Registry. These investigators reported on the results of 23,771 patients maintained on CAPD or continuous cycling PD between January 1981 and July 1988. Using an inclusion criterion of at least 30 days of dialysis, and defining renal recovery as regaining sufficient renal function to permit life without dialysis for at least 3 months, these investigators found 281 patients (1.1%) meeting the criteria to dis-
continue dialysis. A Cox model analysis showed an increased chance for renal recovery in PD patients with systemic immunological diseases with renal involvement [relative risk for recovery (rr) = 2.48], in patients with renal infarction related to renal vascular occlusion (rr= 4.13), and in patients greater than 60 or less than 21 years of age (rr= 1.72). Reduced chance for renal recovery was associated with diabetic glomerulosclerosis (rr=0.25) and polycystic kidney disease (rr=0.13).

Two previous studies reported higher rates of recovery of renal function in patients treated with CAPD. Cancarini et al. (4) found that 8.0% (60 of 75) of their CPD patients, compared to 1.2% (1 of 75) of their HD patients, regained sufficient renal function to discontinue dialysis. Neither the term “ESRD” nor the criteria used for discontinuing dialysis were defined. Rottembourg et al. (6), defining ESRD as a combination of clinical findings and/or a creatinine clearance of about 5 cc/minute, found that 3.3% (10 of 300) of their CPD patients recovered renal function, compared to only 0.8% (4 of 495) of their HD patients. A minimum of 3 months of dialysis was required as part of their inclusion criteria. Recovery of renal function was defined as residual renal function reaching 12 cc/minute.

Other investigators observed different results. Sekkarie et al. (8) observed that 211 of 7404 dialysis patients (2.8%) regained renal function, which was defined as being alive and not requiring dialytic therapy or renal transplantation for at least 30 days. They found no significant difference in the renal function recovery rates of patients managed on PD versus HD. Patients treated with dialysis for less than 3 months were excluded, although patients with diagnoses of acute tubular necrosis, cortical necrosis, and drug-induced renal failure as their primary cause of renal failure were excluded from this study. Michel et al. (9), studying 198 CAPD patients and 212 HD patients, noted a 4.5% renal recovery rate for CPD patients and a 3.2% renal recovery rate for HD patients (p = NS). These authors defined the recovery of renal function as the ability to discontinue dialysis for a minimum of 3 months and have a creatinine clearance greater than 10 cc/minute. They included patients that were maintained on dialysis for less than 3 months.

The present study examined the rates of recovery of renal function in large populations of CPD and HD patients. About 50% of patients from our practice that developed ESRD choose, in a nonbiased process, CPD as their initial dialysis modality. There are virtually no exclusion criteria for patients selecting CPD and the only requirements are that patients have a place to live and that they have an intact abdominal cavity. They are not directed toward CPD or HD based on diagnosis of ESRD. Our CPD population, therefore, can be considered nonselective. In fact, the basic demographic data for patients starting CPD are not different from the demographic data for the patients starting HD in our unit between 1993 and 1999.

Twenty-nine of 1200 CPD patients (2.4%) cared for in our unit recovered sufficient renal function to permit the discontinuation of dialysis for a minimum of 30 days. In comparison, 305 of 19,032 patients (1.6%) managed with HD in New England and only 30 of 430 patients that started HD in our New Haven facility recovered sufficient GFR to allow the discontinuation of dialysis for at least 30 days (p < 0.05 for both groups compared to the New Haven CPD patients). If only those CPD patients that initiated dialysis between 1993 and 1999 are analyzed, 150 of 369 (4.1%) recovered sufficient GFR to allow the discontinuation of dialysis for at least 30 days. The differences between the rates of recovery of renal function in these CPD patients compared to both HD cohorts are statistically significant, with a p value less than 0.025. All patients entered in this study had to be on dialysis for a minimum of 3 months, as in the USRDS database.

In New England, only 13.3% of new ESRD patients started CPD between 1993 and 1998. The criteria for assigning patients to HD or CPD in the various New England units could not be determined. In this database, 2924 patients started CPD in this time interval; 60 recovered renal function (2.1%). This rate of recovery is higher, but not significantly so, than the HD patients in New England. These data are difficult to interpret since we cannot comment on the selection biases for the assignment of patients to HD or CPD in the various New England dialysis facilities.

This study suggests, therefore, that there may be a therapeutic advantage to using CPD to treat newly diagnosed ESRD patients that have a potentially reversible cause of renal failure. Such causes might include atheroembolic disease, scleroderma, malignant hypertension, allergic interstitial nephritis, hemolytic-uremic syndrome, etc.

It needs to be emphasized that the present work represents a retrospective study and issues of patient selection for CPD and HD have not been adequately controlled for. Furthermore, we do not have accurate data for the HD patients from 1979 through 1992. Nevertheless, the differences between rates of recovery of renal function in the CPD patients and the HD patients are noteworthy. Our CPD facility is an excellent facility to use for a study to examine the rates of recovery of renal function since our facility is nonselective and nearly half the new ESRD patients seen by our group start CPD. A prospective, multicenter study should be organized to look more carefully at this question. The issue of patient selection for the
different therapeutic modalities needs to be built into the study design of such an investigation.

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REFERENCES