Chapter III

Treatment Modalities for ESRD Patients

Key Words:
CAPD
CCPD
Dialysis dose
Dialyzer membrane
ESRD modality
Hemodialysis
Home hemodialysis
Peritoneal dialysis
Transplant, renal

The main categories available for the treatment of end-stage renal disease (ESRD) include renal transplantation, hemodialysis, and peritoneal dialysis. In this chapter hemodialysis (HD) is subdivided into center HD, which is the most common modality, and home HD. Peritoneal dialysis (PD) refers predominantly to continuous ambulatory PD (CAPD) and continuous cycling PD (CCPD) with a small subgroup of other forms of PD. Renal transplantation may be from a living donor (usually from a blood relative) or a cadaveric donor. Transplantation is discussed in more detail in Chapter VII.

During the course of renal replacement therapy patients may move from one treatment modality to another, for example from CAPD to transplantation and, after transplant failure, to hemodialysis and perhaps to a second transplant. The following sections review the different treatment options briefly, discuss the use of different modalities and trends over time, and examine demographic differences in patterns of modality utilization. The USRDS Dialysis Morbidity and Mortality Study (DMMS) allows description of treatment with hemodialysis in more detail for a random sample of patients. Chapter IV provides further details regarding a large variety of prescribed medication from this national study of HD and PD patients.

Treatment Modality Options

An Abbreviated History

For patients reaching ESRD before 1960, no treatment other than dietary modification was available. During the 1960s hemodialysis, peritoneal dialysis and renal transplantation became a reality for ESRD patients (Peters). Before that time dialytic modalities as temporary treatment were saving some patients with acute renal failure and transplants were successful only from identical twins. In 1960 Belding Scribner treated the first patients for *chronic* renal failure. This became possible through the creation of a new vascular access, the external arterio-venous Quinton-Scribner shunt. The biggest obstacle to chronic use of peritoneal dialysis was overcome by the development during the 1960s of the soft Tenckhoff catheter with Dacron cuffs. These cuffs served to create a bacterial barrier in the subcutaneous tunnel. Renal transplantation from non-identical twins became a reality during the 1960s through improved understanding of immunology and immuno-suppressive therapies.

Congress enacted Medicare coverage for end-stage renal disease as part of the Social Security Amendments of 1972, which became effective in July 1973 (Fox; Rettig 1982). Several legislative changes in Medicare's ESRD program have sought to encourage reduction in treatment costs through shifts in modality to home dialysis and changes in payment

methods (HCFA). A report from the Institute of Medicine discusses the potential impact of reductions in the reimbursement rate (actual as well as due to inflation) for dialysis treatments (Rettig, 1991). Some additions to coverage have also been made, notably outpatient erythropoietin therapy for the anemia of dialysis patients and an increase (for up to 3 years) for immunosuppressive drugs after transplantation.

Description of Options

Over 250,000 ESRD patients are currently alive in the United States as a result of ESRD therapy, compared to an estimated 11,000 patients in 1973 (Evans, 1981). Opinions differ about the quality of life for ESRD patients, but subjectively patients report general satisfaction (Evans, 1985).

Renal transplantation: Renal transplantation from living related and cadaveric donors became a clinical reality during the 1960s (Hamilton). Surgical technique had already been well developed before this time but advances in the understanding and pharmacologic manipulation of the immune response made transplantation from non-identical donors a reality. Tissue typing came into routine use during the 1960s, as did the direct cross-match between donor cells and recipient serum. More recently, improved immunosuppression with cyclosporine, tacrolimus (FK-506), and other newer agents has further expanded treatment prospects and graft survival (Merion, Kahan, and Wagner). Despite these developments, cadaveric transplantation has shown only a minor growth in the United States since 1986 due to limited availability of donor organs (Prottas; Chapter VII).

Living donors are predominantly blood relatives, although there has been an increase in recent years in living genetically unrelated transplants. A cadaver donor is a person who is brain dead, such as an accident victim, but who is maintained on artificial life support. Transplantation from a cadaver donor usually requires a prolonged waiting time, averaging close to 2 years, whereas transplantation from a living donor can be scheduled in advance and is more likely to be done as an initial ("preemptive") or early renal replacement therapy. Survival of the transplanted kidney (graft or allograft) is influenced by a variety of factors (Opelz; Held 1994a; Braun) such as HLA matching, duration of organ preservation (warm and cold ischemia time) following removal of the organ, presence or absence of panel reactive antibodies, patient demographic factors, rejection episodes, immunosuppressive drug regimens, etc. These factors are described further in Chapter VII.

Hemodialysis: The artificial kidney is another term for hemodialysis. It removes toxins and excess fluid via extracorporeal circulation of blood through the dialyzer. Treatments are most commonly scheduled three times weekly and last 3 to 4 hours. A vascular access is required, using an arterio-venous (AV) fistula, vascular graft, or indwelling vascular catheter. The treatment is performed predominantly as "center hemodialysis" in a hospital-based or freestanding dialysis unit. In this setting dialyzers are commonly reprocessed for multiple use by the same patient.

Hemodialysis may be performed at home as "home hemodialysis" after the patient and an assistant (often the spouse) undergo several weeks of training. Home hemodialysis encourages patient independence and allows freedom to schedule dialysis to meet patient convenience. Those treated with home hemodialysis seem to enjoy a better quality of life (Evans 1985) and are reported to have better survival (Woods) compared to center hemodialysis. Recently, home hemodialysis has been performed as a daily treatment given as a short daytime (Buoncristiani) or slow nighttime dialysis (Pierratos).

Peritoneal dialysis: Using the peritoneal membrane, this alternative dialytic therapy requires placement of a catheter into the abdominal cavity and repeated instillations and drainage of sterile dialysate. Because of concentration gradients, toxins move from the plasma to the dialysate during the dwell time, which usually lasts for several hours in CAPD (shorter in other forms of PD). Toxins, having partly or almost fully equilibrated with the dialysate, are removed when the dialysate is drained. Fluid is removed through osmotic ultrafiltration by use of hypertonic dialysate solutions.

Several peritoneal dialysis options are available. The most common is continuous ambulatory PD (CAPD). The patient usually performs four exchanges of 2-3 liters dialysate on a daily basis at home. Continuous cycling PD (CCPD) is also predominantly a home treatment and utilizes several exchanges through a programmed machine (cycler), typically every night, with one long dwell time throughout the day. The utilization of CCPD has increased in recent years, accounting for 15 percent of PD use in 1995 and over 22 percent in 1996 (see Chapter IV). Combinations of CAPD and CCPD have recently been utilized, particularly in large patients with no

residual renal function (Diaz-Buxo). Intermittent PD (IPD) with exchanges of dialysate three to seven times weekly for 8 to 12 hours is performed with the cycle (also an automated PD). However, with IPD the abdomen is empty when disconnected from the cycler (see Chapter IV). Several other variations of home PD have been described (Twardowski) but are not uniformly recorded and thus are not discussed further in this report. CAPD and CCPD are used frequently for patients who prefer the independence of self-care and for those who have difficulty with vascular access or other aspects of hemodialysis. Thus, there may be two extreme groups of patients who are selected for PD: those who are stable and independent and those who are unstable and poorly tolerant of hemodialysis. Co-morbid conditions at the initiation of PD and HD have been described by the USRDS for a random sample of patients (USRDS 1992). The fraction of CAPD patients that switches to hemodialysis during the first few years of treatment is much larger than the fraction of hemodialysis patients that switches to CAPD (see Reference Table C.9). Recurrent peritonitis may be in part responsible for this observation. One may also speculate that a low delivered dose of CAPD could prompt some switching to hemodialysis once residual renal function is lost.

Data for Modality Analyses

To determine the sequential changes in treatment modalities for individual patients, the USRDS uses a complex analytical process, examining a variety of data sources. In addition to the main database, the facility surveys of the ESRD Networks and HCFA billing data are used. The actual process is described in greater detail in Chapter XIII. For many cases, treatment modality and dates of change in modality must be inferred indirectly from sources such as the Medicare payment files. Because the USRDS is continually refining this process, slight variations between the modality data reported in different Annual Data Reports should be expected.

Trends in Modality Utilization

The USRDS longitudinal patient treatment files ("database") for all ESRD patients and the year-end Facility Survey of all Medicare-approved dialysis units allow description of the treatment modality in use for all ESRD patients on December 31 of each year. Figure III-1 shows these counts for 10 years, 1987-96. Data for the most recent year may represent a low estimate because of somewhat incomplete data. The Facility Survey counts of the year-end point prevalence are slightly higher than counts from the USRDS database because they include both Medicare and non-Medicare patients. Although the USRDS

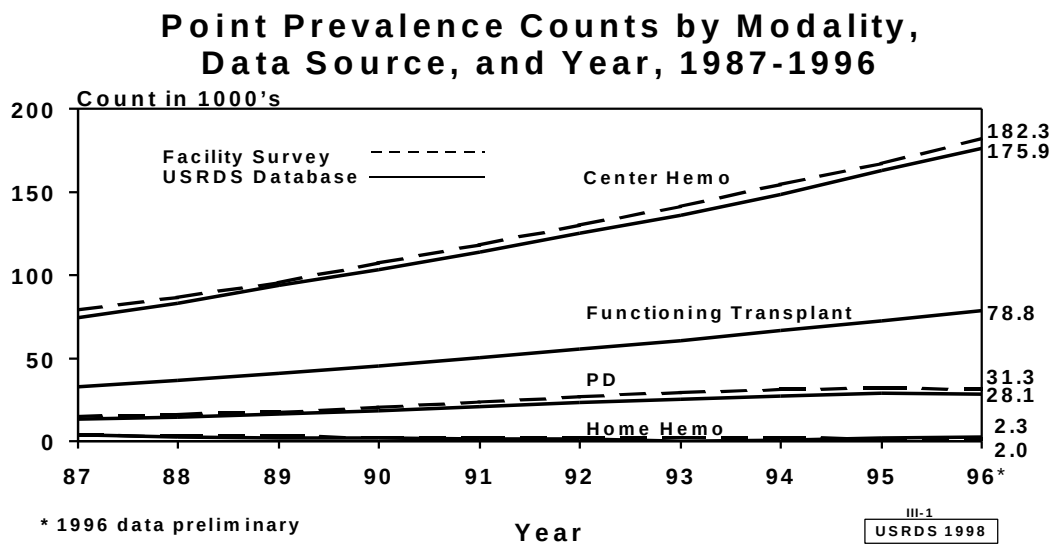

Figure III-1

Point prevalence counts of ESRD patients by treatment modality, data source, and year, 1987-1996. Counts include Puerto Rico and U.S. Territories. Source: Reference Tables C.1, I.12

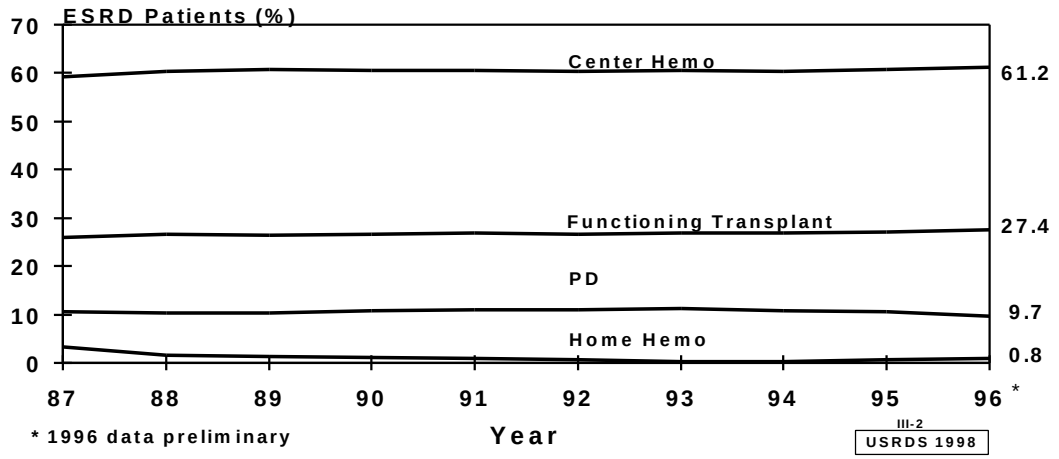

Figure III-2

Percent distribution of prevalent ESRD patients, by treatment modality and year, 1987-1996. Percentages include Puerto Rico and U.S. Territories. Source: Reference Table C.1

database does include some non-Medicare patients, over 93 percent of the patients contained in this source are Medicare patients.

Over the past decade, the overall number of patients treated for ESRD has increased steadily as shown by the count of patients on each treatment modality. The only exception is the small home hemodialysis group, which showed little change in recent years. Throughout the period, patients treated with center hemodialysis constituted the largest group; patients with a functioning renal transplant were the second largest group with almost 79,000 patients. Transplant recipients who lost their transplant function and returned to dialysis are shown in the appropriate dialysis group in the year-end point prevalence counts.

Peritoneal dialysis, mostly CAPD and CCPD, has been the third most common form of ESRD therapy. During the early 1980s, the use of CAPD showed a relatively steep increase (see earlier USRDS reports). Since 1988, however, the percent change per year for each of the three major groups showed nearly the same rate of increase.

Figure III-2 shows the same data as a percent distribution of patients by modality for each year from the USRDS database. The fraction of patients with a functioning renal transplant increased during the 1980s until 1988. This was due to both a rise in the number of transplants performed and improvements in graft survival (see Chapter VII). However, the relatively constant percentage since 1988 is likely a reflection of the scarcity of available organ donors and the continual growth of dialysis patients. The fraction of patients treated with peritoneal dialysis has been fairly constant since the mid 1980s, although the number of PD patients continues to increase (Figure III-1). At the end of 1996, peritoneal dialysis patients accounted for 9.7 percent of all ESRD patients and approximately 14 percent of all dialysis patients. Before the mid 1980s, the fraction of ESRD patients on center hemodialysis had decreased relative to other modalities (see earlier USRDS reports). Since 1988, the percent distribution for all modalities has been remarkably stable, suggesting similar fractional growth for each modality. Only the small group of patients utilizing home hemodialysis has remained low, perhaps with a minor increase after 1994.

There were 1 to 3 percent of patients for whom the modality could not be determined from available data or whose modality was changing at year-end. Their data are not included in Figure III-2. Additionally, patients who initiated dialysis therapy during the last 2 months of the most recent year, 1996 are automatically placed in this category according to definitions outlined in Chapter XIII. Despite this, essentially all prevalent Medicare patients are accounted for in this analysis.

The distribution of patients on home hemodialysis and forms of peritoneal dialysis is shown in Figure III-3. When adding center hemodialysis (not shown) to the percentages in this figure, the numbers would add to 100 percent of all dialysis patients (note that figure III-2 indicates percentages of all ESRD patients, which includes patients with functioning transplants). The use of CCPD increased during the 1980s and early 1990s, with a particularly steep increase in 1995 and 1996. As of December 1996, CCPD accounted for approximately 4.2 percent of all dialysis and about one third (4.2/13.3) of the peritoneal dialysis patients. These fractions reflect a clear increase for CCPD in recent years. Intermittent peritoneal dialysis has been declining and is rarely used. Patients treated with other PD or unknown or uncertain dialysis accounted for only 1.3 percent of all dialysis patients at the end of 1996. The fraction treated by CAPD has shown a sharp decrease since 1993. This occurred apparently in favor of CCPD, since the total fraction of dialysis patients treated with PD remained fairly constant over the past 10 years.

Regional differences in the utilization of various treatment modalities are described as the percent distribution of patients by modality in each of the 18 ESRD Networks in Table III-1. Percentages in the dialysis modality columns are calculated from point prevalences in 1994, 1995, and 1996, rather than 1996 alone. This is done to provide stability for the reported percentages. Compared to the national summary data (labeled TOTAL), this table shows large variations for certain regions. The median age for prevalent patients in 1996 (alive on December 31) varied by region from 53.7 to 59.5 for an overall median age of 55.7 years. For the assessment of the percent of patients with a functioning transplant, only patients aged less than 65 years were considered. The fraction of ESRD patients with a functioning transplant had an almost two-fold range from the highest to the lowest region (27.1 to 50.6 percent) with an average of 38 percent.

The fraction of dialysis patients on CAPD ranged from 7.0 to 16.1 with an average of 10.6 percent of all dialysis patients. The relatively high percentages observed in Midwestern states may be related, in part, to the distances of patients from their nearest dialysis facility, as previously described in the USRDS 1991 Annual Data Report. CCPD was used in 3.4 percent of dialysis patients and also had a wide range of utilization (2.5 to 5.2 percent). The utilization of CCPD versus CAPD deserves further study.

The fraction of dialysis patients treated by home hemodialysis shows a large variation by region. One region appears to be promoting home hemodialysis (1.9 percent), while the remainder range between 0.1 and 1.1 with an average of 0.7 (Table III-1). No correlation of the utilization of home hemodialysis with that of other forms of home dialysis (CAPD or CCPD) is obvious in this table.

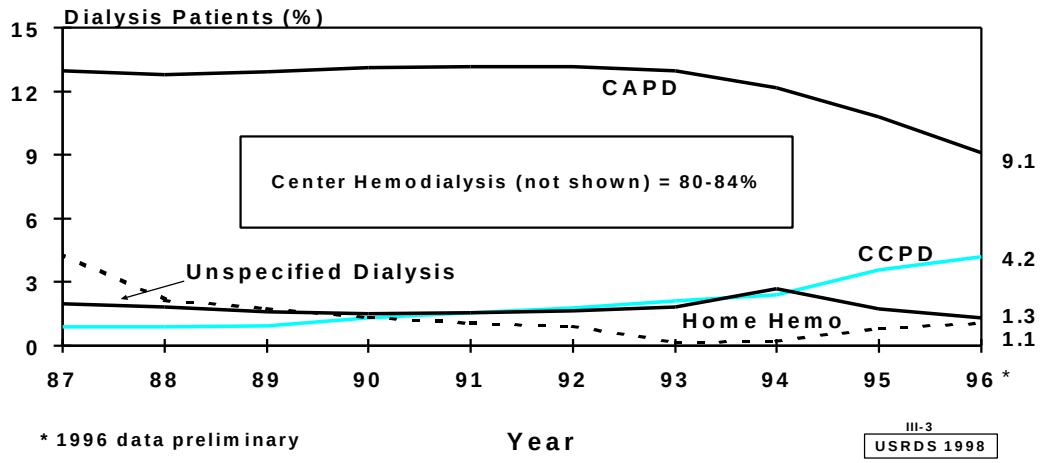

Figure III-3

Percent distribution of prevalent dialysis patients, by treatment modality and year, 1987-1996. Center hemodialysis not shown. Unspecified dialysis includes other PD and uncertain dialysis. Percentages include Puerto Rico and U.S. Territories. Source: Reference Table C.1

Living Patients on December 31 By Treatment Modality, By Network 1994 Through 1996

Network Number (State)	Total Count[a]	Functioning Transplant (%) Age 0-64 only[a]	Median Age[a]	Dialysis Modality (%)[b] Center Hemo	Home Hemo	CAPD	CCPD	Other PD/ Unknown
1 (CT,MA,ME,NH,RI,VT)	12,090	46.6	58.8	80.8	0.6	11.7	5.2	1.8
2 (NY)	19,847	31.6	57.5	83.5	0.6	11.4	2.5	2.0
3 (NJ, Puerto Rico, Virgin Isl.)	12,561	28.7	57.6	79.8	0.7	12.3	4.9	2.4
4 (DE, PA)	14,715	40.9	58.9	86.6	0.6	8.4	2.5	2.0
5 (DC, MD, VA, WV)	17,513	34.3	56.6	83.8	0.9	9.8	3.1	2.4
6 (GA ,NC, SC)	24,281	27.1	56.2	84.1	0.8	9.6	4.1	1.4
7 (FL)	15,851	34.9	59.5	85.0	1.9	7.2	3.4	2.4
8 (AL, MS, TN)	15,812	31.8	55.8	86.9	0.7	8.3	2.7	1.5
9 (IN, KY, OH)	21,093	43.4	56.7	78.1	0.6	15.7	3.7	1.9
10 (IL)	13,395	41.8	56.3	83.5	1.1	10.2	3.4	1.8
11 (MI, MN, ND, SD, WI)	21,173	50.6	55.7	80.3	0.6	14.8	2.6	1.7
12 (IA, KS, MO, NE)	11,861	46.5	57.1	77.0	1.1	16.1	4.4	1.4
13 (AR, LA, OK)	11,858	33.2	56.0	85.6	0.4	9.7	3.1	1.3
14 (TX)	21,085	32.5	56.0	87.7	0.4	7.0	3.3	1.5
15 (AZ, CO, NM, NV, UT, WY)	11,713	41.3	55.4	82.5	0.7	10.1	4.6	2.1
16 (AK, ID, MT, OR, WA)	8,716	48.4	53.7	77.4	3.1	13.8	3.1	2.6
17, 18 (CA, HI)	31,915	37.6	56.8	84.8	0.1	9.4	3.4	2.2
Unknown Network	2,036	86.5	45.9	90.6	0.0	4.9	1.0	3.2
TOTAL	287,515	38.0	55.7	83.3	0.7	10.6	3.4	1.9

[a] *for December 31, 1996, only*

[b] *Percentages add to ~ 100 across for dialysis only*

Source: Reference Tables C.7, C.8, special analysis

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Table III-1

Although it is difficult to fully explain the observed regional differences, it is important to draw attention to them, since the observed variations from the national average may stimulate local or regional efforts to be directed towards improving patient access to all treatment modality options. Future studies need to address causes for these large regional differences in modality utilization.

One aspect of the activity in renal transplantation by year is shown in Figure III-4. This figure shows the numbers of patients on the waiting list for a cadaveric kidney transplant by year for 1987-96. In addition, the number of cadaveric donor transplantations performed during each of these years is shown. These data are based on the Annual Facility Survey completed by all Medicare-approved providers at the end of each year (see Reference Tables, Section I). The number of cadaveric transplants performed per year had increased steeply before 1986. Only a small increase can be observed since 1986. The relatively stable number of cadaveric transplants performed in recent years is in sharp contrast with the steeply increasing number of patients on the waiting list for cadaveric transplants. This widening gap between supply and demand for cadaveric kidneys from 1987 through 1996 (Figure III-4) has serious implications, since it prolongs the waiting period for ESRD patients desiring a cadaveric transplant. Thus, this figure clearly demonstrates the need for increased cadaveric organ donation in the United States.

The number of living donor transplants has increased slightly, though steadily, since 1989. Figure III-5 shows the total number of kidney transplants by year for the period 1988-1996. For the same period, the numbers of living related and living unrelated transplants are shown. These modes of transplantation have increased steadily, particularly

Patients on Waiting List for Kidney Transplant and Cadaveric Donor Transplants By Year, 1987-96

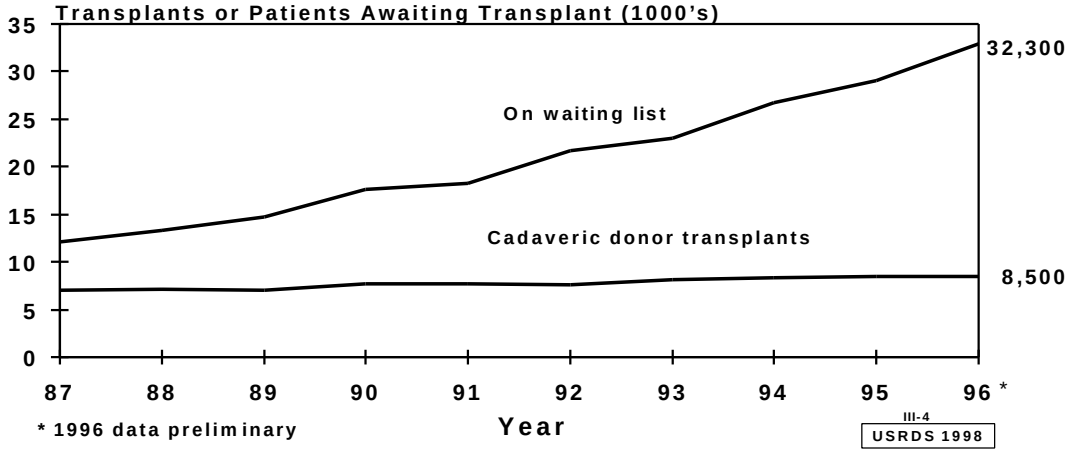

Figure III-4

Counts of patients on renal transplant waiting list and counts of renal transplants from a cadaveric donor by year, 1987-1996. Source: Reference Table I.9

the small group of biologically unrelated donor transplants. Living donor transplantation provides superior patient and graft survival (Chapter VII). More details about the transplant process and the demographics of transplant donors and recipients are given in Chapter VII.

Dose of Hemodialysis

Waves 1, 3, and 4 of the Dialysis Morbidity and Mortality Study collected data on random samples of United States hemodialysis patients. The data collected regarding the delivered dialysis dose from

Total Transplants and Transplants from Living Donors by Year, 1988-1996

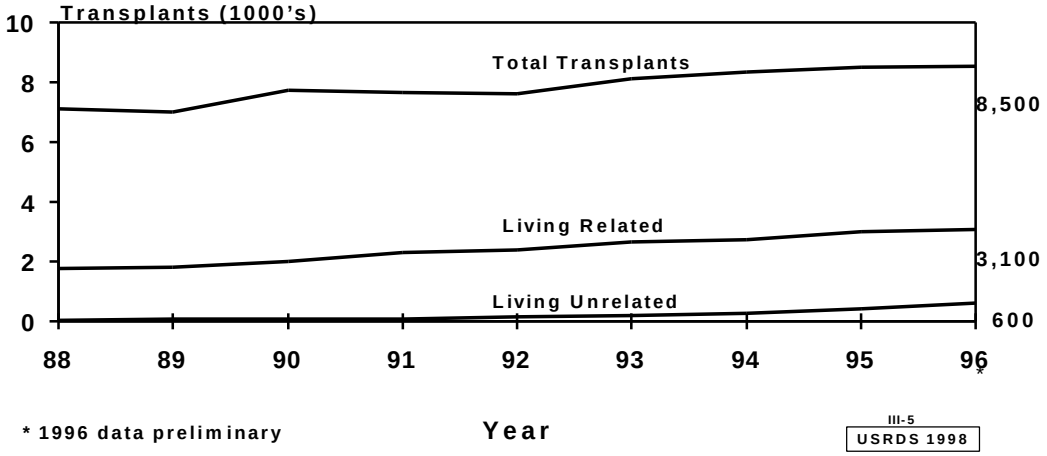

Figure III-5

Counts of renal transplants and counts of renal transplants from living related and living unrelated donors by year, 1988-1996. Source: Reference Tables I.9, F.1

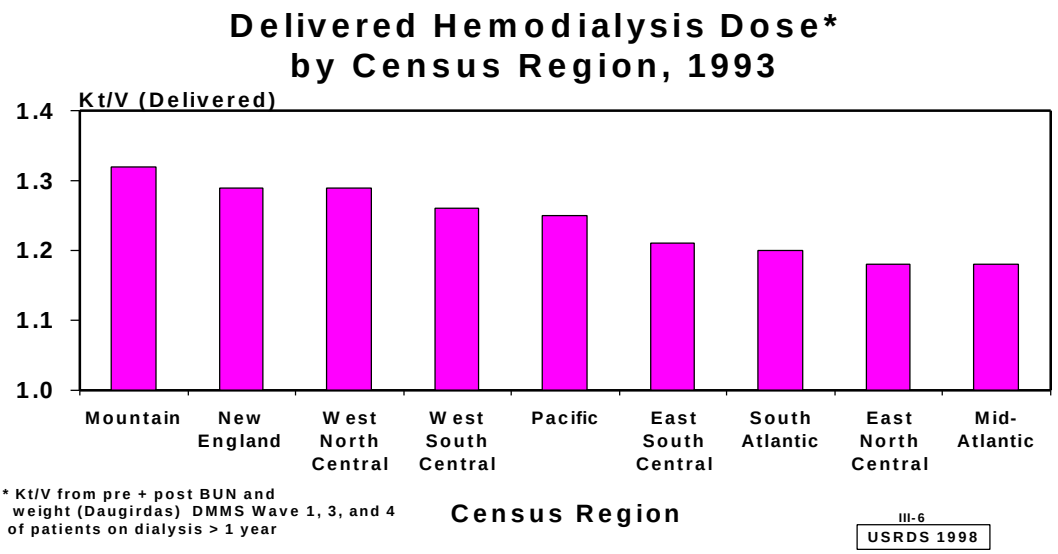

Figure III-6

Delivered hemodialysis dose from DMMS Wave 1, 3, and 4 by census region, 1993. Source: Special analysis

this study have been a rich source of information on this important treatment parameter. To minimize the role of residual renal function, which is measured infrequently, patients on dialysis for less than 1- year were excluded from analysis. Calculating the delivered dialysis dose from pre- and post-dialysis BUN and weight in this large national random sample of HD patients allows description of regional patterns.

Figure III-6 shows the delivered dialysis dose by census region for December 1993. The average Kt/V varied between 1.18 and 1.32. This variation appears large and is expected to affect mortality. Some of this

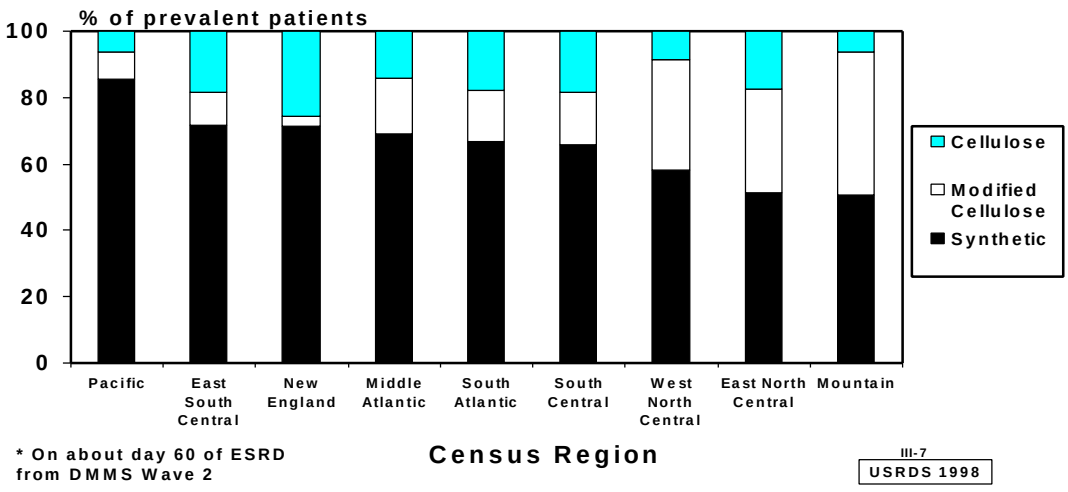

Figure III-7

Dialyzer membrane type (cellulose, modified cellulose, or synthetic) use among incident patients from DMMS Wave 2, 1996-97. Source: Special analysis

variation may be related to differences in dialysis prescription; however, differences in post-dialysis BUN sampling technique may also contribute. Further study is needed to elucidate reasons for the observed differences.

Membrane Type in Hemodialysis

DMMS has also been instrumental in gathering information about the membrane type used in hemodialysis. Figure III-7 shows data from the more recent Wave 2 of this USRDS Special Study. The membrane type in use has gradually changed over time from predominantly unmodified cellulose to predominantly synthetic membranes, as reported in the USRDS 1997 Annual Data Report. Among a random sample of patients starting HD therapy during 1996 and early 1997 the use of dialyzer membrane on about day 60 of ESRD is shown in Figure III-7. The use of synthetic membrane (mostly polysulfone) varied by geographic region from 50 to 86 percent, with wide variations in cellulose and modified cellulose membranes. Future studies should explore reasons for these large variations and evaluate previously reported correlations of membrane use and mortality (Hakim 1996).

Utilization of ESRD Modalities by Patient Characteristics

Wide variations in the utilization of the various treatment modalities existed by patient characteristics in 1996. Numerous factors influence the selection of treatment modality (Nissenson) and large differences are observed in international comparisons (Chapter XII). The access to transplantation has been studied (Gaylin; Bloembergen 1997; Webb) by demographic and other factors and is discussed further in Chapter VII.

Table III-2 describes modality use by age, sex, race, and cause of ESRD. Overall, center hemodialysis was the most common form of ESRD therapy (61.2 percent) among prevalent patients at the

ESRD Treatment Modality by Age, Sex, Race, and Primary Disease, 1996

Patient Characteristic	N	ESRD Modality (%)[a] Functioning Transplant	Center Hemo	Home Hemo	CAPD	CCPD	Other PD	Unknown
All Patients	**287,515**	**27.4**	**61.2**	**0.8**	**6.6**	**3.1**	**0.1**	**0.9**
Age 0-19	5,233	66.8	16.9	0.6	3.6	10.5	0.6	1.0
Age 20-44	74,567	47.9	41.0	0.6	6.7	3.1	0.1	0.6
Age 45-64	111,576	30.0	58.1	0.8	7.2	3.0	0.1	0.8
Age 65+	96,139	6.3	82.8	0.9	6.0	2.7	0.1	1.2
Male	155,514	30.2	58.9	0.8	6.1	3.0	0.1	0.8
Female	132,001	24.1	63.9	0.8	7.1	3.1	0.1	1.0
Native American	4,509	19.7	67.6	2.7	6.7	2.4	0.0	0.8
Asian/Pacific Islander	10,099	26.4	60.3	0.7	8.2	3.5	0.2	0.7
Black	91,981	15.3	75.5	0.6	5.3	2.3	0.1	0.8
White	175,745	34.3	53.3	0.8	7.1	3.4	0.1	0.9
Other/Unknown	5,181	18.7	68.9	0.5	7.1	3.2	0.4	1.1
Diabetes	93,601	17.8	70.1	0.7	7.2	3.1	0.1	1.0
Hypertension	70,199	15.5	73.8	0.8	6.1	2.7	0.1	0.9
Glomerulonephritis	51,176	43.3	44.6	0.8	7.2	3.3	0.1	0.6
Cystic Kidney Disease	13,593	47.8	40.7	1.0	6.6	3.2	0.1	0.5
All Other[b]	58,946	38.4	51.0	0.8	5.7	3.1	0.1	0.9

[a] *Percentages add across to ~ 100; Preliminary results.*

[b] *Includes other known, uncertain, and missing causes.*

Source: Reference Tables C5,C6

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Table III-2

end of 1996. Functioning renal transplant accounted for 27.4 percent, CAPD/CCPD for 9.7 percent and home hemodialysis for 0.8 percent of all ESRD patients treated at the end of 1996. Only 1.0 percent of prevalent patients was treated by other forms of PD or by uncertain or unknown dialysis. When CAPD/CCPD is re-analyzed as the percentage of only dialysis patients (i.e., by excluding the transplant percentages from the denominator), CAPD/CCPD accounted for 13.4 percent of dialysis, whereas all PD made up 14.7 percent of all dialysis when other PD/ unknown modality was counted as PD.

There are large differences in ESRD treatment modalities by race. As shown in Table III-2, in the category of functioning transplant, Blacks were under-represented by a wide margin when compared to the average of 27.4 percent. The differences for the fractions with functioning transplants are likely due to differences by race both in transplantation rates (Gaylin) and in transplant graft survival. Both issues are discussed in more detail in Chapter VII.

By age group, younger patients had a much higher fraction of functioning transplants than older patients did. Over two thirds (66.8 percent) of ESRD patients in the under-20 age-group had a functioning transplant, while there were 30.0 percent in the 45-64 age-group and only to 6.3 percent in the 65 year and older group with a functioning transplant. The percentage using CAPD/CCPD appeared relatively stable across age groups ranging from 2.7 to 10.7 percent. Center hemodialysis was used infrequently in the pediatric ages, accounting for only 16.9 percent of patients under age 20. In contrast, the oldest age group (>65 years) was primarily (82.8 percent) treated by center hemodialysis. Home hemodialysis showed increasing fractions in older age groups.

Home hemodialysis was used by 0.8 percent of all ESRD patients and 1.0 percent of all dialysis patients according to the USRDS/HCFA database. These percentages are higher than those reported in 1994 and 1995.

Males had a higher percentage of functioning transplants (30.2 percent) compared to females (24.1 percent), which agrees with the finding of greater transplantation rates for males in multivariate analyses (Gaylin; Webb). Males and females utilized CAPD/CCPD at similar percentages (13.0 and 13.4 percent, respectively) when analyzed for all dialysis patients rather than for all ESRD patients.

Table III-2 also shows treatment modality use for prevalent patients by major cause of ESRD. The fraction of patients with a functioning transplant was much higher for patients with glomerulonephritis and

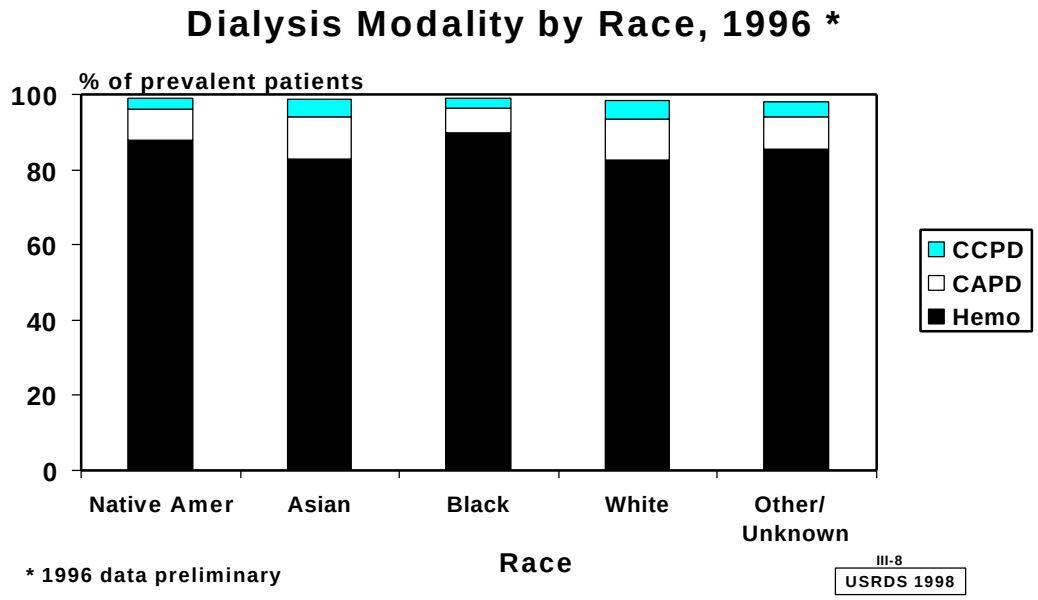

Figure III-8

Dialysis modality use by race, 1996. This figure excludes transplants. (Note: Rows do not add to 100% because home HD and unknown dialysis are not shown.) Source: Reference Table C.5

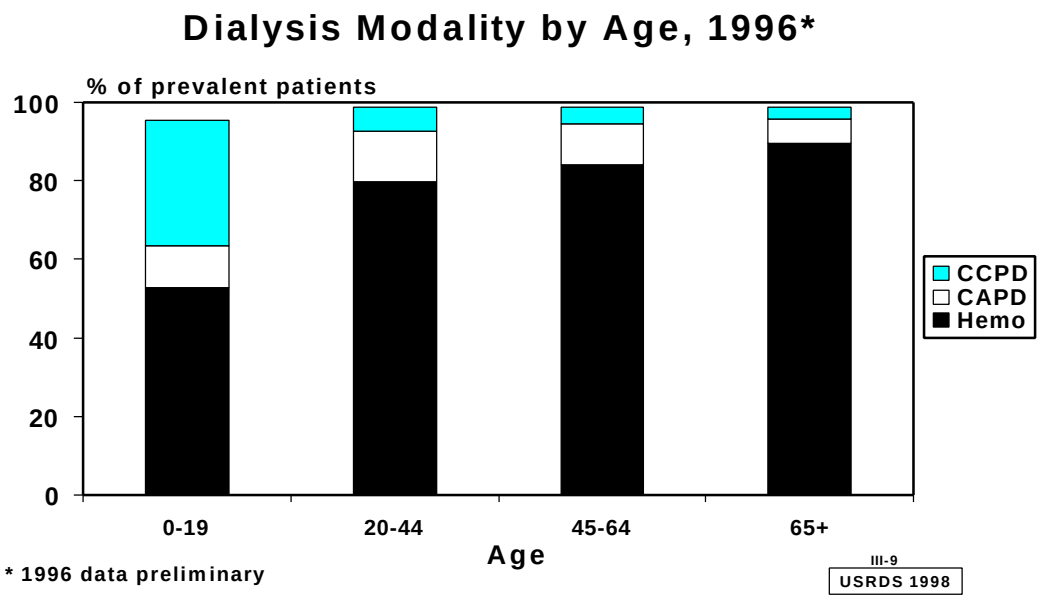

Figure III-9

Dialysis modality use by age, 1996. This figure excludes transplants. (Note: Rows do not add to 100% because home HD and unknown dialysis are not shown.) Source: Reference Table C.6

cystic kidney disease (43.3 percent and 47.8 percent respectively). In contrast, prevalent patients with diabetes or hypertension as a cause of ESRD had only 17.8 and 15.5 percent with a functioning transplant, respectively. Some of the differences may be related to the age distribution by cause of ESRD and higher transplant rates for younger age groups. The use of CAPD/CCPD appears to be similar by diagnosis group in this table.

Utilization of Dialytic Modalities by Patient Characteristics

After exclusion of patients with functioning renal transplant (overall approximately 27 percent), the utilization of the three major dialytic modalities can be studied. Figure III-8 shows the distribution of HD, CAPD, and CCPD by race group. For all groups, HD predominates. The patterns for Whites and Asians are quite similar with relatively large fractions of CAPD and also CCPD. These two forms of PD are utilized to a much smaller extent among Black dialysis patients, while Native Americans have an intermediary pattern. Numerous factors influence the choice of dialytic modality including distance to a center, independence, personal preference, education, socio-economic parameters, and co-morbid factors (USRDS 1992 ADR).

Patient age is an additional factor influencing the use of dialytic modalities. Figure III-9 shows that the pattern for pediatric patients is very different from that of adult patients. In children, PD is used in almost half of the dialysis patients and mostly as CCPD. More detail is provided by subgroups of age in the chapter on pediatric ESRD (Chapter VIII).

For adult patients there is a pattern for older age to be associated with decreasing use of CAPD and of CCPD, while HD use is increasing with age. These recent patterns for 1996 need to be considered preliminary and future trends need to be monitored to see the effect of the increasing utilization of CCPD and greater attention to dose of PD. Outcome studies from the DMMS Wave 2 for over 4,000 new patients treated with HD or PD will be of interest to assist in choosing the treatment modality best suited for certain groups of patients.

References

Bloembergen WE, Port FK, Mauger EA, Wolfe RA. A comparison of mortality between patients treated with hemodialysis and peritoneal dialysis. J Am Soc Nephrol 1995a; 6: 177-183.

Bloembergen WE, Port FK, Mauger EA, Wolfe RA. A comparison of cause of death between patients

treated with hemodialysis and peritoneal dialysis. J Am Soc Nephrol 1995b; 6: 184-191.

Bloembergen WE, Mauger EA, Wolfe RA, Port FK. The association of gender and access to cadaveric renal transplantation. Am J Kidney Dis 1997; 30:733-738.

Braun WE. Long-term complications of renal transplantation. Kidney Int 1990; 37:1363-1378.

Buoncristiani U, Fagugli R, Quintaliani G, Kulurianu H. Rationale for daily dialysis. Home Hemodial Int 1995, 1:12-18..

Canada-USA (CANUSA) Peritoneal Dialysis Study Group: Adequacy of dialysis and nutrition in continuous peritoneal dialysis: Association with clinical outcomes. J Am Soc Nephrol 1996; 7: 198-207.

Daugirdas JT. Second generation logarithmic estimates of single-pool variable volume of Kt/V: An analysis of error. J Am Soc Nephrol 1993; 4:1205-1213.

Diaz-Buxo JA. The place for automated peritoneal dialysis. Adv Perit Dial 1992; 8:98-101.

Evans RW, Blagg CR, Bryan FA. A social and demographic profile of hemodialysis patients in the United States. JAMA 1981; 245:491.

Evans RW, Manninen DL, Garrison LP, Jr., Hart LG, Blagg CR, Gutman RA, Hull AR, Lowrie EG. The quality of life of patients with end-stage renal disease. N Engl J Med 1985; 312:553-559.

Fox RC, Swazey JP. The Courage to Fail: A Social View of Organ Transplants and Dialysis. 2d rev. ed. Chicago: University of Chicago Press, 1979.

Gaylin DS, Held PJ, Port FK, Hunsicker LG, Wolfe RA, Kahan BD, Jones CA, Agodoa LYC. The impact of comorbid factors on access to renal transplantation. JAMA 1993; 269:603-608.

Golper, TA, Brier, ME. Racial differences in the practice of peritoneal dialysis in Network 9. Adv Perit Dial 1993; 9:161-164.

Habach G, Port FK, Mauger E, Wolfe RA, Bloembergen WE. Hospitalization among US dialysis patients: Hemodialysis versus peritoneal dialysis. J Am Soc Nephrol 1995; 5: 1940-1948.

Hakim RM, Held PJ, Stannard D, Wolfe R, Port FK, Daugirdas JT, Agodoa L: The effect of the dialysis membrane on mortality of chronic hemodialysis patients. Kidney Int 1996; 50: 566-570.

Hamilton D. Kidney transplantation: a history. In: Morris PJ, ed. Kidney Transplantation: Principles and Practice. Grune and Stratton, London, 1984.

Health Care Financing Administration. Proposed rule: prospective reimbursement for dialysis services. Fed Reg 1982; 42:6556-6575.

Held PJ, Kahan BD, Hunsicker LG, Liska D, Wolfe RA, Port FK, Gaylin DS, Garcia JR, Agodoa LYC, Krakauer H. The impact of HLA mismatches on the survival of first cadaveric kidney transplants. N Engl J Med 1994a; 331: 765-770.

Held PJ, Carroll CE, Liska DW, Turenne MA, Port FK. Hemodialysis therapy in the United States: What is the dose and does it matter? Am J Kidney Dis 1994b; 24: 974-980.

Held PJ, Port FK, Wolfe RA, Stannard DC, Daugirdas JT, Bloembergen WE, Greer JW, Hakim RM. The dose of hemodialysis and patient mortality. Kidney Int 1996; 50:550-556.

Khan BD, Van Curen CT, Flechner SM, Jarowenko M, Yasumura T, Rogers AJ, Yoshimura N, LeGrue S, Drath D, Kerman RH. Clinical and experimental studies with cyclosporine in renal transplantation. Surgery 1985; 97:125-131.

Merion RM, White DJG, Thiru S, Evans DB, Calne RY. Cyclosporine: five years' experience in cadaveric renal transplantation. N Engl J Med 1984; 310:148-154.

Nissenson AR, Prichard SS, Chen IKP, Gokal R, Kubota M, Maiorca R, Riella MC, Rottembourg J, Stewart JH. Non-medical factors that impact on ESRD modality selection Kidney Int 1993; 43 (Suppl 40):S1-S8.

Nolph KD, Jensen RA, Khanna R, Twardowski ZJ. Weight limitations for weekly urea clearances using various exchange volumes in continuous ambulatory peritoneal dialysis. Perit Dial Int 1994; 14:261-264.

Opelz G. For the Collaborative Transplant Study. HLA matching and transplant survival: effect of HLA matching in 10,000 cyclosporine-treated cadaver kidney transplants. Transpl Proc 1987; 19:641-646.

Owen WF, Lew NL, Liu Y, Lowrie EG, Lazarus JM. The urea reduction ratio and serum albumin concentration as predictors of mortality in patients undergoing hemodialysis. N Engl J Med 1993; 329: 1001-1006.

Peters PC. Dialysis and transplantation: the past. Semin Nephrol 1982; 2:79-89.

Pierratos R, Uldall M, Ouwendyk R, Francoeur R, Vas S. Two Year Experience with Slow Nocturnal Hemodialysis (SNHD). J Am Soc Nephrol 1996;7: 1417.

Prottas JM. Shifting responsibilities in organ procurement: a plan for routine referral. JAMA 1988; 260:832-833.

Rettig RA. The Federal government and social planning for end-stage renal disease: past, present, and future. Semin Nephrol 1982; 2:111-133.

Rettig RA, Levinsky RA (eds). Kidney Failure and the Federal Government, National Academy Press, Washington DC, 1991.

Twardowski ZJ. Peritoneal dialysis: glossary III. Perit Dial Int 1990; 10:173-175.

United States Renal Data System. Characteristics of dialysis prescription in the U.S., 1986-87. Am J Kidney Dis 1992a; 20 (Suppl.2):39-47.

United States Renal Data System. Patient selection to peritoneal dialysis versus hemodialysis according to comorbid conditions. Am J Kidney Dis 1992; 20(Suppl.2): 20-26.

United States Renal Data System. USRDS 1993 Annual Data Report. National Institutes of Heath, National Institute of Diabetes and Digestive and Kidney Diseases. Bethesda, MD. 1993.

United States Renal Data System. USRDS 1995 Annual Data Report. National Institutes of Health, National Institutes of Diabetes and Digestive and Kidney Diseases. Bethesda, MD. 1995.

Wagner K, Herget S, Heemann V. Experimental and clinical experience with the use of tacrolimus (FK-506) in kidney transplantation. Clin Nephrol 1996; 45: 332-335.

Webb RL, Port FK, Gaylin DS, Agodoa LY, Greer J, Blagg CR. Recent trends in cadaveric renal transplantation. In: Terasaki PI, ed. Clinical Transplants 1990. UCLA Tissue Typing Laboratory, Los Angeles, 1991: 75-87.

Woods JD, Port FK, Stannard D, Blagg CR, Held PJ. Comparison of mortality with home hemodialysis and center hemodialysis: A national study. Kidney Int 1996; 49: 1464-1470.

Young EW, Bloembergen WE, Woods JD, Emmert G, Port FK, Wolfe RA, Jones CA, Held PJ: Iron use among erythropoietin-treated U.S. hemodialysis patients. J Am Soc Nephrol 1996; 7, 1469.