National Surveillance of Dialysis-Associated Diseases in the United States, 1997

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SUMMARY
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- See the **Summary Table** on the following page.

- This survey was performed yearly during 1982-1997 by the Centers for Disease Control and Prevention (CDC) and the Health Care Financing Administration (HCFA).

- **This survey was NOT performed in 1998**. We are currently in the process of revising the survey which will be performed again at the end of 1999.

- **Hepatitis B vaccine use.** For 1997, the survey question was changed to include vaccine receipt among patients treated, or staff members working, during the last week of the year. Previous surveys had included patients and staff members from throughout the year. In part because of this change in methodology, the percent vaccinated increased to 87% among staff and 47% among patients.

- **Hepatitis B vaccine efficacy**. A case-control study based on data from the 1995 survey showed that hepatitis B vaccine was 70% effective in preventing newly-acquired hepatitis B virus infection in chronic hemodialysis patients (Am J Kidney Disease, 1999;32:1-6).

- **Hepatitis C virus**. In 1997, routine testing for antibody to hepatitis C virus (anti-HCV) was performed on staff at 25% of centers and on patients at 48% of centers. At centers testing, anti-HCV was found in 1.6% of staff and 9.3% of patients.

- **Vascular access**. During 1995-1997, the percentage of patients dialyzed through central catheters increased from 13% to 17%. This trend is worrisome since infections and antimicrobial use are higher in patients dialyzed through catheters.

- **Vancomycin use**. The median percentage of patients reported to have received vancomycin during December decreased from 5.6% in 1995 to 4.5% in 1998. We hope that this is due to efforts of personnel at many dialysis centers to avoid unnecessary vancomycin use, and that such efforts will be continued and/or expanded.

- **Vancomycin-resistant enterococcus (VRE)**. The percent of centers reporting one or more patients infected or colonized with VRE increased from 11.5% in 1995 to 29.8% in 1996. This most likely represents increased recognition, rather than an actual increase, of VRE.

- **Voluntary surveillance for bacteremia and vascular access infections.** Because of the importance of these issues, CDC has developed a voluntary surveillance system which will be available for general use in March 1999. See Appendix V or contact Elaine Miller at 404-639-6413 for more information.

SUMMARY TABLE

National Surveillance of Dialysis-Associated Diseases in the United States, 1995-1997

Category	Unit of Measurement	Year		
		1995	1996	1997
Centers responding to survey	number of centers	2,647	2,808	3,077
Patient:staff ratio	median	4.2	3.9	4.1
Reuse dialyzers	% of centers	77	81	82
Total staff, all centers	number of staff	54,194	59,882	63,054
Hepatitis B vaccination, staff	% of staff	82	82	87*
Test staff for anti-HCV	% of centers	16	20	25
Anti-HCV prevalence, staff	% of staff	2.0	1.3	1.6
Total patients, all centers	number of patients	224,954	228,527	253,001
Vascular access Arteriovenous graft	% of patients	65	63	60
Arteriovenous fistula		22	22	23
Central catheter		13	15	17
Hepatitis B vaccination, patients	% of patients	35	36	47*
Test patients for anti-HCV	% of centers	39	44	48
Anti-HCV prevalence, patients	% of patients	10.4	10.1	9.3
HIV infection	% of patients	1.4	1.4	1.3
AIDS	% of patients	0.7	0.7	0.6
Vancomycin use, December	% of patients, median	5.6	5.1	4.5
Vancomycin-resistant enterococcus (VRE)	% of centers with ≥ 1 patient	11.5	21.3	29.8
Methicillin-resistant *Staphylococcus aureas* (MRSA)		40	48	56
Active tuberculosis		7.9	7.4	6.8

Anti-HCV denotes antibody to hepatitis C virus

* Note differences in methodology in 1997 as explained in the Summary

INTRODUCTION

The Centers for Disease Control and Prevention (CDC) has been conducting surveillance of hemodialysis-associated hepatitis since the early 1970s (1), when CDC reported that the incidence of HBV infection among patients and staff during 1972-1974 had increased by more than 100% to 6.2% and 5.2%, respectively. These early surveys had only a 50% to 65% response rate of centers listed by the National Dialysis Registry. In an effort to obtain a higher response rate, and thus more complete information, CDC initiated a cooperative program with the Health Care Financing Administration (HCFA) in 1976 that provided for a questionnaire from CDC to be included in HCFA's annual facility survey. As a result of this collaboration, the response rates to the CDC questionnaire now exceed 90%.

Since collaboration with HCFA was begun, the CDC survey has been performed for calendar years 1976, 1980, and 1982 to 1997 (2-12). Other hemodialysis-associated diseases and practices not related to hepatitis have been included over the years, and the questionnaire is continually updated to collect data about hemodialysis practices and hemodialysis-associated diseases of current interest and importance. The objectives of this yearly survey are to (a) determine the frequency with which certain hemodialysis practices, including measures designed to prevent disease, are used, (b) determine the frequency of hemodialysis-associated complications and diseases, and (c) use this information to suggest further measures to prevent complications and disease in hemodialysis patients and staff.

METHODS

In conjunction with the annual facility survey performed by HCFA for calendar year 1997, CDC distributed a questionnaire (see Appendix I) by mail to all 3,228 chronic hemodialysis centers licensed by HCFA. All responses were reviewed, and approximately 20% of centers that responded provided inaccurate or inconsistent responses and were contacted for clarification of responses. The survey covered:

a. hemodialysis practices, such as the types of dialysate (acetate vs bicarbonate) used, use of high flux (dialyzer UFR $\geq$20) and high efficiency (dialyzer UFR 10-19) dialysis, reuse of disposable dialyzers, type of vascular access, procedures for cleaning and disinfection of dialysis equipment, and management of patients

positive for hepatitis B surface antigen (HBsAg).

b. the results of testing patients and staff for HBsAg, antibody to HBsAg (anti-HBs), and antibody to hepatitis C virus (anti-HCV).

c. the number of patients who received vancomycin in December 1997, and whether ≥1 patient with vancomycin-resistant enterococcus (VRE), methicillin-resistant *Staphylococcus aureus* (MRSA), or active tuberculosis requiring treatment was dialyzed during 1997.

d. the occurrence of other hemodialysis-associated complications and diseases such as hepatitis C/non-A non-B hepatitis, vascular access infections, bacteremia, pyrogenic reactions and new dialyzer syndrome.

e. the number of patients with human immunodeficiency virus (HIV) infection and policies for testing patients for HIV.

The incidence of hepatitis B virus (HBV) infection was defined as the percentage of all patients or staff present in the facility in 1997 who became positive for HBsAg during 1997. The prevalence rates of chronic HBV infection and immunity were defined as the percentage of all patients or staff present in the facility during the last week of December 1997 who were positive for HBsAg or anti-HBs, respectively. All patients or staff (i.e., regardless of their susceptibility to HBV infection) were included in calculations of the incidence and prevalence of HBV infection. Among groups of dialysis centers, the median percent of patients receiving vancomycin in December 1997 was calculated by weighting each dialysis center by the number of patients treated.

Information on dialysis center location and ownership was obtained from a data tape supplied by HCFA. The results of the 1997 survey were compared to results from previous surveys.

Proportions were compared with the chi square or Fisher's exact test; when adjustment for confounding variables was required, the Mantel-Haenszel test or logistic regression was used. All p-values were two-tailed; a p-value of <0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Questionnaires were returned by 3,077 (95%) of 3,228 centers. These 3,077 centers

represented 253,001 patients and 63,054 staff members. During 1985-1997, the median number of patients per center increased from 50 to 71, the median number of staff per center increased from 15 to 17, and the median patient to staff ratio increased from 3.4 to 4.1 (Table 1). During the same period, the proportion of freestanding (i.e., located outside the hospital) centers increased from 56% to 77%, and the proportion of centers operating for profit increased from 46% to 70% (Table 2).

In 1997, 84% of centers used a record-keeping system to track dialysis-associated diseases in patients. Among those using a formal system, 14% used a computer database, 45% used written records other than patient charts, and 41% used both computer and written records. Of centers using a formal record-keeping system, 82% included HBsAg, 78% vascular access infections, 72% pyrogenic reactions, 74% anti-HBs, 70% bacteremia, and 51% anti-HCV.

Dialysis Practices and Reuse of Disposables

In 1997, 13% of centers reported using only conventional dialyzer membranes, of which most were either cuprophan or cellulose acetate, and 87% reported using high flux dialyzer membranes, of which most were polysulfone, on at least some of their patients (Table 3).

In 1997, 63% of centers reported treating some patients by high flux dialysis, an increase from 15% in 1987, and 70% reported treating some patients by high efficiency dialysis (Table 4). During the same period, increases in numbers of patients treated with high flux and high efficiency dialysis also occurred (Table 4).

During 1990-1997, all centers treated water used for dialysis; in comparison, 5% of centers reported using untreated water for dialysis in 1980 (Table 5). The use of reverse osmosis (RO) for treatment of water, either alone or with other modalities such as deionization (DI), increased from 26% in 1980 to 97% in 1997.

During 1976-1986, the percentage of centers that reported reuse of disposable dialyzers increased from 18% to 82% (Table 6). Among centers that reused disposable dialyzers, the average (median 15) and maximum (median 30) number of reuses changed little during 1991-1997 (Table 7). Sixty-two percent of centers reported using only an automated system for reprocessing dialyzers (vs 59% in 1992), 34% only a manual system (vs 33% in 1992), and 5% both systems.

During 1983-1997, the proportion of centers using formaldehyde for reprocessing dialyzers decreased from 94% to 34% (Table 8). The percentage of centers using peracetic acid-hydrogen peroxide (Renalin™[1], Minntech Corporation, Minneapolis, MN) for reprocessing dialyzers increased from 5% in 1983 to 56% in 1997, while the use of a glutaraldehyde-based germicide (Diacide™, Alden Scientific, Winthrop, MA) increased from less than 1% to 7% during the same period. In 1997, 75 (3%) centers used heat to disinfect dialyzers between reuses (versus 17 [0.9%] in 1994).

During December 25-31, 1997 (the time frame for which this information was requested),
59.7% of patients were dialyzed through an arteriovenous graft, 22.8% through an arteriovenous fistula, and 17.5% through a temporary or permanent central catheter (Table 9). Since 1995, the percent of patients dialyzed through catheters increased from 12.7% to 17.5% (Table 9). Among the ESRD networks, use of fistulas (the most desirable access type) ranged from 14.7% to 33.9% and central catheters (the least desirable access type) from 11.1% to 24.1% (Table 10).

Hepatitis B Vaccine and Prevalence of Anti-HBs

During 1983-1996, the proportion who had ever received at least three doses of hepatitis B vaccine increased from 5%-36% among patients and from 26%-82% among staff; in 1997, the figures were 46.7% for patients and 86.6% for staff members (Table 11). Note that the survey questions on vaccination were changed for the 1997 survey, and referred only to patients treated or staff members who worked during the last week of the year (footnote, Table 11). The vaccination data may be more accurate for 1997 than for previous years, since determination of vaccine status at the end of the year, at the time the survey is completed, should be easier and more accurate than determining vaccine status for patients treated (or staff members who worked) at any time during the year, as was requested in previous surveys. Among the ESRD networks, hepatitis B vaccination among patients in 1997 varied from 29.9% (network 18) to 58.0% (network 12) (Table 12). The largest absolute increase in vaccination during 1996-1997

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[1] Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

occurred in networks 3 and 14 (Table 12).

Incidence and Prevalence of HBV Infection

In 1997, 83% of centers reported screening patients monthly for HBsAg, 1% bimonthly, 8% quarterly, 3% semiannually, and 3% never. During 1976-1997, the incidence of HBV infection decreased from 3.0% to 0.05% among patients and from 2.6% to 0.05% among staff members, with the largest decline in both groups occurring during 1976-1980; during the same period, the prevalence of HBsAg-positivity among patients and staff members declined from 7.8% to 0.9% and 0.9% to 0.4%, respectively (Tables 13 and 14). In 1997, 3.3% of centers reported ≥ 1 patient with newly acquired (incident) HBV infection, 24.1% of centers reported ≥ 1 patient with chronic (prevalent) HBV infection, and 25.5% of centers treated ≥ 1 patient with either acute or chronic HBV infection.

In 1997, there was no difference in HBV incidence between centers using a separate room and dedicated dialysis machine, with or without separate staff members, to treat HBsAg-positive patients and centers using only a dedicated machine and no separation practices (Table 15). As in previous years, reuse of dialyzers was not associated with any increased risk of HBV infection in either patients or staff (data not shown). In 1997, 71% of centers accepting HBsAg-positive patients used both a separate room and dedicated dialysis machine to treat such patients (vs 78% in 1989 and 70% in 1993).

This national surveillance project was initiated primarily because of the high incidence of HBV infection reported among hemodialysis patients and staff in the early 1970s (1). Hemodialysis patients may acquire HBV infection from community sources, or from transmission in hemodialysis centers due to inadequate infection control precautions (13-15) or to accidental breaks in technique (16). Factors contributing to the decline in HBV infection since the 1970s have been previously reviewed (9). A logistic regression model of data pooled from 1992-1994 showed the following independent risk factors for acute HBV infection: treatment of an acute or chronic HBV-infected patient the previous year; accepting HBsAg-positive patients and not treating these patients with a separate room and machine; having <50% patients vaccinated against HBV; and receipt of dialysis in California, New Jersey, New York, or Texas (10). A case-control study based on the 1995 survey showed that hepatitis B vaccine was

approximately 70% effective in preventing newly acquired HBV infection (17).

HBsAg-positive patients at a dialysis center are a potential source of nosocomial transmission. Some centers with a policy of using a separate room and machine for HBsAg-positive patients may share equipment and staff between infected and susceptible patients, risking cross contamination. In 1994, five outbreaks of HBV infection among hemodialysis patients were reported from three states (18). In some instances, failure to perform routine screening for HBsAg and/or to routinely review screening results led to the failure to recognize HBsAg-positive patients and isolate them. In other instances, HBsAg-positive patients were isolated in separate rooms with separate machines, but shared staff and equipment with susceptible patients. Thus the low incidence of HBV infection among dialysis patients overall does not preclude the need to continue to adhere to the specific recommendations for preventing transmission of HBV in this setting (Appendices II and III).

Hepatitis C (Non-A Non-B Hepatitis)

The incidence of non-A non-B hepatitis in 1997 was reported to be 0.2% among patients and 0.07% among staff (Table 16).

In 1997, 48% of centers tested patients for anti-HCV, and the prevalence of anti-HCV at these centers was 9.3% (Table 17). Among the ESRD networks, anti-HCV prevalence ranged from 5.5% to 12.4%; networks with higher anti-HCV prevalence rates were more likely to test their patients for anti-HCV (Table 18). Anti-HCV prevalence was 9.3% at both centers that reused and did not reuse dialyzers.

In 1997, 25% of centers tested staff for anti-HCV, and the prevalence of anti-HCV at these centers was 1.6% (Table 17). Anti-HCV prevalence among staff was similar at centers that reused (1.6%) and did not reuse (1.7%) dialyzers ($p=0.9$).

Outbreaks of non-A, non-B hepatitis, a disease primarily transmitted by the bloodborne route, have been reported among hemodialysis patients (19,20). The results of the 1997 survey show that reported incidence rates of non-A non-B hepatitis continue at low levels among patients and staff. However, difficulty in diagnosing this syndrome, including the fact that approximately 75% of cases of non-A non-B hepatitis in healthy adults are asymptomatic, may make these reported rates unreliable. Recommendations for detection and prevention of non-A

non-B hepatitis and hepatitis C in hemodialysis units have been published (21,22) (Appendix IV).

In the United States, 80-90% of cases of non-A non-B hepatitis are reportedly caused by HCV (23). Interpretation of the results of enzyme immunoassays (EIAs) that screen for anti-HCV is limited by several factors: 1) these assays will not detect anti-HCV in 10%-20% of hemodialysis patients infected with HCV; 2) these assays do not distinguish between acute and chronic or past infection; 3) in the acute phase of HCV infection, there may be a prolonged interval between onset of illness and seroconversion; and 4) in populations with a low prevalence of infection, the rate of false positivity for anti-HCV is high, and the positive predictive value of the tests is low.

Monthly determination of liver enzymes, rather than of anti-HCV, is recommended for screening for both non-A non-B hepatitis and hepatitis C (21,22). This recommendation has been made because non-A non-B hepatitis can be caused by agents (viral or nonviral) other than HCV; and, if caused by HCV, anti-HCV may not be detectable or may be found only after a prolonged interval following exposure or onset of hepatitis (24-28). Thus, acute non-A, non-B hepatitis remains a diagnosis of exclusion (29), even with the availability of a licensed test for anti-HCV. Issues surrounding prevention of HCV transmission in long-term hemodialysis settings are currently undergoing discussion, and an update of recommendations is being considered.

Vancomycin Use and Vancomycin-Resistant Enterococci (VRE)

The median percent of patients receiving vancomycin in December decreased from 5.6% in 1995 to 4.5% in 1997. In 1997, vancomycin use was higher at smaller centers, centers owned by governments, and at centers treating a higher percentage of patients with central catheters (Table 19). Additionally, vancomycin use varied among the ESRD networks from 2.7% of patients in network 17 to 6.9% of patients in network 3 (Table 20).

The percentage of centers reporting $\geq$1 patients with VRE increased from 11.5% (303/2,634) in 1995 to 29.8% (918/3077) in 1997. In 1997, VRE was reported more often from centers that treated patients with MRSA, government centers, and hospital (vs freestanding) centers (Table 21). Among the ESRD networks, reporting of VRE varied from 13.3% (network

7) to 57.7% (network 1) (Table 22).

VRE, first reported in 1989 among renal failure patients in England (30), has emerged as a major nosocomial pathogen. At 189 hospitals reporting to CDC's National Nosocomial Infections Surveillance (NNIS) system, the percentage of enterococcal isolates from all body sites that were resistant to vancomycin increased from 0.3% in 1989 to 10.5% in 1997 (31,32). Numerous outbreaks have been reported (33,34). In three studies of hospitalized patients infected or colonized with VRE conducted by CDC, patients receiving dialysis comprised 12% (3/26) (35) (CDC, unpublished data), 17% (8/46) (34), and 22% (20/93) (36); CDC, unpublished data) of such patients. A recent surveillance study at 49 hospitals showed that receipt of hemodialysis or peritoneal dialysis was an independent risk factor for VRE bacteremia (37). Risk factors for VRE include severity of illness and receipt of antibiotics, particularly vancomycin (38). "Recommendations for Preventing the Spread of Vancomycin Resistance," including guidelines for prudent vancomycin use, have been published (38) and additional information specific to dialysis units is provided in Appendix II.

The data reported here on treatment of VRE patients are limited in that the survey does not distinguish between clinical infection and colonization (i.e., positive culture for the organism without invasive infection). Centers that perform surveillance for VRE with stool or rectal cultures, or that treat patients from hospitals where such culturing is done, would be more likely to report VRE colonized patients, introducing "surveillance bias."

Methicillin-Resistant *Staphylococcus Aureus* (MRSA)

The percentage of centers reporting $\geq$1 patients with MRSA increased from 40.3% (1,056/2,620) in 1995 to 55.9% (1,720/3,077) in 1997.

S. aureus is the most common cause of vascular access infections and related bacteremias in hemodialysis patients (39,40). At hospitals reporting to the NNIS system, the percentage of *S. aureus* isolates resistant to methicillin (i.e., MRSA) increased from 2.4% in 1975 to 29% in 1991 (41). Knowledge of the MRSA prevalence is important in decisions regarding antibiotic choice, which in turn is important in preventing the spread of resistance to vancomycin and other antibiotics (Appendix II).

Tuberculosis

One or more patients with active tuberculosis requiring treatment was reported by 6.8% (210/3,077) of centers.

The 1997 survey studied the prevalence, rather than the incidence, of active tuberculosis. Several studies at individual dialysis centers have reported high incidence rates of tuberculosis (42-44). A recent study reported small numbers of patients with active TB in New Jersey during 1995-1995, with TB rates higher than in the New Jersey general population (45) (unpublished data, Theresa Simon, 1996).

It is thought that ESRD patients who have tuberculous infection without active disease are more likely to progress to active tuberculosis because of ESRD-associated immunodeficiency. Therefore, CDC recommends that ESRD patients be screened (i.e., tuberculin skin tested using the Mantoux technique) for tuberculosis and given preventive therapy if they are found to be infected (46,47). CDC also recommends that medical care facilities assess the risk of nosocomial transmission of *Mycobacterium tuberculosis* and develop a tuberculosis control plan appropriate for the level of risk (48).

Bacteremia and Vascular Access Infections

Centers having a formal system to track bacteremia and vascular access infections were asked to report the number of these events during 1997. To calculate rates per patient-year, we used the number of patients dialyzed at each center during December 25-31, 1997 as an estimate of the average daily census during 1997; this number would then equal the total patient-years for that unit during the year. Among 1,973 centers, the reported bacteremia rate was 10.1 per 100 patient-years (13,985/138,559). Among 1,983 centers, the reported rate of vascular access infection without bacteremia was 9.5 per 100 patient-years (12,949/135,926).

Bacteremia in hemodialysis patients may be secondary to vascular access infections or to infections at other sites (e.g., lung, gastrointestinal tract, or genitourinary tract) (49). Rates of bacteremia have been reported to vary from 8.4 to 18.4 episodes per 100 patient-years (39,40,50-52).

Pyrogenic Reactions

Twenty-one percent of centers reported pyrogenic reactions in the absence of septicemia among their patients (Table 23).

Since 1989, when changes were made in the survey instrument, 19-22% of centers have reported pyrogenic reactions in the absence of septicemia. Possible mechanisms by which certain practices (reuse of dialyzers; use of bicarbonate dialysate, high flux dialyzer membranes, or high flux dialysis) may cause pyrogenic reactions have been presented in previous reports (6-8).

New Dialyzer Syndrome

New dialyzer syndrome was reported in patients by 23% of centers in 1997. The proportion reporting this complication has decreased from 43% of centers in 1984 (Table 24).

Human Immunodeficiency Virus Infection

During 1985-1997, the percentage of centers that reported providing dialysis for patients with HIV infection increased from 11% to 39% (Table 25). In 1997, 1.3% (range among the networks 0.2%-3.1%) of patients were reported to have HIV infection and 0.6% (range among the networks 0%-1.4%) to have AIDS (Tables 25-26). Since a minority of centers routinely test for HIV (see below), these figures may be underestimates.

Since 1989, there have been small decreases in the proportions of centers testing patients for anti-HIV on admission (28% in 1989 and 22% in 1997) or routinely after admission (17% in 1989 and 12% in 1997).

Transmission of HIV in dialysis centers has been reported in developing countries (53-55), and an instance of transmission of HIV from a dialysis patient with known HIV infection to a staff member via a needlestick injury has been reported in the U.S. (CDC, unpublished data). Otherwise, there have been no reports of nosocomial HIV transmission in dialysis centers, and the likelihood of such transmission appears to be low when standard barrier or universal precautions are practiced. Patients with HIV infection can receive either hemodialysis or peritoneal dialysis without additional precautions, such as isolation from other patients by either room or machine (56,57). Additionally, routine testing of dialysis patients or staff for anti-HIV for purposes of infection control is not necessary.

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Table 1

Numbers of Hemodialysis Centers, Patients, and Staff Surveyed,
United States, 1985-1997

		No. of Patients		No. of Staff		Median
Year	No. of Centers	Total	Median Per Center	Total	Median Per Center	Patient/Staff Ratio
1985	1,250	80,151	50	24,034	15	3.4
1986	1,350	87,505	51	25,044	15	3.5
1987	1,486	97,225	52	27,123	14	3.6
1988	1,586	107,804	55	28,501	14	3.7
1989	1,726	122,734	56	32,486	15	3.8
1990	1,882	140,608	59	36,907	16	3.8
1991	2,046	155,877	63	40,298	16	3.8
1992	2,170	170,028	64	43,535	17	3.9
1993	2,304	180,341	65	45,943	16	3.9
1994	2,449	206,884	72	50,353	17	4.1
1995	2,647	224,954	71	54,194	17	4.2
1996	2,808	229,527	70	59,882	18	3.9
1997	3,077	253,001	71	63,054	17	4.1

Table 2
Location and Ownership of Hemodialysis Centers,
1985-1997, United States

Percent of Hemodialysis Centers

	Location		Ownership		
Year	Hospital	Free-standing	Profit	Non-profit	Government
1985	44	56	46	44	11
1986	42	58	49	41	10
1987	39	61	51	40	9
1988	37	63	53	39	8
1989	35	65	55	38	7
1990	34	66	56	37	7
1991	35	65	56	35	9
1992	33	67	57	34	9
1993	31	69	62	32	6
1994	29	71	62	31	6
1995	27	73	63	30	7
1996	26	74	66	28	6
1997	23	77	70	25	5

Table 3
Dialyzer Membrane Types Used by Hemodialysis Centers
1988-1997, United States

	Percent of Centers Using*							
	Conventional Dialyzers			High Flux Dialyzers†				Any
Year	Cuprophan	Cellulose Acetate	Regenerated Cellulose	Cellulose Triacetate	PAN	Poly-sulfone	PMMA	High Flux Dialyzer
1988	76	59	16	--	4	17	1	23
1989	78	57	14	3	4	22	1	29
1990	75	55	15	3	5	26	1	34
1991	70	60	15	4	4	34	1	41
1992	63	55	15	5	3	43	3	50
1993	59	56	18	7	3	52	4	59
1994	50	54	18	9	3	59	4	67
1995	44	49	18	13	2	69	4	77
1996	36	44	17	12	2	78	4	84
1997	27	43	12	14	2	80	3	87

* Total >100% for each year since many centers use >1 dialyzer membrane.

† PAN denotes polyacrylonitrile; PMMA denotes polymethylmethacrylate.

Table 4

Treatment of Patients with High Flux* and High Efficiency Dialysis†

1987-1997, United States

	No. (%)		No. (%)	
	High Flux Dialysis		High Efficiency Dialysis	
Year	Centers	Patients	Centers	Patients
1987	224 (15)	5,057 (5)	--	--
1988	284 (18)	8,351 (8)	--	--
1989	387 (22)	12,658 (10)	396 (23)	9,598 (8)
1990	478 (25)	17,363 (12)	528 (28)	14,587 (10)
1991	624 (30)	26,379 (17)	642 (31)	19,456 (12)
1992	765 (35)	35,862 (21)	823 (38)	26,737 (16)
1993	899 (39)	48,192 (27)	1027 (45)	39,016 (22)
1994	1094 (45)	63,266 (31)	1259 (51)	53,439 (26)
1995	1331 (50)	82,732 (37)	1650 (62)	69,670 (31)
1996	1620 (58)	95,062 (42)	1860 (67)	80,297 (35)
1997	1924 (63)	116,730 (46)	2161 (70)	94,402 (37)

* Dialyzer UFR ≥20

† Dialyzer UFR 10-19; information on high efficiency dialysis was not collected until 1989.

Table 5

Water Treatment Systems Used in Hemodialysis Centers,
1980-1997 United States

	No. (%) of Centers				
Year	None	RO*	DI†	RO and DI	Other
1980	52 (5)	187 (19)	137 (14)	72 (7)	520 (54)
1984	24 (2)	572 (47)	168 (14)	404 (34)	37 (3)
1987	8 (1)	754 (51)	143 (10)	558 (38)	23 (2)
1989	1 (<1)	884 (51)	118 (7)	689 (40)	33 (2)
1990	0 (0)	1015 (54)	122 (6)	750 (40)	5 (0.3)
1991	0 (0)	1106 (54)	110 (5)	814 (40)	16 (1)
1992	0 (0)	1201 (55)	99 (5)	852 (39)	18 (1)
1993	0 (0)	1268 (55)	84 (4)	937 (41)	15 (1)
1994	0 (0)	1338 (55)	78 (3)	1019 (42)	14 (1)
1995	0 (0)	1470 (56)	74 (3)	1076 (41)	27 (1)
1996	0 (0)	1617 (58)	51 (2)	1114 (40)	22 (1)
1997	0 (0)	1806 (59)	51 (2)	1178 (38)	26 (1)

* Reverse osmosis

† Deionization

Table 6
Number of Hemodialysis Centers Having Dialyzer Reuse Programs
1976-1997, United States

Year	Total Centers	No. (%) Reusing
1976	750	135 (18)
1980	956	179 (19)
1982	1,015	435 (43)
1983	1,120	579 (52)
1984	1,201	693 (58)
1985	1,250	764 (61)
1986	1,350	855 (63)
1987	1,486	948 (64)
1988	1,586	1,058 (67)
1989	1,726	1,172 (68)
1990	1,882	1,310 (70)
1991	2,046	1,453 (71)
1992	2,170	1,569 (72)
1993	2,304	1,688 (73)
1994	2,449	1,835 (75)
1995	2,647	2,048 (77)
1996	2,808	2,261 (81)
1997	3,077	2,523 (82)

Table 7

Frequency of Dialyzer Reuse Reported by Hemodialysis Centers, 1986-1997, United States

	No. of	Average Reuses			Maximum Reuses		
Year	Centers	Mean	Median	Range	Mean	Median	Range
1986	841	10	9	3-70	26	23	3-106
1987	943	11	10	1-85	27	25	4-119
1988	1058	11	10	2-50	28	25	3-131
1989	1172	12	10	1-50	28	25	3-150
1990	1310	13	12	1-50	30	30	3-131
1991	1453	14	13	2-50	32	30	3-181
1992	1659	14	13	1-50	33	30	5-264
1993	1688	15	13	2-60	33	30	5-149
1994	1835	15	14	1-55	35	30	1-160
1995	2048	15	14	1-80	36	30	1-192
1996	2261	15	14	1-56	37	30	1-155
1997	3077	17	15	1-65	38	30	1-179

Table 8

Chemical Germicides for Reprocessing Dialyzers
in Hemodialysis Centers, 1983-1997, United States

	Percentage of Centers						
	Formaldehyde*				Peracetic Acid	Glutaral-dehyde	Heat
Year	All	<4.0%	≥4.0%†	Unknown‡			
1983	94	57	28	15	5	<1	--
1984	86	43	42	14	12	3	--
1985	80	43	47	10	17	3	--
1986	69	40	48	12	28	3	--
1987	62	42	51	7	34	4	--
1988	54	50	40	10	40	6	--
1989	47	58	37	5	46	7	--
1990	43	62	33	5	49	8	--
1991	42	66	32	2	50	9	--
1992	40	68	32	0	52	8	<1
1993	40	67	33	0	51	8	1
1994	40	70	30	0	52	7	1
1995	38	--	--	--	54	7	1
1996	36	--	--	--	54	7	3
1997	34	--	--	--	56	7	3

* The percentage of centers listed for each concentration of formaldehyde is the percentage of total formaldehyde users (data not collected in 1995-1997).

† Concentration recommended by CDC if dialyzer is stored at room temperature.

‡ Unknown concentration of formaldehyde

Table 9

Type of Vascular Access Used for Hemodialysis, 1995-1997, United States

Year	Number of Patients	Percent of Patients Dialyzed Through* Fistula	Graft	Catheter
1995	153,320	22.2	65.1	12.7
1996	176,609	22.1	62.9	14.9
1997	195,588	22.8	59.7	17.5

* The percent of patients dialyzed by each access type during the final week of the year.

Table 10
Vascular Access by End Stage Renal Disease (ESRD) Network,
December 25-31, 1997, United States

ESRD Network	States, Districts, or Territories	Total Patients	Percent Dialyzed Through Fistula	Graft	Catheter
14	TX	15,850	14.7	70.3	14.9
8	AL MS TN	11,698	16.9	70.5	12.6
18	S.CA	14,129	18.2	70.6	11.1
5	DC MD VA WV	13,040	18.9	64.4	16.7
6	GA NC SC	18,207	19.3	63.7	17.0
13	AR LA OK	8,767	19.6	63.1	17.3
9	IN KY OH	12,945	22.1	53.8	24.1
12	IA KS MO NE	6,477	22.2	57.6	20.2
4	DE PA	9,690	23.5	54.4	22.2
7	FL	11,552	23.7	55.2	21.1
17	AS GU HI MP N.CA	9,587	23.8	65.0	11.1
10	IL	8,822	24.2	53.5	22.3
11	MI MN ND SD WI	12,020	24.3	57.4	18.2
15	AZ CO NM NV UT WY	7,086	26.5	55.0	18.4
16	AK ID MT OR WA	4,632	27.3	57.9	14.8
3	NJ PR	8,895	32.1	45.0	22.9
2	NY	14,694	32.8	51.9	15.4
1	CT MA ME NH RI VT	7,497	33.9	46.6	19.4
	All	195,588	22.8	59.7	17.5

Rows are sorted by percent dialyzed through a fistula.

Table 11
Use of Hepatitis B Vaccine in Hemodialysis Centers
1983-1997, United States

Year	No. (%) Ever Receiving Three Vaccine Doses	
	Patients	Staff
1983	3,619 (5.4)	5,670 (26.1)
1984	4,495 (6.0)	7,181 (31.6)
1985	6,290 (7.8)	8,521 (35.5)
1986	8,815 (10.1)	9,877 (39.4)
1987	12,270 (12.8)	11,316 (41.9)
1988	17,019 (15.8)	12,949 (45.5)
1989	21,623 (17.6)	15,578 (48.0)
1990	24,260 (18.2)	19,311 (53.0)
1991	25,397 (16.9)	22,499 (56.1)
1992	37,459 (23.6)	30,069 (69.4)
1993	47,183 (28.8)	34,885 (76.1)
1994	61,492 (31.0)	40,008 (79.6)
1995	74,217 (35.0)	44,542 (82.4)
1996	79,133 (36.0)	48,817 (81.9)
1997	87,749 (46.7)*	43,341 (86.6)*

* For 1997, the figures are based on patients who were being treated during December 25-31, or staff members who were working during December 25-31. For previous years, the figures are based on patients treated at any time during the year, or staff members who worked at any time during the year.

Table 12

Use of Hepatitis B Vaccine in Hemodialysis Patients

by End Stage Renal Disease (ESRD) Network, 1995-1997, United States

ESRD Network	State(s), Districts, or Territories	Percent Vaccinated 1996	1997	Absolute Change	Percent Change
18	S.CA	18.3	29.9	11.6	63.4
10	IL	22.3	31.5	9.2	41.3
2	NY	27.8	36.5	8.7	31.3
3	NJ PR	19.6	37.4	17.8	90.8
17	AS GU HI MP N.CA	24.9	39.0	14.1	56.6
15	AZ CO NM NV UT WY	31.5	42.8	11.3	35.9
5	DC MD VA WV	39.3	45.5	6.2	15.8
1	CT MA ME NH RI VT	40.7	47.2	6.5	16.0
9	IN KY OH	38.7	47.7	9.0	23.3
13	AR LA OK	38.6	50.9	12.3	31.9
7	FL	40.5	52.0	11.5	28.4
4	DE PA	40.7	53.0	12.3	30.2
8	AL MS TN	45.7	53.7	8.0	17.5
11	MI MN ND SD WI	49.8	54.1	4.3	8.6
6	GA NC SC	40.4	54.5	14.1	34.9
14	TX	37.2	55.0	17.8	47.8
12	IA KS MO NE	51.8	55.2	3.4	6.6
16	AK ID MT OR WA	48.4	58.0	9.6	19.8
	All	36.0	46.7	10.7	29.7

Rows are sorted by percent vaccinated in 1997.

Table 13
Incidence and Prevalence of HBsAg in Hemodialysis Patients
1976-1997, United States

Year	Total*	Incidence*	Total†	Prevalence†
1976	33,875	3.0	22,876	7.8
1980	62,723	1.0	43,796	3.8
1982	66,326	0.5	49,275	2.7
1983	67,229	0.5	54,343	2.4
1984	76,327	0.3	60,782	2.3
1985	80,151	0.3	62,172	2.1
1986	87,505	0.3	67,387	1.9
1987	97,225	0.2	74,249	1.7
1988	107,804	0.2	80,651	1.5
1989	122,734	0.1	90,596	1.4
1990	140,608	0.2	101,763	1.2
1991	155,877	0.2	116,651	1.3
1992	170,028	0.1	128,264	1.2
1993	180,341	0.1	135,798	1.2
1994	206,884	0.1	149,743	1.1
1995	224,954	0.06	162,970	1.1
1996	229,527	0.08	177,324	1.1
1997	253,001	0.05	195,935	0.9

* Total denotes patients treated at any time during the year, and incidence the percent of such patients who converted to HBsAg-positive.

† Total denotes patients treated during one week of December, and prevalence the percent of such patients who were HBsAg-positive.

Table 14
Incidence and Prevalence of HBsAg in Hemodialysis Staff
1976-1997, United States

Year	Total*	Incidence*	Total†	Prevalence†
1976	15,946	2.6	ND‡	
1980	20,057	0.8	15,603	0.9
1982	20,356	0.6	16,235	0.5
1983	21,688	0.5	18,714	0.6
1984	22,912	0.3	19,793	0.5
1985	24,034	0.2	20,346	0.3
1986	25,044	0.1	21,094	0.4
1987	27,123	0.1	22,334	0.4
1988	28,501	0.1	23,778	0.3
1989	32,486	0.1	26,112	0.3
1990	36,907	0.04	29,252	0.3
1991	40,298	0.04	33,079	0.3
1992	43,535	0.03	36,000	0.3
1993	45,943	0.02	37,992	0.3
1994	50,353	0.02	40,951	0.3
1995	54,194	0.02	43,465	0.4
1996	59,882	0.05	47,215	0.3
1997	63,054	0.05	50,321	0.4

* Total denotes staff who worked at any time during the year, and incidence the percent of such staff who converted to HBsAg-positive.

† Total denotes staff who worked during one week of December, and prevalence the percent of such staff who were HBsAg-positive.

‡ Not done

Table 15

Effect of Separation Practices for HBsAg-Positive Patients on Incidence of HBsAg in Hemodialysis Patients 1976-1997, United States

	Incidence of HBsAg (%) by Separation Practices		
Year	Room and Machine	Machine Only	None
1976	3.9*	--	6.8
1980	0.8*	2.0	1.5
1983	0.5*	0.9	1.1
1987	0.3*	0.5	1.7
1989	0.2†	0.2	0.6
1990	0.3	0.3	0.5
1991	0.3	0.3	0.5
1992	0.2*	0.4	0.3
1993	0.2*	0.4	0.4†
1994	0.18	0.21	0.13
1995	0.09	0.14	0.05
1996	0.13	0.16	0.05
1997	0.055	0.038	0.037

Note: Only centers with ≥1 HBsAg-positive patient are included.

* P<0.05, room and machine vs machine only and none

† P<0.05, room and machine vs none

Table 16
Incidence of Non-A Non-B Hepatitis in Hemodialysis Patients and Staff, 1982-1997, United States

Year	Total Patients*	Incidence (%)	Total Staff*	Incidence (%)
1982	60,326	1.7	ND†	
1983	61,778	1.8	19,276	0.5
1984	74,923	1.6	22,865	0.3
1985	80,151	1.4	24,034	0.2
1986	87,760	1.5	25,044	0.2
1987	96,554	1.2	27,123	0.2
1988	106,826	1.0	28,501	0.1
1989	122,734	0.7	32,486	0.1
1990	140,608	0.5	36,907	0.1
1991	155,435	0.5	40,298	0.1
1992	169,340	0.5	43,535	0.1
1993	180,139	0.6	45,904	0.1
1994	206,273	0.4	50,353	0.1
1995	224,358	0.3	50,028	0.05
1996	227,197	0.4	59,480	0.04
1997	249,194	0.2	62,482	0.07

* Patients and staff at centers not supplying information on non-A non-B hepatitis were excluded from the totals

† Not done

Table 17

Antibody to Hepatitis C Virus (anti-HCV) Testing and Prevalence among Hemodialysis Patients and Staff, 1992-1997, United States

Group	Year	Percent of Centers Testing	Total Tested	Anti-HCV Prevalence No. (%)
Patients	1992	22	27,086	2,202 (8.1)
	1993	29	37,654	3,654 (9.7)
	1994	34	50,438	5,306 (10.5)
	1995	39	61,400	6,362 (10.4)
	1996	44	75,601	7,652 (10.1)
	1997	48	91,098	8,434 (9.3)
Staff	1992	10	2,889	45 (1.6)
	1993	15	4,825	75 (1.6)
	1994	16	5,679	106 (1.9)
	1995	16	6,238	122 (2.0)
	1996	20	8,472	113 (1.3)
	1997	25	11,649	190 (1.6)

Table 18

Antibody to Hepatitis C Virus (anti-HCV) Testing and Prevalence Among Hemodialysis Patients by End Stage Renal Disease (ESRD) Network, 1997, United States

ESRD Network	States, Districts, or Territories	Centers		Patients	
		Total	Test for Anti-HCV (%)	Total Tested	Anti-HCV Positive (%)
3	NJ PR	101	54.5	4,771	12.4
11	MI MN ND SD WI	227	38.3	5,502	12.2
5	DC MD VA WV	214	50.5	6,569	12.1
2	NY	159	59.1	8,284	12.0
4	DE PA	158	62.7	5,831	10.0
14	TX	228	45.6	6,666	10.0
7	FL	210	49.0	5,725	9.6
10	IL	106	34.9	2,670	9.1
13	AR LA OK	183	71.6	6,478	9.1
8	AL MS TN	210	52.9	5,439	8.7
17	AS GU HI MP N.CA	125	40.0	3,261	8.5
6	GA NC SC	298	51.7	9,560	7.3
1	CT MA ME NH RI VT	111	51.4	3,804	7.2
18	S.CA	173	36.4	4,685	6.8
12	IA KS MO NE	153	43.8	2,661	6.5
9	IN KY OH	199	34.2	4,165	6.1
16	AK ID MT OR WA	89	37.1	1,603	5.7
15	AZ CO NM NV UT WY	133	46.6	3,424	5.5
	All	3077	48.2	91,098	9.3

Rows are sorted by percent anti-HCV positive

Table 19

Receipt of Vancomycin by Chronic Hemodialysis Patients, by Center Characteristic, United States, December 1997

Factor	Total Patients	Received Vancomycin*	P-Value†
All	184,638	4.5	--
Size			
1-40	25,045	5.3	0.009
41-80	62,459	4.8	
81+	99,074	4.3	
Location			
Hospital	36,953	4.6	0.6
Freestanding	149,621	4.5	
Owner			
Profit	130,967	4.5	0.02
Nonprofit	49,632	4.5	
Government	5,979	6.0	
Central catheters§			
0-4.9%	14,970	3.0	0.0001
5-9.9%	33,181	3.5	
10-14.9%	38,963	4.3	
15-19.9%	30,611	4.7	
20-24.9%	24,935	5.4	
25-29.9%	16,059	4.7	
30%+	27,667	6.0	

* Median percent of patients receiving vancomycin in December 1997

† Wilcoxon test for heterogeneity among the groups

§ Percent of patients dialyzed through a central catheter during December 25-31, 1997

Table 20

Receipt of Vancomycin by Chronic Hemodialysis Patients, by End Stage Renal Disease (ESRD) Network, United States, December 1995 and 1997

ESRD Network	States, Districts, or Territories	Total Centers 1997	Received Vancomycin* 1996	Received Vancomycin* 1997	Absolute Change
17	AS GU HI MP N.CA	125	3.1	2.7	-0.4
14	TX	218	4.5	3.4	-1.1
16	AK ID MT OR WA	84	4.2	3.4	-0.8
18	S.CA	162	3.8	3.5	-0.3
15	AZ CO NM NV UT WY	127	4.7	3.9	-0.8
8	AL MS TN	191	5.1	4.0	-1.1
10	IL	97	4.8	4.4	-0.4
1	CT MA ME NH RI VT	107	5.8	4.5	-1.3
4	DE PA	150	4.8	4.5	-0.3
6	GA NC SC	283	5.1	4.5	-0.6
11	MI MN ND SD WI	211	5.6	4.5	-1.1
5	DC MD VA WV	213	5.3	4.7	-0.6
12	IA KS MO NE	146	5.7	5.0	-0.7
13	AR LA OK	180	6.8	5.4	-1.4
9	IN KY OH	190	6.3	5.5	-0.8
2	NY	144	6.3	5.6	-0.7
7	FL	204	6.2	6.1	-0.1
3	NJ PR	96	7.7	6.9	-0.8
	All	2928	5.2	4.5	-0.7

* Median percent of patients receiving vancomycin in December of 1996 or 1997 (rows are sorted on this value for 1997)

Table 21

Reporting of One or More Patients with Vancomycin-Resistant Enterococci (VRE), by Center Characteristic, United States, 1997

Factor	Total Centers	No (%) with VRE	Relative Risk	P-value*
All	3077	918 (29.8)	--	--
Treat MRSA Patients				
No	1356	191 (14.1)	1.0	Ref
Yes	1720	726 (42.2)	3.0	<0.001
Owner				
Profit	2152	569 (26.4)	1.0	Ref
Nonprofit	770	280 (36.4)	1.4	<0.001
Government	155	69 (44.5)	1.7	<0.001
Location				
Hospital	722	288 (39.9)	1.5	<0.001
Freestanding	2354	630 (26.8)	1.0	Ref

Ref denotes reference category

* Compared with reference category

Table 22

Reporting of One or More Patients with Vancomycin-Resistant Enterococci (VRE), by End Stage Renal Disease (ESRD) Network, United States, 1995-1997

ESRD Network	States, Districts or Territories	Percent of Centers Reporting VRE 1995	1997	Absolute Change 1995-1997
7	FL	2.8	13.3	10.5
8	AL MS TN	2.9	14.8	11.9
13	AR LA OK	1.9	14.8	12.9
14	TX	9.8	20.2	10.4
16	AK ID MT OR WA	9.5	20.2	10.7
6	GA NC SC	7.4	20.8	13.4
15	AZ CO NM NV UT WY	5.8	28.6	22.8
5	DC MD VA WV	8.7	29.0	20.3
11	MI MN ND SD WI	7.4	31.7	24.3
9	IN KY OH	6.7	33.2	26.5
3	NJ PR	28.2	35.6	7.4
12	IA KS MO NE	12.1	35.9	23.8
18	S.CA	7.9	38.2	30.3
17	AS GU HI MP N.CA	18.4	38.4	20.0
2	NY	29.5	39.6	10.1
10	IL	16.7	44.3	27.6
4	DE PA	27.7	56.3	28.6
1	CT MA ME NH RI VT	30.7	57.7	27.0
	All	11.5	29.8	18.3

Rows are sorted by percent reporting VRE in 1997

Table 23

Frequency of Pyrogenic Reactions (PR) Reported by Hemodialysis Centers, 1976-1997, United States

Year	Total Centers	No. (%) Centers Reporting ≥1 PR	PR Clusters
1976	540	72 (13)	--*
1980	956	97 (10)	--
1982	1,017	109 (11)	--
1983	1,135	131 (12)	--
1984	1,203	134 (11)	--
1985	1,251	131 (11)	--
1986†	1,350	213 (16)	33 (2.4)
1987	1,485	205 (14)	38 (2.6)
1988	1,586	231 (15)	54 (3.4)
1989‡	1,726	383 (22)	47 (2.7)
1990	1,882	377 (20)	61 (3.2)
1991	2,046	402 (20)	62 (3.0)
1992	2,170	419 (19)	67 (3.1)
1993	2,304	481 (21)	68 (3.0)
1994	2,449	528 (22)	59 (2.4)
1995	2,647	511 (20)	45 (1.7)
1996	2,808	577 (21)	49 (1.7)
1997	3,077	648 (21)	53 (1.7)

* Information not collected until 1986

† 1976-1985, reporting for a 3-month period only; 1986-1997, reporting for entire year.

‡ 1989-1997, definition of pyrogenic reactions included on questionnaire.

Table 24

Frequency of New Dialyzer Syndrome

Reported by Hemodialysis Centers, United States, 1984-1997

Year	Total Centers	Number (%) Centers Reporting Reactions
1984	1201	498 (43)
1985	1250	467 (38)
1986	1350	544 (40)
1987	1486	576 (39)
1988	1586	633 (40)
1989	1726	539 (31)
1990	1882	530 (28)
1991	2046	578 (28)
1992	2170	527 (24)
1993	2304	620 (27)
1994	2449	674 (28)
1995	2647	622 (24)
1996	2808	597 (21)
1997	3077	693 (23)

Table 25
Chronic Hemodialysis Centers Reporting Patients
with HIV Infection, 1985-1997, United States

Year	No.(%)of Centers with HIV Infection	No.(%) of Patients with HIV Infection	No.(%) of Patients with Clinical AIDS
1985	134 (11)	244 (0.3)	-
1986	238 (18)	546 (0.6)	332 (0.4)
1987	351 (24)	924 (1.0)	462 (0.5)
1988	401 (25)	1,253 (1.2)	670 (0.6)
1989	456 (26)	1,248 (1.0)	663 (0.5)
1990	493 (26)	1,533 (1.1)	739 (0.5)
1991	601 (29)	1,914 (1.2)	967 (0.6)
1992	737 (34)	2,501 (1.5)	1,126 (0.7)
1993	792 (34)	2,780 (1.5)	1,350 (0.7)
1994	914 (37)	3,144 (1.5)	1,593 (0.8)
1995	1022 (39)	3,090 (1.4)	1,606 (0.7)
1996	1088 (39)	3,112 (1.4)	1,512 (0.7)
1997	1214 (39)	3,298 (1.3)	1,501 (0.6)

Table 26

Chronic Hemodialysis Centers Reporting Patients with HIV Infection/AIDS, by End Stage Renal Disease (ESRD) Network, 1997, United States

ESRD Network	States, Districts or Territories	Total Patients	Percent with HIV Infection	Percent with AIDS
3	NJ PR	11,708	2.6	1.4
2	NY	18,468	3.1	1.3
5	DC MD VA WV	16,631	2.7	1.1
7	FL	15,165	2.1	0.9
6	GA NC SC	22,679	1.6	0.8
14	TX	19,681	0.8	0.7
1	CT MA ME NH RI VT	9,771	1.1	0.5
4	DE PA	12,859	1.5	0.5
10	IL	11,374	1.3	0.5
13	AR LA OK	11,023	0.9	0.5
8	AL MS TN	14,701	0.8	0.4
11	MI MN ND SD WI	15,752	0.6	0.3
17	AS GU HI MP N.CA	11,959	0.8	0.3
18	S.CA	18,117	0.6	0.3
9	IN KY OH	16,856	0.5	0.2
12	IA KS MO NE	8,580	0.5	0.2
15	AZ CO NM NV UT WY	9,027	0.2	0.1
16	AK ID MT OR WA	6,087	0.2	0.0
	All	250,438	1.3	0.6

Rows are sorted by percent with AIDS

Appendix II
Infection Control Precautions for Dialysis Units

Dialysis Unit Precautions

In 1977, CDC published precautions to prevent transmission of HBV in dialysis centers (B1). In 1987, universal precautions were developed to prevent transmission of all bloodborne pathogens, including HBV and HIV, in health care and other settings (B2). In 1996, an updated system of precautions, termed standard precautions, was published to replace universal precautions for the hospital and most healthcare settings (B3). The infection control measures currently recommended for dialysis units incorporate features of each of these guidelines. These measures are effective against HBV, the most highly transmissible organism in hemodialysis units; therefore, they should also be effective against other viruses (e.g., HCV) and bacteria (e.g.,VRE).

Note that dialysis unit precautions are more stringent than universal or standard precautions. For example, standard precautions require the use of gloves only when touching blood, body fluids, secretions, excretions, or contaminated items. In contrast, dialysis unit precautions require glove use whenever patients or hemodialysis equipment is touched. Standard precautions do not restrict the use of supplies, instruments, and medications to a single patient; dialysis unit precautions specify that none of these be shared between any patients.

Since dialysis patients may, known or unknown to the staff, be infected or colonized with a variety of bacteria and viruses, the following precautions should be used during care of **all dialysis patients at all times**.

Assign each patient a: (1) dialysis chair or bed and machine; and (2) supply tray (tourniquet, antiseptics, if possible blood pressure cuff). Avoid sharing these items.

Do not share clamps, scissors, other nondisposable items unless sterilized or disinfected between patients.

Prepare and distribute medications from a centralized area. Medication carts should not be used. Separate clean and contaminated areas; for example, handling and storage of medications and hand washing should not be done in the same or adjacent area to that where blood samples or used equipment are handled.

Disposable gloves should be worn by staff members for their own protection when handling patients or dialysis equipment and accessories. Gloves should be worn when taking blood pressure, injecting saline or heparin, or touching dialysis machine knobs to adjust flow rates. For the patient's protection, the staff member should use a fresh pair of gloves with each patient to prevent cross-contamination. Gloves also should be used when handling blood specimens. Staff members should wash their hands after each patient contact.

Avoid touching surfaces with gloved hands that will subsequently be touched with ungloved hands before being disinfected.

Staff members may wish to wear protective eyeglasses and masks for procedures in which spurting or spattering of blood may occur, such as cleaning of dialyzers and centrifugation of blood.

Staff members should wear gowns, scrub suits, or the equivalent while working in the unit and should change out of this clothing at the end of each day.

After each dialysis, (1) change linen; (2) clean and disinfect the dialysis bed/chair and nondisposable equipment (especially control knobs and other surfaces touched by gloved hands).

Crowding patients or overtaxing staff may facilitate cross- transmission. Avoid clutter and allocate adequate space to facilitate cleaning and housekeeping.

Staff members should not smoke, eat, or drink in the dialysis treatment area or in the laboratory. There should be a separate lounge for this purpose. However, all patients may be served meals. The glasses, dishes, and other utensils may be cleaned in the usual manner by the hospital staff. No special care of these items is needed.

Hepatitis B Virus (HBV)

Because HBV is so highly transmissible in hemodialysis centers, several precautions in addition to those outlined above have been recommended specifically to deal with this pathogen.

Patients and staff should be vaccinated and screened as per Appendix III.

HBsAg-positive patients should undergo dialysis in a separate room designated only for HBsAg-positive patients. They should use separate machines, equipment, and supplies, and most importantly, staff members should not care for both HBsAg-positive and susceptible patients on the same shift or at the same time. If a separate room is not possible, they should be separated from HBV susceptible patients in an area removed from the mainstream of activity and should undergo dialysis on dedicated machines. Anti-HBs-positive patients may undergo dialysis in the same area as HBsAg-positive patients, or they may serve as a geographic buffer between HBsAg-positive and HBV susceptible patients; in either instance they may be cared for by the same staff member. When the use of separate machines is not possible, the machines can be disinfected by using conventional protocols, and the external surfaces can be cleaned or disinfected with soap and water or a detergent germicide.

Although there is no evidence that patients or staff members in centers that reuse dialyzers are at greater risk of acquiring HBV infection, it might be prudent that HBsAg-positive patients not participate in dialyzer reuse programs. HBV can occur in high concentration in blood, and

handling dialyzers used on HBsAg-positive patients during the reprocessing procedures might place staff members at risk for HBV infection.

MRSA and VRE

CDC recommends contact precautions for care of hospitalized patients infected or colonized with MRSA, VRE, or certain other antimicrobial-resistant bacteria (B3, B4). Dialysis unit precautions as outlined above include many of the measures recommended under contact precautions. However, under contact precautions (but not dialysis unit precautions) a private isolation room and (in certain instances) a separate gown are recommended. These measures were recommended to prevent possible transmission via contaminated environmental surfaces such as counter tops and bed rails. Hospitalized patients spend nearly 24 hours a day in their hospital bed, whereas dialysis patients spend only 3-5 hours three times a week in the dialysis unit. Note that feces are the main reservoir for VRE. The potential for bacterial contamination of environmental surfaces would appear to be much greater in hospitalized patients than in most dialysis outpatients.

Dialysis unit precautions should be used for care of all patients; at present we do not advise additional precautions for most patients with MRSA or VRE. However, additional precautions would be prudent for patients with infective material that can not be contained (e.g., wound drainage that can not be contained by dressings and is culture-positive for MRSA or VRE; or a positive stool culture for VRE and fecal incontinence, a colostomy, diarrhea, or poor hygiene). For these patients, if an isolation room is not available, enhanced attention to patient separation and environmental cleaning might be sufficient. Staff should wear a separate gown when caring for such patients.

Dialysis units should reevaluate their compliance with dialysis center precautions and improve precautions for care of all patients where necessary. Another approach would be cohorting--assign patients with known MRSA or VRE to certain dialysis stations at one end of the unit, use dedicated staff to care for them, and ensure that strict precautions are used at these stations.

Prudent Vancomycin Use

Prudent vancomycin use is another important issue discussed in the CDC guideline "Recommendations for Preventing the Spread of Vancomycin Resistance" (B4). Antibiotic use can be considered in three categories: prophylaxis given to uninfected patients in an attempt to prevent infection; empiric therapy, given to patients with signs and symptoms of infection, pending culture results; and continuing therapy, given after culture results are known.

Prophylaxis with vancomycin should not be given, other than for certain surgical procedures (B4).

Empiric treatment with vancomycin is appropriate, pending culture results, in patients with

beta-lactam allergy, or in instances where serious infection with beta-lactam resistant gram-positive bacteria (i.e., MRSA or *Staphylococcus epidermidis*, which are generally beta-lactam resistant) is likely. Knowing the percent of *S. aureus* that are methicillin-resistant in your area, and the percent of serious infections due to *S. epidermidis*, is important in determining empiric antibiotic coverage.

Continuing treatment depends on culture results. If the patient has allergy to beta-lactam antibiotics, or if beta-lactam resistant bacteria are isolated (with the exception of single blood cultures positive for *S. epidermidis*), vancomycin is appropriate. Depending on susceptibility results, alternative antibiotics (e.g., cephalosporins) with dosing intervals ≥48 hours, which would allow post-dialytic dosing, could be used. Recent studies suggest that cefazolin given 3 times a week provides adequate blood levels (B5-B6).

References

B1. Centers for Disease Control and Prevention. Control measures for hepatitis in dialysis centers. Viral Hepatitis Investigations and Control Series. November 1977.

B2. Centers for Disease Control and Prevention. Recommendations for prevention of HIV transmission in health-care settings. MMWR 1987;36 (No. 2S):3S-18S.

B3. Garner JS, the Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. Infect Control Hosp Epidemiol 1996;17:53-80.

B4. Centers for Disease Control and Prevention. Recommendations for preventing the spread of vancomycin resistance. MMWR 1995;44 (No. RR-12):1-13.

B5. Marx MA, Frye RF, Matzke GR, Golper TA. Cefazolin as empiric therapy in hemodialysis-related infections: efficacy and blood concentrations. Am J Kidney Dis. 1998;32:410-414.

B6. Fogel MA, Nussbaum PB, Feintzeig ID, Hunt WA, Gavin JP, Kim RC. Use of cefazolin in chronic hemodialysis patients: a safe and effective alternative to vancomycin. Am J Kidney Dis. 1998;32:401-109.

Appendix III
Recommendations for Hepatitis B Vaccination and Serologic Surveillance in Chronic Hemodialysis Patients and Staff

The Centers for Disease Control and Prevention (CDC) and the Immunization Practices Advisory Committee (ACIP) have published guidelines for protection against infection with hepatitis B virus (A1). This appendix is meant to collate, summarize, and update, but not replace, sections of these guidelines that deal specifically with hemodialysis patients and staff. If a patient or staff member is exposed to hepatitis B virus, the recommendations of the ACIP (A2) should be followed.

Initial Testing for Hepatitis B Virus Markers

Hemodialysis patients and staff should be tested for hepatitis B surface antigen (HBsAg) and antibody to HBsAg (anti-HBs) when they begin dialysis or employment in the center. They are classified as infected if HBsAg-positive; immune if anti-HBs positive ($\geq$10 milli-international units per milliliter [mIU/ml]) on at least two consecutive occasions; or susceptible if HBsAg-negative and anti-HBs negative (<10 mIU/ml).

For infection control purposes, testing for antibody to hepatitis B core antigen (anti-HBc) is not necessary. However, if testing is done, individuals who are HBsAg-negative and anti-HBc positive have had past hepatitis B virus infection and are immune.

Hepatitis B Vaccination

All susceptible patients and staff should receive hepatitis B vaccine (dosage schedules in Table A1), be tested for anti-HBs 1-2 months after the final dose of vaccine, and be followed up as outlined below. Vaccination of immune (anti-HBs $\geq$10 mIU/ml on two consecutive occasions) persons is not necessary, but also is not harmful.

Screening and Follow up

Screening and Follow up depends on the result of anti-HBs testing 1-2 months after the final dose of vaccine (Table A2). Unvaccinated immune individuals can be screened and followed up as if they were vaccine responders.

Patients, Responders. Patients who are anti-HBs positive ($\geq$10 mIU/ml) after vaccination are responders. They should be tested for anti-HBs each year (Table A2). If the level of anti-HBs falls below 10 mIU/ml, they should receive a booster dose of hepatitis B vaccine and continue to be tested for anti-HBs each year.

Patients, Non-Responders. Patients who are anti-HBs negative (<10 mIU/ml) after vaccination are non-responders. They may be revaccinated with one or more doses of vaccine and retested for anti-HBs 1-2 months later. If they are then anti-HBs positive ($\geq$10 mIU/ml), they

can be reclassified and treated as responders (see above). If they continue to be non-responders (anti-HBs <10 mIU/ml), they should be considered susceptible to HBV infection and tested for HBsAg every month and anti-HBs every 6 months (Table A2).

Staff, Responders. Staff who are anti-HBs positive (≥10 mIU/ml) after vaccination are responders. They do not need any further routine anti-HBs testing (Table A2). If exposed to blood from a patient known to be HBsAg-positive, such staff members should be tested for anti-HBs: if still anti-HBs positive (≥10 mIU/ml), no further action is required; however, if they have become anti-HBs negative (<10 mIU/ml), they should receive a booster dose of vaccine.

Staff, Non-responders. Staff who are anti-HBs negative (<10 mIU/ml) after vaccination are non-responders. At the center's discretion, they can be revaccinated with one or more doses of vaccine, and retested for anti-HBs 1-2 months later. If they then become anti-HBs positive (≥10 mIU/ml), they should be reclassified and treated as responders (see above). If they are not revaccinated, or are still anti-HBs negative (<10 mIU/ml) after vaccination, they continue to be non-responders. Non-responders should be considered susceptible to HBV infection and tested for HBsAg and anti-HBs every 6 months (Table A2). If they are exposed to the blood of a person known to be HBsAg-positive, they should either receive 2 doses of hepatitis B immune globulin (HBIG), or receive 1 dose of HBIG and 1 dose of hepatitis B vaccine. They may receive similar treatment if exposed to the blood of a person known to be at high risk for hepatitis B.

References

A1. Moyer LA, Alter MJ, Favero MS. Review of hemodialysis-associated hepatitis B: revised recommendations for serologic screening. Semin Dial 1990;3:201-4.

A2. Centers for Disease Control. Hepatitis B virus: a comprehensive strategy for eliminating transmission in the United States through universal childhood vaccination. MMWR 1991;40(no. RR-13).

Table A1
Hepatitis B Vaccine Dosage Schedules

Product/Group	Dose	Schedule
Recombivax HB		
Patients	40 µg (1 ml) *	3 doses at 0, 1 and 6 months
Staff	10 µg (1 ml)	3 doses at 0, 1 and 6 months
Engerix-B		
Patients	40 µg (2 ml) †	4 doses at 0, 1 ,2 and 6 months
Staff	20 µg (1 ml)	3 doses at 0, 1 and 6 months or 4 doses at 0, 1, 2 and 12 months

* Special formulation
† Two 1.0-ml doses administered at one site

Table A2
Recommendations for Serologic Surveillance for Hepatitis B Virus (HBV) among Patients and Staff of Chronic Hemodialysis Centers

	Vaccination/Serologic Status and Frequency of Screening		
Group/ Screening Test	Vaccine Nonresponder or Susceptible*	Vaccine Responder or Natural Immunity†	Chronic HBV Infection‡
Patients			
HBsAg	Every month	None	Every year
Anti-HBs	Every 6 months	Every year	If HBsAg becomes negative
Staff			
HBsAg	Every 6 months	None	Every year
Anti-HBs	Every 6 months	None	If HBsAg becomes negative

* Anti-HBs <10 mIU/ml
† Anti-HBs $\geq$10 mIU/ml
‡ HBsAg positive for at least 6 months; or HBsAg positive, anti-HBc positive, IgM anti-HBc negative

Appendix IV
Recommendations for Screening for Non-A Non-B Hepatitis (Hepatitis C)

The assay for antibody to hepatitis C virus (anti-HCV) identifies a high proportion (80% to 90%) of persons with chronic hepatitis C. For patients with acute hepatitis C, however, there may be a prolonged interval between exposure or onset of hepatitis and antibody seroconversion. Persons negative for anti-HCV during their acute illness should be retested at least 3-4 months later to make a final diagnosis. Patients with a diagnosis of non-A, non-B hepatitis who remain negative for anti-HCV may have hepatitis C but fail to elicit an immune response detectable by the current assay, they may be infected with a second agent of non-A, non-B hepatitis, or their hepatitis may have another cause (viral or nonviral). Thus, the diagnosis of acute non-A, non-B hepatitis must continue to rely on the exclusion of other etiologies of liver disease even with the availability of a licensed test for anti-HCV.

Historically, it was recommended that patients be tested monthly for alanine aminotransferase (ALT) or aspartate aminotransferase (AST) to detect possible non-A, non-B hepatitis infections, particularly occurring in clusters, that might indicate a problem with infection control practices. Isolation of dialysis patients with presumed non-A, non-B hepatitis in separate rooms on dedicated machines was not considered necessary or recommended; instead, the use of basic barrier precautions or what are now called universal precautions was emphasized. The availability of a commercial test for anti-HCV does not change these recommendations for the control of non-A, non-B hepatitis in the dialysis center.

1. Dialysis unit precautions as outlined in Appendix II should be used for all patients.

2. Patients who are positive for anti-HCV or have a diagnosis of non-A, non-B hepatitis do not have to be isolated from other patients or dialyzed separately on dedicated machines. In addition, they can participate in dialyzer reuse programs.

3. Patients should be monitored for elevations in ALT and AST monthly. Elevations in liver enzymes currently are more sensitive indicators of acute hepatitis C than anti-HCV.

4. Routine screening of patients or staff for anti-HCV is not necessary for purposes of infection control. Dialysis centers may wish to conduct serologic surveys of their patient populations to determine the prevalence of the virus in their center, and in the case of patients or staff with a diagnosis of non-A, non-B hepatitis, to determine medical management. In addition, if liver enzyme screening indicates the occurrence of an epidemic of non-A, non-B hepatitis in the dialysis setting, anti-HCV screening on serum samples collected during and subsequent to outbreaks may be of value. However, since anti-HCV in an individual cannot measure infectivity, its usefulness for infection control in the dialysis center setting is limited.

Appendix V
Voluntary Surveillance for Bloodstream and Vascular Access Infections in Outpatient Hemodialysis Centers

Bloodstream and vascular access infections are a threat to hemodialysis patients. Because of frequent hospitalizations and receipt of antimicrobials, drug-resistance is a particular problem in this population. However, there are few studies of rates of bacterial infections and antimicrobial resistance in hemodialysis patients, and there are no standardized methods for ongoing data collection.

Therefore, CDC has created a national surveillance system to study these issues. Participation in this project is voluntary–dialysis center personnel decide whether to participate, and may elect to discontinue participation at any time.

Each month, participating dialysis center personnel will record the number of chronic hemodialysis patients ≥18 years old that they treat (broken down into four types of vascular access). A one-page form will be completed for each hospitalization or in-unit intravenous (IV) antimicrobial start among these patients. These data will allow calculation, stratified by type of vascular access, of rates of bloodstream infections, vascular access infections, hospitalizations, and antimicrobial use.

For individual dialysis centers, this surveillance system will provide a simple and standardized method to record data, calculate rates, and compare rates over time. It is hoped that collection and examination of these data will lead to quality improvement measures. For the medical and public health communities, aggregation of these data from many dialysis centers will provide a wealth of information which is not currently available.

We anticipate that this system will be available in March 1999. A protocol describing the system, and information for enrolling, can be received by contacting:

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