The mother’s battle for her child – with sickness, with poverty, with war, with all the forces of exploitation and callousness that cheapen human life – needs to become a common human battle, waged in love and in the passion for survival.
he pediatric ESRD population continues to present unique challenges, as patients enter therapy with a low burden of cardiovascular disease, yet face mortality rates on dialysis that are 150 times greater than those in the general pediatric population. The predominant complications of children with ESRD are related not only to renal disease, hypertension, and infection, but to developmental issues and the difficulties of adjusting to the realities of a chronic disease. This year we present new information on vascular access in pediatric patients at initiation, and compare infectious complications in adults and children with ESRD.

The distribution of ESRD patients by treatment modality is quite different in children compared to adults, with a far greater use of peritoneal dialysis or transplant as the first therapy. The initial use of hemodialysis has, however, grown quite steadily since the early 1990s, with this modality now emerging again as the most common choice of dialytic treatment for children at the start of therapy. By the eighteenth month of ESRD treatment, as expected, transplant is the dominant modality in the prevalent population.

Younger patients are the most likely to carry a primary diagnosis of cystic, hereditary, or congenital disease, while in older children ESRD is more often caused by glomerulonephritis and secondary glomerulonephritis. Hemoglobin levels are lowest in children with secondary glomerulonephritis, such as vasculitis, and in patients of non-white races; at the start of ESRD therapy, hemoglobin levels are 9.3 g/dl overall, 9.4 in whites, and 9.0 in blacks. Overall, 37 percent of children beginning ESRD therapy have received epoetin prior to treatment; in those with a diagnosis of cystic, hereditary, and congenital diseases, however, this number is 51 percent. But despite these differences, hemoglobin levels remain low in this population—almost 0.7 g/dl lower than in the incident adult population.

Preventive care in pediatric patients continues to increase, but still lags behind that in adult patients. Influenza vaccination rates, for example, have more than doubled in the last six years, but only one in five patients is vaccinated. Pneumococcal pneumonia vaccination rates are increasing as well, but this preventive measure reaches barely one in twenty children.

With hemodialysis re-emerging as the dominant dialytic therapy for children, we have added new information this year on the different types of hemodialysis accesses used in the pediatric population. In children who begin therapy on hemodialysis, 87 percent of those younger than 13 receive a catheter, compared to only 27 percent of those age 13–19. Fistulas are used in 7.5 and 54 percent of hemodialysis patients, respectively, and synthetic grafts in
Infectious complications are almost four times more frequent in patients with a catheter than in those without.

Anemia treatment in children lags behind that of adults, particularly for the youngest dialysis patients. Black children have lower hemoglobin levels than children of other races. Overall, children on dialysis have achieved a mean hemoglobin level of 11.6 g/dl, and receive an average weekly epoetin dose of 15,500 units.

With rates of cardiac disease low in the pediatric population, infectious complications are a primary source of morbidity. In the incident population, rates of infectious hospitalizations for both hemodialysis and peritoneal dialysis patients are comparable in adults and children. While they have been increasing steadily in the adult population, concurrent with increased catheter use, in children these rates have varied from year to year, most likely because of the small cohort size. The rate of infection due to internal devices in pediatric hemodialysis patients fell to its lowest point in 1993–1994, but subsequently tripled by 2001. Overall, by three years, the cumulative probability of an infectious hospitalization is 41 percent in children on hemodialysis, compared to 53 percent in adults. Probabilities are closer in children and adults on peritoneal dialysis, at 56 and 60 percent, and in those with a transplant, at 46 and 42 percent.

Several areas of concern continue to emerge with regard to the survival of pediatric patients. Comparisons of incident cohorts from 1988–1992 and 1993–1997 show that the overall survival of dialysis patients has remained essentially unchanged across modalities. The greatest improvement—of 5 to 7 percent—in five-year survival probabilities has occurred for hemodialysis and peritoneal dialysis patients with glomerulonephritis, while in peritoneal dialysis patients with secondary glomerulonephritis the probability of survival fell 7 percent between the two time periods. Comparisons of mortality rates by patient vintage do not show the same dramatic differences seen in the adult population (see Figure 6.35); rates vary widely year-to-year because of small sample sizes, and have remained relatively steady since the early 1980s.

Hemodialysis has emerged as the dominant modality for incident pediatric patients; by month eighteen after initiation of treatment, however, transplant is the predominant modality in the prevalent population. The mean hemoglobin at initiation in pediatric patients is 9.3 g/dl, well below recommended guidelines. Eighty-seven percent of patients under age 13 initiate dialysis with a catheter as their access. There are few differences between boys and girls in mean hemoglobin or mean EPO dose per week, though EPO doses for black girls were higher in the late 1990s and earlier in this decade. Survival of pediatric patients has changed little over the past ten years when comparing cohorts from 1988–1992 and 1993–1997. Cause-specific mortality in prevalent pediatric dialysis patients has shown little change, while mortality due to infection has increased in the adult population.
The mean age of children beginning therapy for ESRD is 12.3; those with glomerulonephritis tend to be older, while those with cystic, hereditary, or congenital disease have an average age of 9.4 (Figure 8.3).

White children are most likely to have received EPO prior to initiating ESRD therapy, and black children least likely (Figure 8.4). Whites also have the highest initial hemoglobin levels, regardless of primary diagnosis, while black children have the lowest levels overall and among patients with cystic kidney disease (Figure 8.5). Across the racial groups, patients with cystic kidney disease have the greatest rates of pre-ESRD EPO and the highest hemoglobin levels.

The mean estimated glomerular filtration rate of children beginning ESRD therapy is 10.3 ml/min/1.73 m²—10.7 for whites, and 9.7 for blacks (Figure 8.6). Albumin levels less than the test’s lower limit occur in 49 percent of patients overall, but in 59 percent of black children, and in 78 percent of black children with secondary glomerulonephritis (Figure 8.7).

Rates of influenza vaccinations are increasing slowly, but fewer than one in five pediatric patients was vaccinated in the 1999–2002 period—far below the HP2010 goal of 90 percent (Figure 8.8). Only 6 percent of patients receive a pneumococcal pneumonia vaccination in a two-year period, and only 7 percent are vaccinated against hepatitis B (Figures 8.9–10). Children with a transplant are, consistently, the least likely to be vaccinated.

Lipid monitoring in pediatric patients has become more frequent than it was in the 1990s, with 44 percent now receiving at least one test in a year (Figure 8.11).
In the 1991–2001 period, catheters were used in 87 percent of pediatric patients younger than 13, and only 27 percent of those 13 and older; fistulas, in contrast, were used in only 7.5 percent of the younger patients, but in more than half of the older (Figure 8.12). Differences are less pronounced by race, though non-white patients are more likely to have AV grafts. Catheter use is more frequent in girls, and AV fistulas and grafts are used more often in boys.

Removal rates for dialysis catheters are 23.8 and 19.7 times higher than those for arteriovenous fistulas and arteriovenous grafts, respectively, demonstrating the reliability of permanent accesses (Figure 8.13). Peritonitis is the most common infectious event associated with peritoneal catheters (Figure 8.14).
emoglobin levels in children on dialysis tend to be lower than those in adult patients (Figure 8.15). Levels differ little by gender, but by race tend to be lowest in black children and, in 2001–2002, highest in Native Americans. 

Mean weekly EPO doses for patients on dialysis are highest in adults and in children age 10–19 (Figure 8.16). The greatest disparities in dosing continue to occur across modalities, with pediatric patients on peritoneal dialysis receiving less than one-third the weekly EPO dose as their counterparts on hemodialysis.

Carnitine is an essential compound in the oxidative process of fatty acids. Carnitine deficiency may play a role in the increasing prevalence, demonstrated by the USRDS, of congestive heart failure, cardiomyopathy, and sudden death, seen particularly in young black children. The percent of pediatric dialysis patients receiving a carnitine test declined slightly in 2002, and remains less than 2 percent (Figure 8.17). Although adult patients are less likely to receive testing than children, they are more likely to receive levocarnitine injections; only 3.2 percent of pediatric patients received L-carnitine in 2002.

At the end of 2002, more than 70 percent of pediatric dialysis patients had a hemoglobin meeting the K/DOQI target of 11 g/dl or higher (Figure 8.18). Weekly EPO doses are now 15,000–16,000 units.

By race, there are few differences between males and females in mean hemoglobin or mean EPO dose per week, though in blacks, EPO doses for girls were higher than doses for boys in the late 1990s and the early years of this decade (Figure 8.22).
Mean hemoglobin (g/dl) & trends in mean hemoglobin & weekly EPO dose: prevalent dialysis patients

Mean hemoglobin

Hemoglobin & EPO dose

Mean hemoglobin (g/dl), by gender: whites (prevalent dialysis)

Mean hemoglobin & EPO dose, by gender: whites (prevalent dialysis)

Mean hemoglobin (g/dl), by gender: blacks (prevalent dialysis)

Mean hemoglobin & EPO dose, by gender: blacks (prevalent dialysis)
n the pediatric population, overall hospital admission rates for infection are highest in patients with a transplant, reaching 543 admissions per 1,000 patient years at risk in 2001 (Figure 8.23). This is in contrast to the adult ESRD population, in which, since 1995, rates have been greatest for those on hemodialysis. Admission rates for children on hemodialysis have risen 47 percent since 1991, compared to a 64 percent increase for adults on the same modality.

Admission rates for bacterial infections in peritoneal dialysis and transplant patients are, given the variability related to the small number of pediatric patients, similar across age groups (Figure 8.24). For hemodialysis patients, however, admission rates are far higher in adults—118 admissions per 1,000 patient years in 2001, compared to 27 in the pediatric population.

The highest rates of admission for urinary tract infections occur, in contrast, in the youngest patients (Figure 8.25). Admission rates for children with a transplant were 151–213 per 1,000 patient years at risk in 1999–2001, compared to 66–74 in adults. In the dialysis population, rates vary little across the age groups.

Given, again, the variation in pediatric admission rates due to the small cohort size, rates of admission for infections due to an internal device and for peritonitis (in peritoneal dialysis patients) do not vary widely between pediatric and adult patients (Figures 8.26–27).

Figures 8.28–30 illustrate the cumulative percentages of patients hospitalized for infections in the three years after initiating ESRD treatment. By the end of this period, 41 percent of children on hemodialysis, 56 percent of those on peritoneal dialysis, and
46 percent of those with a transplant will have been hospitalized for an infection, compared to 53, 60, and 42 percent, respectively, of adult patients. One in five children receiving dialysis is hospitalized during these three years for an infection related to an internal device, and one in ten of those on hemodialysis is admitted for a bacterial infection.

In the pediatric transplant population, 13 and 15 percent of patients are hospitalized during the three-year period for viral and bacterial infections, respectively. Rates are lower in adult patients with transplants, at 7 and 11 percent.

(Figures 8.23–27) incident dialysis patients (in Figure 8.27, peritoneal dialysis only), & first-time, kidney-only transplant patients, with Medicare as primary payor; unadjusted. Infectious hospitalizations represent inpatient claims with a principal diagnosis code for infection. (Figure 8.28) incident hemodialysis patients with Medicare as primary payor, 1991–1999 combined. (Figure 8.29) incident peritoneal dialysis patients with Medicare as primary payor, 1991–1999 combined. (Figure 8.30) first-time, kidney-only transplant patients with Medicare as primary payor, 1991–1999 combined.
Because of the small population size, hospital admission rates and hospital days for pediatric patients vary widely by individual years. When years are combined, however, some trends begin to emerge. Among prevalent dialysis patients with cystic, hereditary, and congenital diseases, for example, admissions per patient year at risk have increased since 1991–1994, while hospital days for these patients have fallen (Figure 8.31). For patients with secondary glomerulonephritis/vasculitis, in contrast, the number of hospital days has grown 16 percent; hospitalizations are longer and more frequent for patients with this diagnosis. Overall admission rates remain relatively stable, while overall hospital days have declined from 13.9 to 11.4 days per patient year at risk.

Among pediatric transplant patients, admission rates by primary diagnosis are quite similar (Figure 8.32). The number of hospital days is again highest for patients with secondary glomerulonephritis/vasculitis, and has grown 53 percent since the early 1990s.

Between 1991 and 1994, admission rates for dialysis patients were highest for those on the modality less than three years (Figure 8.33). By the 1999–2002 period, however, these rates had declined, and rates were highest in older vintage patients. Differences by vintage are not as apparent in the number of hospital days per patient year at risk.

Since the late 1980s, five-year survival probabilities in the pediatric population have remained relatively stable across modalities and primary diagnoses, showing little improvement (Figures 8.34–35). Survival continues to be highly dependent on the type of renal replacement therapy; in 1993–1997, approximately 92 percent of children beginning therapy with a transplant survived five years, compared to 81 percent of those on hemodialysis, and 83 percent of peritoneal dialysis patients.

By primary diagnosis, the greatest probability of survival in children treated with either type of dialysis occurs in those with glomerulonephritis, 87–89 percent of whom live five years after the initiation of therapy. Survival probabilities for those with secondary glomerulonephritis/vasculitis are among the lowest, at 79 percent for hemo-
(8.34) Adjusted five-year survival, by modality & primary diagnosis: 1988–1992 (combined) incident patients

(8.35) Adjusted five-year survival, by modality & primary diagnosis: 1993–1997 (combined) incident patients

(8.36) Unadjusted mortality rates, by vintage: prevalent dialysis patients

dialysis patients and 77 percent for those on peritoneal dialysis.
Because of the small patient population, mortality rates by patient vintage do not show consistent patterns of change (Figure 8.36). When averaged over the 22-year period, however, rates are the same across vintage groups, at 43 deaths per 1,000 patient years at risk.

[Figure 8.31] period prevalent dialysis patients, age 0–19; unadjusted. [Figure 8.32] period prevalent transplant patients, age 0–19; unadjusted. [Figure 8.33] period prevalent dialysis patients, age 0–19; unadjusted. [Figures 8.34–35] incident ESRD patients, age 0–19. All probabilities are adjusted for age, gender, & race; overall probabilities are also adjusted for primary diagnosis. ESRD patients age 0–19, 1996 & 1997, used as reference population. [Figure 8.36] period prevalent dialysis patients, age 0–19; unadjusted.
Overall hospitalization rates have remained relatively steady since 1991 for both pediatric and adult dialysis patients (Figure 8.37). Patients age 0–9 have the highest rates for overall admissions, for infections due to internal devices, and for infections not related to these devices. The highest rates of cardiovascular admissions, in contrast, occur among adults.

While rates can vary widely by year, girls tend to have higher admission rates than boys for all diagnoses (Figure 8.38). And, again for all diagnoses, admission rates by race and ethnicity tend to be greater among black children than among those of other races or ethnic groups (Figure 8.39). In 2002, for example, overall hospitalization rates for black children on dialysis were 30 percent higher than those for whites, and 56 percent higher than those for Hispanics.

Compared to those of adults, rates of both all-cause and cause-specific mortality remain significantly lower in the pediatric population (Figure 8.40). Rates tend to be higher in children age nine and younger than in their older counterparts, and in girls compared to boys (Figure 8.41). The most consistent change over time has occurred in mortality due to cardiovascular disease, with rates falling since 1993 for both the youngest children and for boys.

(8.37) Unadjusted cause-specific hospital admissions, by age: prevalent dialysis patients

(8.38) Unadjusted cause-specific hospital admissions, by gender: prevalent dialysis patients

(8.39) Unadjusted cause-specific hospital admissions, by race/ethnicity: prevalent dialysis patients

(Figures 8.37–39) the category “infection due to internal device” includes infections related to vascular access devices & peritoneal dialysis catheters. At the end of 1998 a new ICD-9-CM code was added for infections due to internal devices in peritoneal dialysis patients; data prior to this date are omitted. — (Figure 8.37) period prevalent dialysis patients, unadjusted.

(Figures 8.38–39) period prevalent dialysis patients, age 0–19, unadjusted. For Hispanic patients we present data beginning in 1996, the first full year after the April 1995 introduction of the revised Medical Evidence form, which contains more specific questions on race & ethnicity. — (Figure 8.40) period prevalent dialysis patients; unadjusted.

(Figures 8.40–41) The Death Notification form was revised in September 1990 to include more detailed categories for cause of death; prior to this time cardiovascular deaths were often classified as being of “other” causes. Because of this, data for cardiovascular & “other” deaths prior to 1991 have been omitted here.
(8.40) Unadjusted cause-specific mortality, by age: prevalent dialysis patients

- All
- Cardiovascular disease
  - 0-9
  - 10-19
  - 20+
- Infection
- Other

(8.41) Unadjusted cause-specific mortality, by gender: prevalent dialysis patients

- All
- Cardiovascular disease
  - Male
  - Female
- Infection
- Other
Infectious complications

The cumulative incidence of infectious complications in children on hemodialysis is 41 percent at three years compared to almost 53 percent in adults. For those on peritoneal dialysis, the cumulative incidence of any infection is 56 percent, a level slightly less than that of adults at 60 percent. In transplant patients, the cumulative incidence of infectious hospitalization is 46 percent in children, a level only slightly higher than the 42 percent found in adults.

Overall hospitalization & mortality

When comparing cohorts from 1988–1992 and 1993–1997, survival of pediatric patients has changed little over the past ten years.

Cause-specific hospitalization & mortality

Cause-specific mortality in prevalent pediatric dialysis patients has shown little change, while mortality due to infection has increased in the adult population.