My strategy is simply to resolve
To see it through, whatever it might bring,
And hope that something other should emerge,
That words that come to me along the way

Make up a document that chronicles
A solitary life, bounded by hope.
And so I offer you these rites of spring.
In 2006, the most recent year of available data, the number of kidney transplants performed in the United States surpassed 18,000. This was an increase of 3.5 percent over the number performed in 2005, growth that has remained fairly constant throughout the past decade. Of special note is the continued increase in the use of deceased donor organs since 2003. From 1988 through 2002, the percentage of kidney transplants from deceased donors had been declining steadily; from 2003 through 2006, however, it has grown, with the number of transplants rising 6–7 percent per year.

Many factors could be contributing to this shift in the source of organs. In 2003, the Organ Procurement and Transplantation Network implemented the Expanded Criteria Donor program, helping to streamline the distribution of "marginal" kidneys to patients willing to accept such kidneys. In 2006, 20 percent of adult kidney transplant recipients received a kidney from an expanded criteria donor, up from 16 percent a decade earlier. At the same time, the use of kidneys from donations after cardiac death has also seen an increase. In 1996, 1 percent of kidneys from deceased donors transplanted into adult recipients were reported to be from donations after cardiac death. A decade later, in 2006, this had grown to 10 percent. Initiatives such as the Organ Donation Breakthrough Collaborative and the Organ Transplantation Breakthrough Collaborative (including the 58 DSA Challenge, initiated by the Health Resources and Services Administration), have improved deceased donor conversion rates, undoubtedly contributing to the growing use of kidneys from deceased donors since 2003.

The use of living donors, however, has fallen in the most recent two years, down 3 percent in 2006 from its highest point in 2003. Perhaps due to increased access to deceased donors, this decline in the use of living donors has resulted in a net increase in transplantations consistent with the average increase of 3.7 percent per year over the past decade. While the total number of living donations is down, however, the use of living unrelated donors continues to increase relative to the total number of living donations, and now accounts for 45 percent of all living donor transplantations. The rising use of kidney paired exchange programs will continue to increase the number of living unrelated kidney donations performed in the United States.

While the number of transplantations increased by 4 percent in 2006, the number of patients on the kidney transplant waiting list has grown by 8 percent. At the conclusion of 2006, nearly 70,000 patients were awaiting a kidney transplant in the United States. Nearly one-third of those on the waiting list, however, were inactive, resulting in approximately 46,000 active candidates. Waiting times across the country continue to increase, with the median time to transplant projected to be nearly four years for candidates added to the list in 2008, and six years for sensitized patients added in the same year. Of patients added to the waiting list in 2001, approximately 16 percent died while awaiting a transplant, while 12 percent of white candidates and 22 percent of non-white candidates were still awaiting a transplant five years after being added to the list. Continued efforts to increase the donor pool will help alleviate the continuing problem of the donor shortage in the United States.

With one-year survival with a functioning transplant at 90 and 95 percent for recipients of deceased and living donor transplants, respectively, attention continues to focus on improving long-term transplant outcomes. Conditional on
surviving the first year with a functioning transplant, 50 percent of deceased and living donor transplant recipients are projected to have a functioning transplant at 12 and 25 years, respectively. These conditional half-lives are only slightly better than those observed a decade earlier. For recipients who die with a functioning transplant, cardiovascular disease continues to be the leading cause of death.

New to this year’s transplant chapter is a focus on adult versus pediatric transplantation. The majority of the chapter addresses adult recipients, while the final pages are dedicated to pediatric recipients, defined as those under the age of 18 at the time of transplantation. At the conclusion of 2006, there were 747 pediatric patients on the kidney transplant waiting list, 468 (63 percent) of whom were currently active. Pediatric patients transplanted in 2006 waited less than seven months to receive their transplant. There were 813 transplants performed in pediatric patients in 2006, with transplants from living donors accounting for 53 percent. One-year graft survival was over 93 percent for all pediatric patients transplanted between 2002–2006. At five years post-transplant, graft survival was 88, 84, and 72 percent, respectively, for patients transplanted at ages 0–4, 5–10, and 11–17, respectively. “Chronic rejection” was most commonly listed as the cause of graft failure for pediatric patients whose grafts failed during 2002–2006, with non-compliance noted as a primary or contributing cause of graft failure in 23 percent.
This year we introduce data on active listings. More than 68,000 patients were on the wait list for a kidney or kidney-pancreas transplant in 2006; just two-thirds of them, however, were active listings. While the total number of wait-listed patients has grown fivefold since 1991, the number of active listings is just 3.5 times greater, as inactive listings continue to increase. Five percent of all patients on the wait list have multiple listings.

The distribution by age of wait-listed patients has changed considerably since 1991. In that year, just 28.7 percent of patients were age 50 or older; by 2006, however, this had risen to 56.8 percent, with 15.2 percent age 65 or older. Distribution by gender has remained stable, with males accounting for approximately six in ten wait-listed patients. By race, patients of races other than white are gradually accounting for a larger proportion of the wait list. The number of African Americans, for example, rose from 32.8 percent in 1991 to 35.3 percent in 2006, and the number of Asians increased from 4.4 to 7.2 percent.

The median wait time for adults listed in 2003, the most recent year the median was observed, was two years and ten months. Median wait times are projected to be four years for adults added to the waiting list in 2006. Non-white candidates continue to have longer wait times than white candidates, and candidates with B and O blood types wait longer than patients with A and AB blood types. Sensitized patients, defined here as those with a PRA of 10 percent or greater, tend to wait approximately twice as long as unsensitized patients. Geographic variation exists in median wait times for adults. In 2006, adults transplanted in Alabama and Mississippi waited the longest, at 4.5 and 3.8 years, respectively. The states of New Hampshire, Indiana, Maine, Iowa, Utah, Arkansas, and Kentucky all had median wait times less than or equal to one year for adults transplanted in 2006. Projected wait times for adults listed in 2006 in the given state follow similar patterns.
Forty-five percent of both new and prevalent adult patients on the transplant wait list are willing to accept an expanded criteria donor (ECD) kidney. This percentage varies widely, however, by OPTN region, ranging from 17–21 percent of listings in Region 5 to 84–86 percent of those in Region 9.

For adult, first-time kidney transplant candidates, the likelihood of dying while awaiting a transplant has increased only slightly since the early 1990s. For patients listed in the most recent year, the probability of death rises from 0.04 in the first year after listing to 0.28 in the fifth year — up from 0.025 and 0.22, respectively, for patients listed in 1991.

Five years after a first listing on the kidney-only wait list in 2001, nearly 69 percent of white patients have received a transplant, compared to 53.6 percent of African Americans and 57.0 percent of Asians. The number who die prior to transplant ranges from 13.7 percent among Asians to 18.7 percent among African Americans. The number who are still waiting for a transplant at five years after listing, however, is nearly twice as high in non-white patients as in whites, at 22.0–23.1 percent compared to just 11.5 percent.
In the population age 20 and older, the rate of new ESRD cases per million population has increased 65 percent since 1991, from 299 to 495. Because growth in the number of transplantations has not kept pace with growth in the incidence of ESRD, the number of transplantations per 100 dialysis patient years has fallen during the same period—29 percent, from 6.4 to 4.6.

Apart from the District of Columbia (with 373 transplants performed per million population), the transplant centers in the state of Minnesota performed the highest number of adult kidney transplants per million population in 2006, at 107, followed closely by Pennsylvania and Wisconsin, at 98 and 89, respectively. When considering the state in which patients live, Vermont, Minnesota, and North Dakota had the highest transplant rates, with 12.5, 9.8, and 8.8 transplants per 100 dialysis patient years, respectively.

Since 1991, the transplant rate per 100 dialysis patient years has fallen 39–45 percent for patients age 18–49, remained steady for those age 50–64, and grown 147 percent for those 65 and above. Rates for both males and females have fallen 29–30 percent, and continue to be slightly higher for men. By primary diagnosis, the transplant rate continues to be greatest among patients with cystic kidney disease, and lowest among those with hypertension and diabetes.

At 2.9 per 100 dialysis patient years in 2006, the rate of transplants from deceased donors has fallen 41 percent since 1991, with a slight increase since 2003. The rate of transplants from all living donors is 17 percent greater than in 1991, at 1.6, but has been falling slightly since 2001. One in five deceased donor transplants in 2006 was from an expanded criteria donor (ECD), while nearly one in ten was a donation after cardiac death (DCD).
The most common initial immunosuppressive regimen for adults transplanted in 2004–2006 was the combination of tacrolimus and mycophenolate mofetil. Steroid use has continued to decline, both at the time of transplant and at one year post-transplant. mTOR inhibitor use has also declined in recent years, both at the time of transplant and one year post-transplant. Induction antibodies are used in over 60 percent of adult transplants, with thymoglobulin being the most common induction agent.

**figures 7.17–22** The most common initial immunosuppressive regimen for adults transplanted in 2004–2006 was the combination of tacrolimus and mycophenolate mofetil. Steroid use has continued to decline, both at the time of transplant and at one year post-transplant. mTOR inhibitor use has also declined in recent years, both at the time of transplant and one year post-transplant. Induction antibodies are used in over 60 percent of adult transplants, with thymoglobulin being the most common induction agent.

**figure 7.11** Transplant rates among all ESRD patients age 20 & older in the given year. **figure 7.12** All transplants performed at U.S. centers, patients age 18 & older, 2006, does not include transplants performed in Puerto Rico. **figure 7.13** Per 100 dialysis patient years; patients age 18 & older, 2006, adjusted for age, gender, race, & primary diagnosis. **figure 7.14** Patients age 18 & older; adjusted for age, gender, race, & primary diagnosis. **figure 7.15** Patients age 18 & older, unadjusted; transplants from donors of unknown type omitted. **figure 7.16** First-time, kidney-only deceased donor transplants, age 18 & older. ECD (expanded criteria donor) status as reported by OPTN. **figure 7.17** First-time, kidney-only transplants, age 18 & older, 2004–2006. Maintenance immunosuppression as identified to OPTN. **figure 7.18** First-time, kidney-only transplants, age 18 & older, 2004–2006. Immunosuppression as identified to OPTN. Excludes steroids. **figure 7.19** Cyclo: cyclosporine A; CsM: cyclosporine microemulsion. Cyclo includes CsA & CsM. MMF: mycophenolate mofetil & mycophenolate sodium. Tac: tacrolimus; includes traditional & modified release formulations. mTOR: mammalian target of rapamycin; includes sirolimus & everolimus. **figure 7.20** For details on how to read the map legends, please see page xvi in the Introduction.
With one-year survival with a functioning transplant at 90 percent for recipients of deceased donor transplants and 95 percent for recipients of living donor transplants (Reference Section F of Volume Three), attention continues to focus on improving long-term transplant outcomes. Five-year survival with a functioning graft was 68 and 80 percent for recipients of kidneys from deceased and living donors, respectively, in 2001, up from 59 percent and 76 percent in 1991. Ten-year survival with a functioning graft was 39 and 57 percent in 1996, up from 33 and 55 percent in 1991. Conditional on surviving the first year with a functioning transplant, 50 percent of recipients are projected to have a functioning transplant at 12 and 25 years for recipients of deceased and living donor transplants, respectively.

Primary non-function, graft failure within seven days of transplant, is now reported in only 2 percent of deceased donor adult transplants and only 1 percent of living donor adult transplants.

Differences in the reported occurrence of delayed graft function (DGF) vary by the type of kidney transplanted. In 2006, DGF was reported in only 3 percent of transplants from living donors. Twenty-one percent of transplants from standard criteria donors (SCDs) experienced DGF, compared to 27 percent of transplants from ECD donors and 39 percent of transplants from donations after cardiac death (DCD).

The numbers of transplanted kidneys that fail during the calendar year (excluding death with function) has remained stable since 2004. The percentage of patients coming onto dialysis from a failed transplant is now approximately 4 percent of the total population starting dialysis in the given year.
figure 7.28 For adult transplant recipients for whom a graft failure during 2006 necessitated dialysis or retransplantation, the median time their transplant had functioned was six years, with 25 percent having transplants that functioned 10 years or more. In another 25 percent of patients, the transplant had functioned less than two and a half years.

figure 7.29 Graft failure rates have continued to show improvement over the past 15 years. In 2006, there were 6.9 graft failures (including death with function) per 100 patient years with a functioning transplant. The rate of graft failures necessitating dialysis or retransplantation was down to 3.5, while the rate of death with a functioning graft remained constant over the same time frame, at approximately 3.4 deaths per 100 patient years with a functioning graft. In 2006, the rate of graft failures due to death with function was almost equal that of graft failures due to return to dialysis or retransplantation.

figure 7.30–31 The primary cause of death for adult patients who die with a functioning graft is cardiovascular disease. Thirty percent of all deaths were reported to be from cardiovascular causes, with infections accounting for 18 percent of deaths and malignancies for 8 percent. The cause of death was unknown or unreported in 21 percent of deaths. When considered as a function of time post-transplant, cardiovascular disease remains the leading known cause of death out to eight years post-transplant. The number of unknown causes of death increases with time from transplantation.
The number of pediatric patients wait-listed for a kidney-only or kidney-pancreas transplant has increased nearly 62 percent since 1991, from 462 to 747. The number of active patients on the list, however, has fallen since its peak of 633 in 2004, and at the end of 2006 was 468 — just 3.5 percent higher than in 1991.

Pediatric transplant candidates wait less than one year to receive their transplants. The time to transplant does not vary substantially by race. As with adult candidates, pediatric patients with blood type B or O wait slightly longer to receive a transplant.

The number of deceased donor transplants in pediatric patients, while growing from 280 in 2003 to 384 in 2006, is now at the same level seen in 1991. The number of living donor transplants, in contrast, is now 55 percent higher than in 1991, at 429.

Overall, the rate of pediatric transplantation per 100 patient years on dialysis has remained fairly stable over the past 15 years, at 40–50. The rate of transplants from deceased donors has been increasing since 2003 — and is now more than 50 percent greater than historic levels of approximately 20 transplants per 100 patient years on dialysis — while the rate of transplants from living donors has remained fairly stable.

Transplant rates in the pediatric population are higher than adult rates, and all have increased since 2000. In 2006, rates were 49.8 per 100 dialysis years in infants, 60.2 and 50.6 in children ages 1–4 and 5–10, and 48.1 in those age 11–17.
For pediatric transplant recipients transplanted during the past five-year period, tacrolimus and mycophenolate mofetil (MMF) is the most common immunosuppressive regimen reported at the time of transplantation, similar to what is observed in the adult transplant population over the same time period.

Pediatric patients age 11–17 have the highest rate of graft failure (including death with a functioning graft) through the first five years post-transplant, with only 72 percent having a functioning graft at five years, compared to 84 and 88 percent of recipients ages 5–10 and less than 5, respectively.

Considering graft failures which necessitate dialysis or retransplantation, recipients age 11–17 again experience the highest failure rates, with 26 percent returning to dialysis by five years post-transplant, compared to 15 and 8 percent of those age 5–10 and 0–5 years, respectively.

“Chronic rejection” was the most frequent cause of graft failure necessitating dialysis or retransplantation in pediatric recipients whose transplants failed during 2002–2006, and chronic and acute rejections accounted for nearly 50 percent of these failures. Non-compliance with immunosuppressive medications was listed as a primary or contributing cause of graft failure in 23 percent of pediatric patients. Patients age 13–17 at the time of graft failure had the highest rates of non-compliance.