

intestine

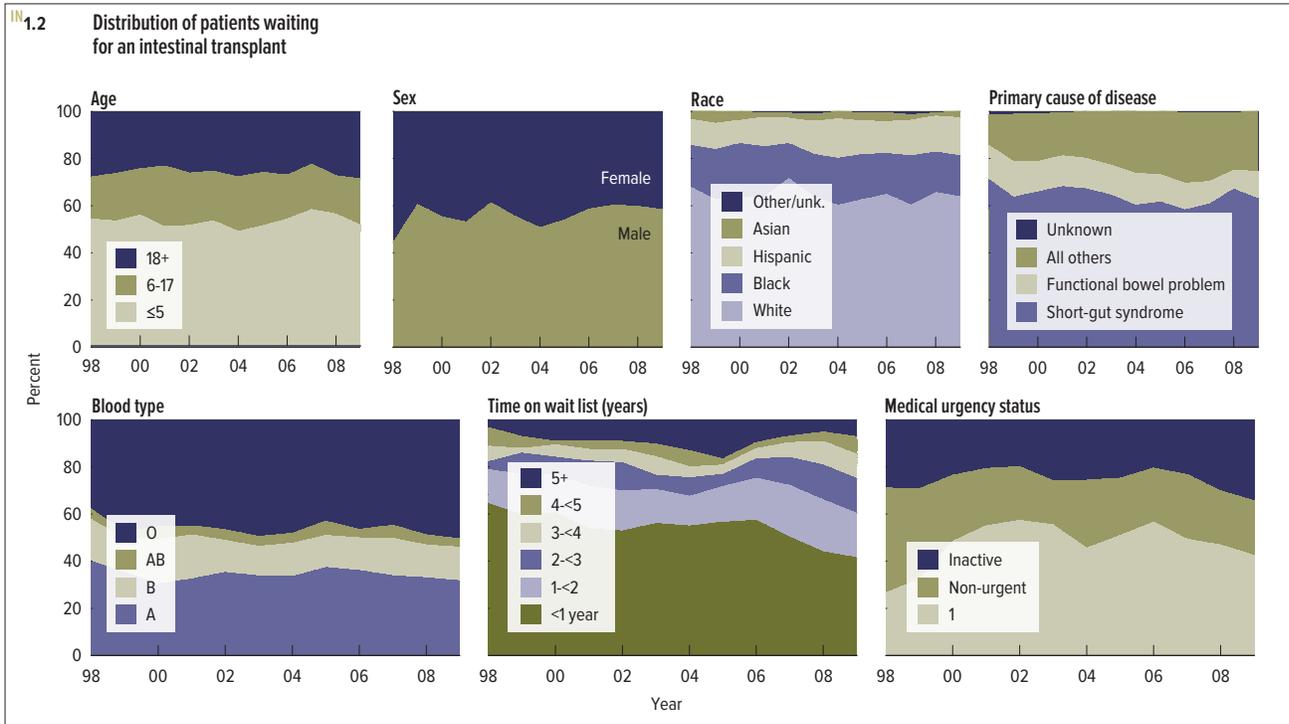
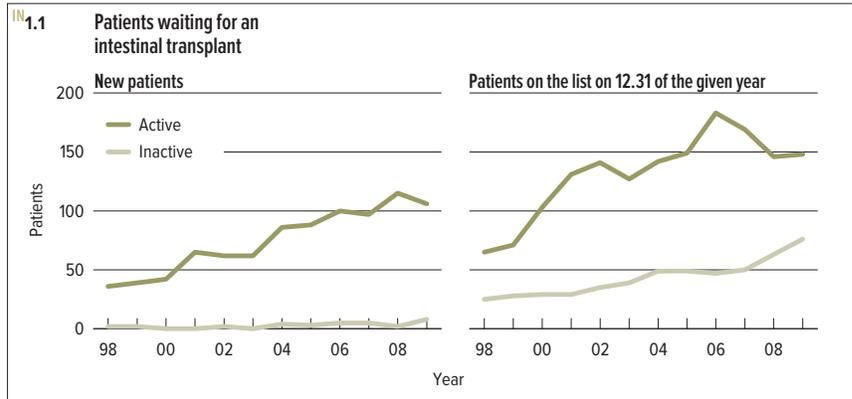
Over the past 20 years, intestinal transplantation has progressed from experimental therapy to accepted treatment for children and adults with intractable, life-threatening intestinal failure. Intestinal transplants may be performed in isolation, with a liver transplant, or as part of a multivisceral transplant that may include liver, intestine, and pancreas. The number of new patients listed for intestinal transplant has been increasing (Figure 1.1). In 2009, 51.8% of those on the waiting list were aged 5 years or younger, 19.6% were aged 6 to 17 years, and 28.6% were aged 18 years or older (Figure 1.2). However, the relative proportion of new patients listed who are aged 18 years or older has been increasing (Figure 1.3). Among those listed in 2006, 60.3% had received an allograft by 3 years after listing, 20.2% had died, 10.7% had been removed from the list, and only 8.8% were still waiting (Figure 1.6). The mortality rate of patients placed on the waiting list has declined remarkably, from 61.1 to 13.1 per 100 wait-list years between 1998 and 2009 (Figure 1.9).

Roughly half of intestinal transplants have been combined with liver transplants, and all but a few have been deceased donor transplants (Figure 3.1). One-year graft survival has increased from 59.5% for transplants in 1991–1995 to 72.2% for transplants in 2008–2009 (Figure 4.2). However, long-term graft survival rates remain relatively low. Five-year graft survival improved from 31.6% for transplants in 1991–1995 to 50.6% for transplants in 2004–2005 (Figure 4.2). Acute rejection remains a challenge, with 43.1% of recipients in 2005–2009 having had an acute rejection by 1 year after transplant (Figure 4.5). Infectious complications are also a major cause of morbidity and mortality after intestinal transplant.

wait list 76
 deceased donation 80
 transplant 81
 outcomes 83
 immunosuppression 84
 center characteristics 85
 maps of transplant centers 86

To know that Brian's life is still blessing lives through his gift of life, which was his spoken desire months before his unexpected death, is a good feeling. Loss is complex and deep, but the gift of life brought us one positive facet.

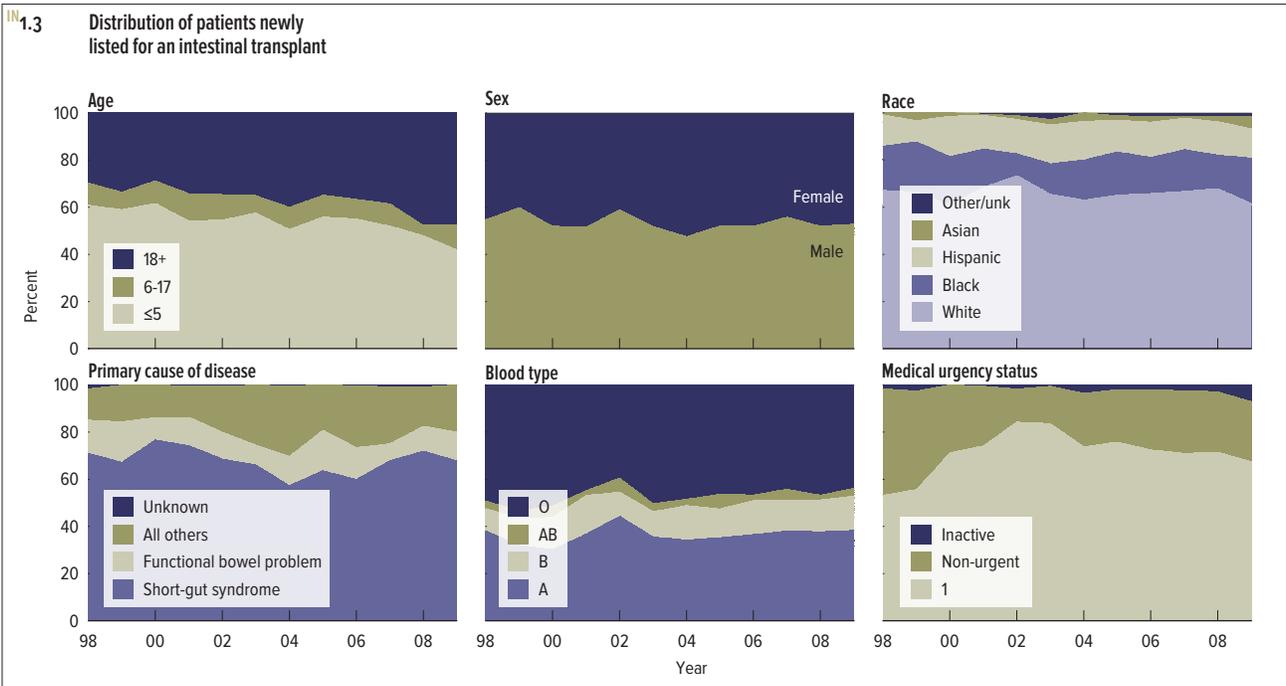
Deb, donor mom



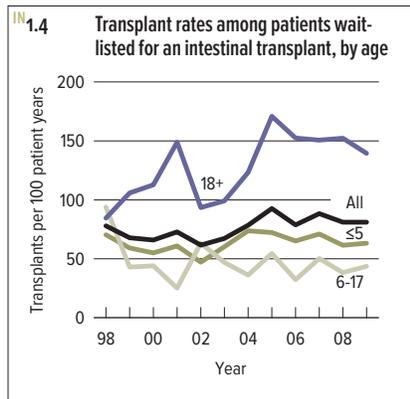
wait list From 1998 to 2009, the number of new patients listed for an intestinal transplant (with or without another organ) increased 3-fold, from 38 to 114 (Figure 1.1). For the same years, the number of patients listed on December 31 of the year increased more than 2-fold, from 90 to 224, with one-third of patients listed as inactive in 2009 (Figure 1.1). In 2009, 51.8% of those on the waiting list for an intestinal transplant were aged 5 years or younger, 19.6% were aged 6 to 17 years, and 28.6% were aged 18 years or older (Figure 1.2). There have been more males than females on the waiting list; in 2009, 58.5% were male. The racial composition of the waiting list has changed little; in 2009, 63.8% were white, 17.4% were black, 16.1%

were Hispanic, and 2.7% were Asian. The most common etiology of intestinal failure was short-gut syndrome. In 2009, 63.0% of patients on the waiting list had short-gut syndrome, while 11.6% had a functional bowel problem; in 25.5%, the etiology was other or unknown. Time on the waiting list has been increasing slightly, although in 2009, 41.5% had been on the list for less than 1 year, and only 7.1% had been on the list for 5 or more years. Since 1998, there has been an increase in the number of patients listed as medically urgent (status 1), from 26.7% in 1998 to 42.4% in 2009.

The relative proportion of newly listed patients aged 18 years or older has been increasing (Figure 1.3). Between 1998 and 2009,

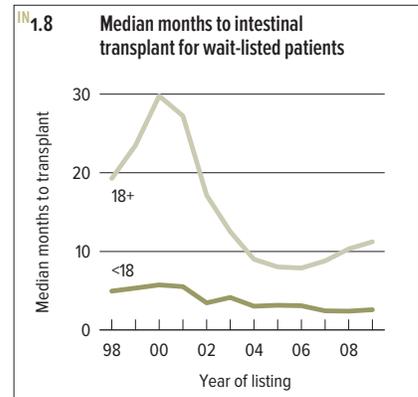
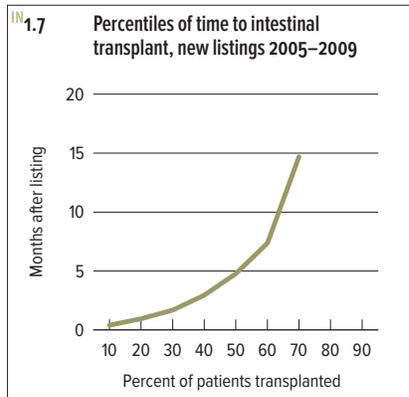
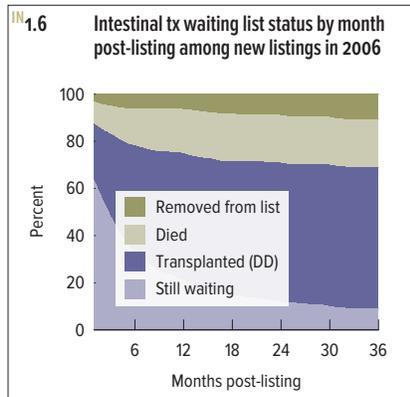


the proportion of newly listed patients who were aged 18 years or older increased from 29.7% to 47.5%, while the proportion aged 6 to 17 years changed little, from 9.4% to 10.4%, and the proportion aged 5 years or younger declined from 60.9% to 42.1%. Over the past decade, there have been no changes in the sex or racial distribution of patients newly listed for intestinal transplant. Similarly, there have been no changes in the cause of disease in these patients, although the categories chosen may not precisely define the true causes of intestinal failure. Medical urgency (status 1) increased from 53.1% in 1998 to 83.6% in 2003, and then declined to 67.5% in 2009.



IN 1.5 Intestinal transplant waiting list activity

| | 2007 | 2008 | 2009 |
|------------------------------|------|------|------|
| Listings at start of year | 234 | 222 | 213 |
| Listings added during year | 281 | 267 | 260 |
| Listings removed during year | 293 | 276 | 246 |
| Listings at end of year | 222 | 213 | 227 |
| Removal reason | | | |
| Deceased donor transplant | 196 | 190 | 181 |
| Living donor transplant | . | . | 1 |
| Patient died | 55 | 49 | 30 |
| Patient refused transplant | 1 | 2 | 1 |
| Trans. to another center | 3 | 3 | 5 |
| Improved, tx not needed | 11 | 17 | 17 |
| Too sick to transplant | 9 | 4 | 7 |
| Other | 18 | 11 | 4 |



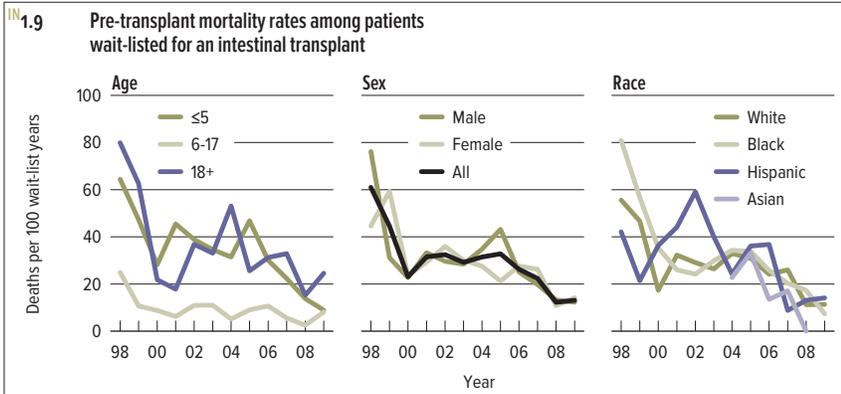
wait list The overall intestinal transplant rate has remained relatively stable, from 78.0 per 100 patient-years on the waiting list in 1998 to 81.0 in 2009 (Figure 1.4). However, the rate within each age group has seen significant changes over this time period, with most of the growth occurring among adults. Indeed, among recipients aged 18 years or older, the transplant rate has increased from 84.7 per 100 patient-years to 139.5. In 2009, the transplant rate for patients aged 5 years or younger was 63.2 per 100 patient-years and among patients aged 6 to 17 years, 43.6 per 100 patient-years on the waiting list.

From 2007 to 2009, death as a reason for removal from the waiting list decreased from 19% to 12% of listings removed (Figure 1.5). In 2009, the number removed because a transplant was no

longer needed was only 6.9% of those removed. Among listings for an intestinal transplant in 2006, 60.3% received a deceased donor organ, 20.2% died, 10.7% were removed from the list, and 8.8% were still waiting 3 years after listing (Figure 1.6).

Among patients listed in 2005–2009, 50% underwent transplant in 4.8 months (Figure 1.7). The median time to transplant has decreased for waiting list candidates younger than 18 years old, from 5.8 months in 2000 to 2.6 months in 2009 (Figure 1.8). Among candidates aged 18 years or older, there has been a decrease in median time to transplant, from a peak of 29.8 months in 2000 to 11.2 months in 2009.

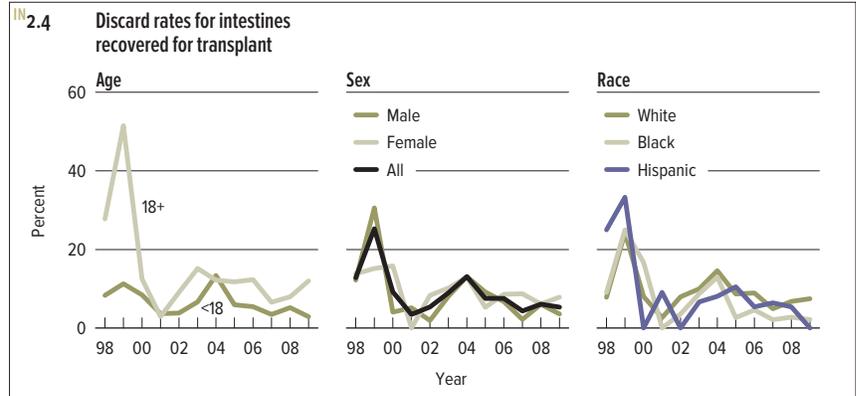
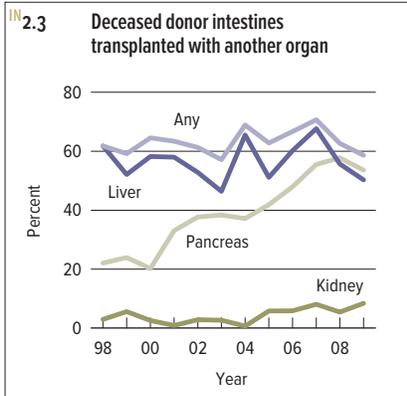
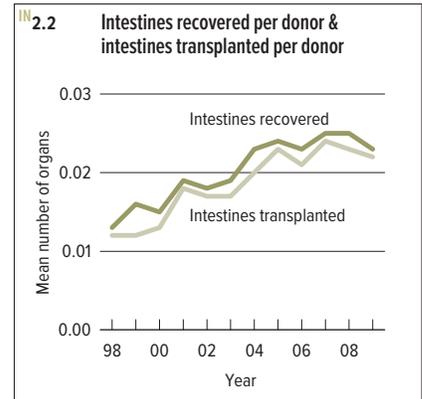
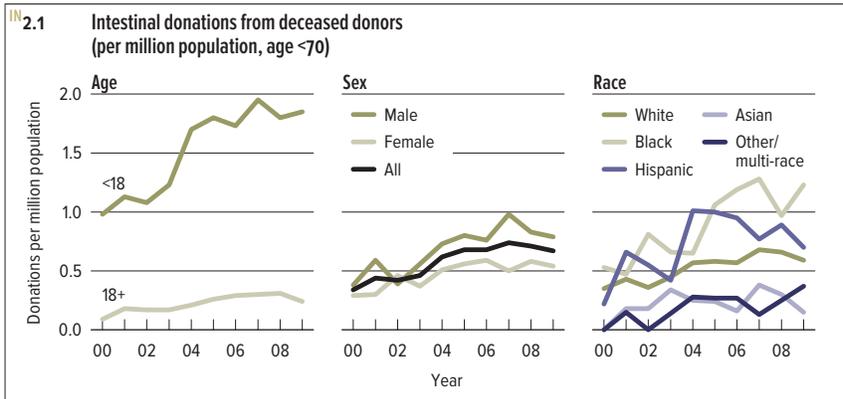
Importantly, death on the waiting list has decreased from 61.1 per 100 wait-list years in 1998 to 13.1 per 100 wait-list years in 2009



IN1.10 Characteristics of patients on the intestinal tx waiting list on December 31, 2009

| | Level | N | % |
|--------------------------|----------------------|-----|------|
| Age | 0-5 | 116 | 51.8 |
| | 6-17 | 44 | 19.6 |
| | 18-34 | 22 | 9.8 |
| | 35-49 | 20 | 8.9 |
| | 50-64 | 19 | 8.5 |
| | 65+ | 3 | 1.4 |
| Sex | Female | 131 | 58.5 |
| | Male | 93 | 41.5 |
| Race | White | 143 | 63.8 |
| | Black | 39 | 17.4 |
| | Hispanic | 36 | 16.1 |
| | Asian | 6 | 2.7 |
| | Other/unknown | 0 | 0.0 |
| Primary cause of disease | Short-gut syndrome | 141 | 63.0 |
| | Func. bowel problem | 26 | 11.6 |
| | All others | 57 | 25.5 |
| | Unknown | 0 | 0.0 |
| Transplant history | Listed for first tx | 207 | 92.4 |
| | Listed for subseq tx | 17 | 7.6 |
| Blood type | A | 71 | 31.7 |
| | B | 32 | 14.3 |
| | AB | 8 | 3.6 |
| | O | 113 | 50.5 |
| Time on wait list | <1 year | 93 | 41.5 |
| | 1-<2 | 42 | 18.8 |
| | 2-<3 | 33 | 14.7 |
| | 3-<4 | 23 | 10.3 |
| | 4-<5 | 17 | 7.6 |
| | 5+ | 16 | 7.1 |
| Medical urgency status | Status 1 | 95 | 42.4 |
| | Non-urgent | 52 | 23.2 |
| | Inactive | 77 | 34.4 |
| | Unknown | 0 | 0.0 |

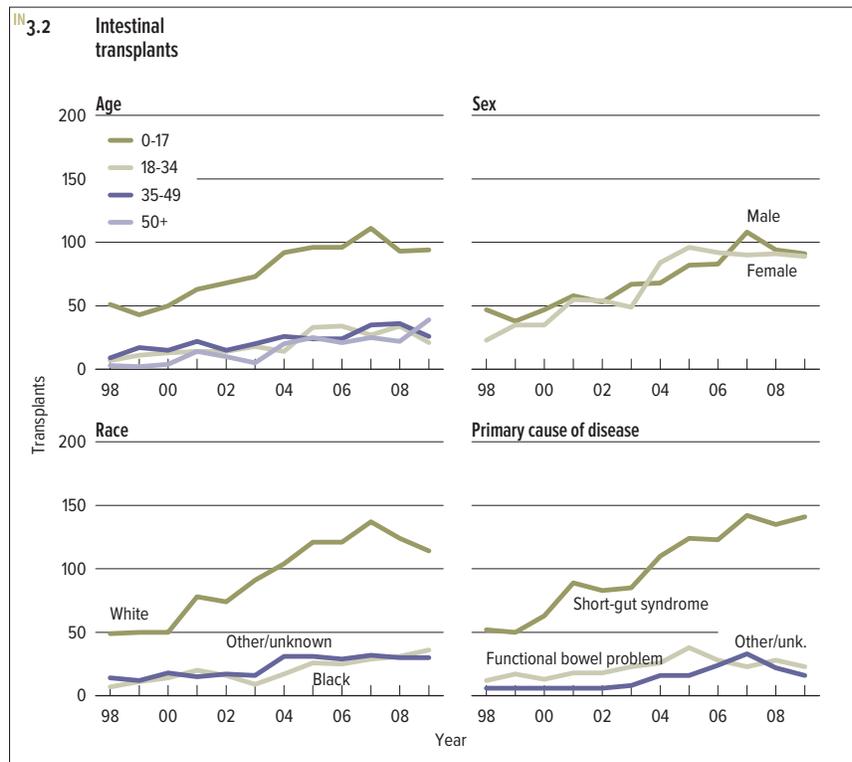
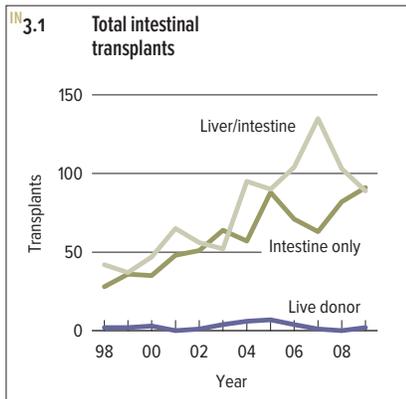
(Figure 1.9). Among patients listed for intestinal transplant at the end of 2009, 51.8% were aged 5 years or younger, 19.6% were aged 6 to 17 years, and 28.6% were aged 18 years or older (Figure 1.10). White recipients accounted for 63.8% of patients listed, followed by blacks (17.4%) and Hispanics (16.1%). The leading cause of intestinal failure was short-gut syndrome, which accounted for 63.0% of patients. Most patients (92.4%) were listed for a first intestinal transplant. Most patients (60.3%) spent less than 2 years on the waiting list, and 39.7% waited 2 or more years. Status 1 listings accounted for 42.4% of patients, and 34.4% of patients were listed as inactive.



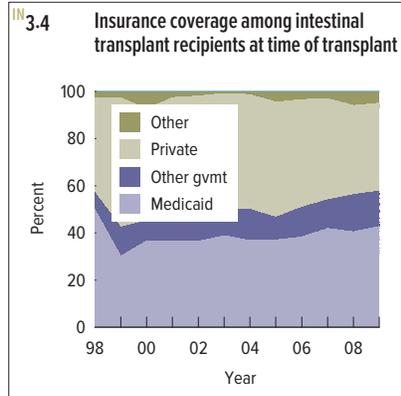
deceased donation

Most deceased donor intestinal allografts have been from donors younger than 18 years old (Figure 2.1). In addition, from 2000 to 2009 there was an increase in donations from deceased donors, consistent with the increase in the number of intestinal transplants during this period. Donations from deceased donors younger than 18 years old increased from 0.98 per million population in 2000 to 1.85 per million population in 2009. Deceased donation rates were higher for males than females. Donation rates were highest for blacks, followed by Hispanics and whites. The number of intestines recovered and transplanted per donor has increased over the past 12 years, and most intestines recovered

from deceased donors were indeed transplanted (Figure 2.2). Fifty-nine percent of deceased donor intestines were transplanted with another organ in 2009; this has changed little over the past 12 years (Figure 2.3). Liver has been the organ most commonly transplanted with intestine, while the number of times a pancreas was transplanted with an intestine has increased dramatically. This increase is likely attributable to several factors, including changes in policy, reporting, and surgical technique. In 2009, 50.3% of intestinal transplants were performed with a liver transplant, while 53.6% were with a pancreas, and 8.4% were with a kidney. The overall discard rate for donor intestines has decreased over the past several years, from 12.8% in 1998 to only 5.3% in 2009 (Figure 2.4).



transplant In the past decade, the number of intestinal transplants increased more than 2-fold, from 70 in 1998 to 180 in 2009 (Figure 3.1). This increase was due to roughly equivalent increases in intestine alone (from 28 to 91) and liver/intestine (from 42 to 89) transplants. The increase in intestinal transplants over the past decade has occurred in all age groups, in males and females, and in whites and blacks (Figure 3.2). In 2009, there were 94 intestinal transplants in those aged 17 years or younger, 21 in those aged 18 to 34 years, 26 in those aged 35 to 49 years, and 39 in those aged 50 years or older. From 2000 to 2009, the rate of deceased donor intestinal transplant increased from 65.2 transplants per 100 patient-years on the waiting list to 80.5 per 100 patient-years (Figure 3.3). The rate of living donor intestinal transplant remains very low; in 2009 it was 0.5 transplants per 100 patient-years on the waiting list. There was 1 living donor intestinal transplant in 2007; there were none in 2008 and 2 in 2009.

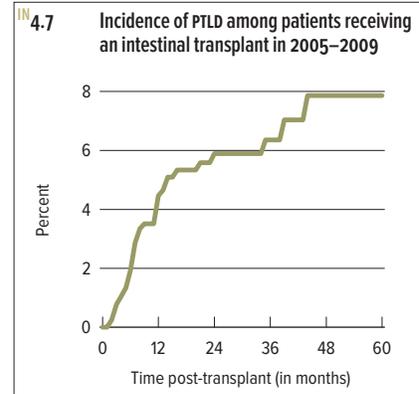
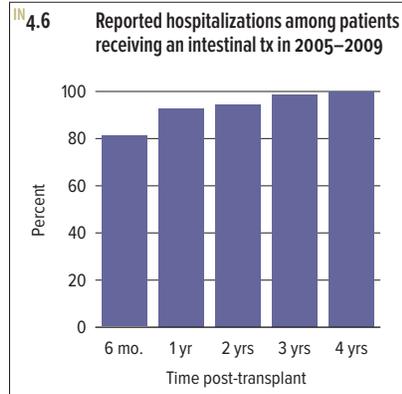
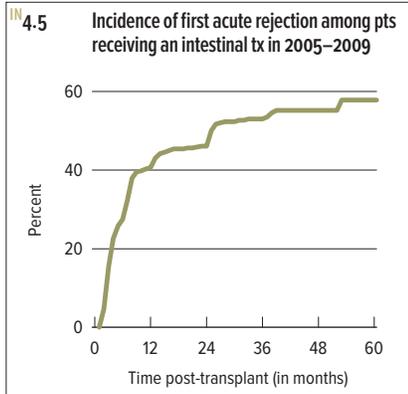
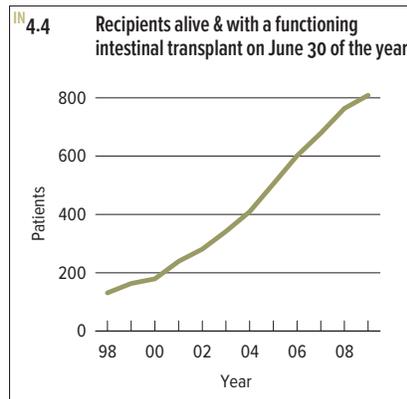
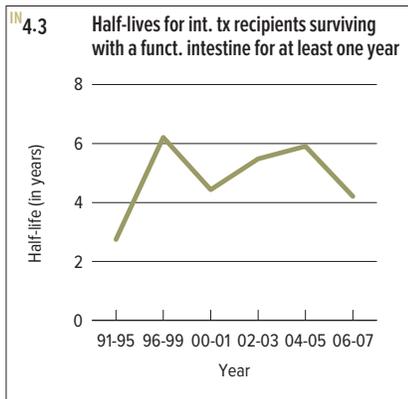
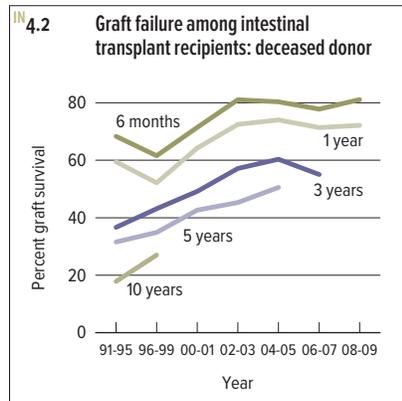
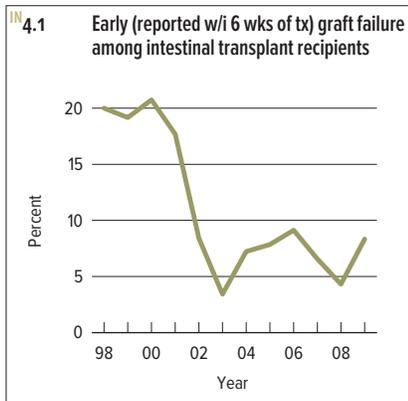


transplant In 2009, 42.8% of intestinal transplant recipients had Medicaid as their primary insurance provider, and 37.2% had private insurance (Figure 3.4). This payer mix is consistent with the large proportion of intestinal transplants that are performed in children; few qualified for Medicare, for example. Among intestinal transplant recipients in 2009, 52.2% were aged 0 to 17 years, 11.7% were aged 18 to 34 years, 14.4% were aged 35 to 49 years, and 21.7% were aged 50 years or older (Figure 3.5). Roughly equal numbers were male and

3.5 Characteristics of intestinal transplant recipients, 2009

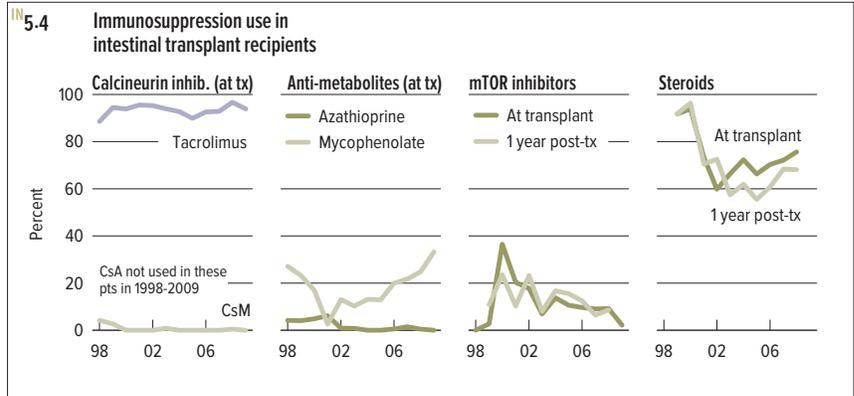
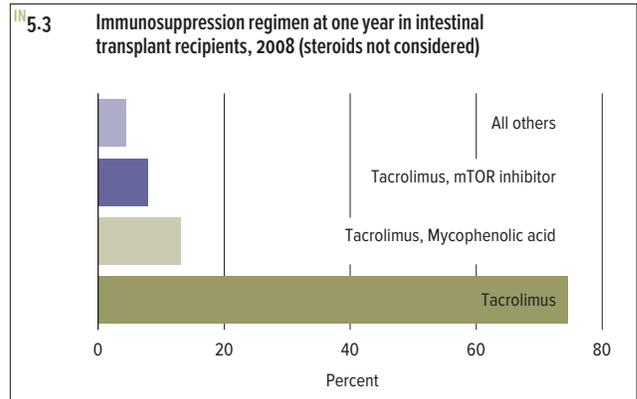
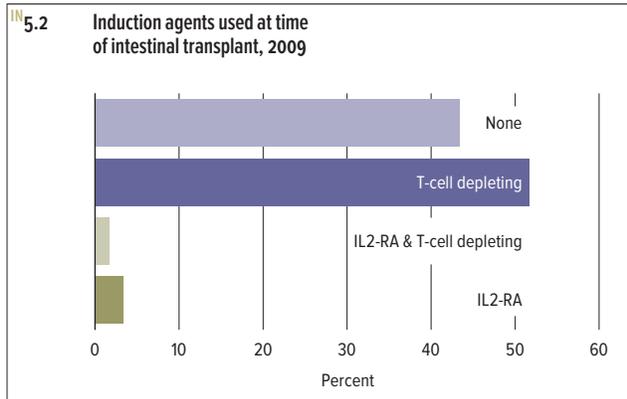
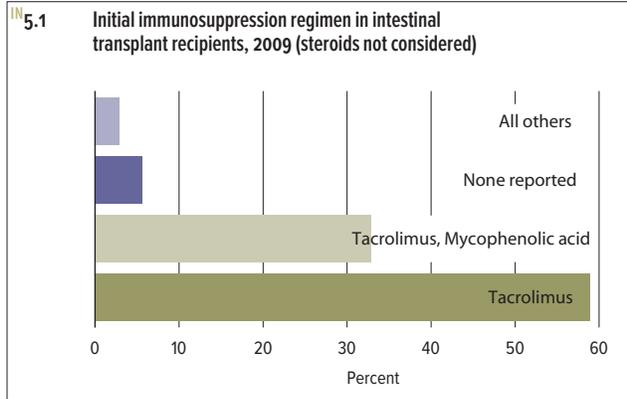
| | Level | N | % |
|------------------------------|--------------------------|-------|-------|
| Age | 0-17 | 94 | 52.2 |
| | 18-34 | 21 | 11.7 |
| | 35-49 | 26 | 14.4 |
| | 50-64 | 38 | 21.1 |
| | 65+ | 1 | 0.6 |
| Sex | Female | 89 | 49.4 |
| | Male | 91 | 50.6 |
| Race | White | 114 | 63.3 |
| | Black | 36 | 20.0 |
| | Hispanic | 20 | 11.1 |
| | Asian | 8 | 4.4 |
| | Other/unknown | 2 | 1.1 |
| Primary cause of disease | Short-gut syndrome | 141 | 78.3 |
| | Functional bowel problem | 23 | 12.8 |
| | Other/unknown | 16 | 8.9 |
| Blood type | A | 78 | 43.3 |
| | B | 26 | 14.4 |
| | AB | 7 | 3.9 |
| | O | 69 | 38.3 |
| Time on waiting list | <30 days | 69 | 38.3 |
| | 31-60 days | 27 | 15.0 |
| | 61-90 days | 19 | 10.6 |
| | 3-<6 months | 28 | 15.6 |
| | 6-<12 months | 22 | 12.2 |
| | 1-<2 years | 7 | 3.9 |
| | 2-<3 years | 4 | 2.2 |
| | 3+ years | 4 | 2.2 |
| | BMI | <18.5 | 69 |
| 18.5-24.9 | | 71 | 39.4 |
| 25.0-29.9 | | 14 | 7.8 |
| 30.0-34.9 | | 8 | 4.4 |
| 35.0-39.9 | | 1 | 0.6 |
| 40.0+ | | 0 | 0.0 |
| Unknown | | 17 | 9.4 |
| Medical condition | Hospitalized: ICU | 21 | 11.7 |
| | Hospitalized: not ICU | 41 | 22.8 |
| | Not hospitalized | 118 | 65.6 |
| Primary payer | Private | 67 | 37.2 |
| | Medicaid | 77 | 42.8 |
| | Other | 36 | 20.0 |
| Donor type | Deceased | 178 | 98.9 |
| | Living | 2 | 1.1 |
| Intestine transplant history | First transplant | 155 | 86.1 |
| | Subsequent transplant | 25 | 13.9 |
| Patient on life support | Yes | 33 | 18.3 |
| Total | | 180 | 100.0 |

female. By race, 63.3% of recipients were white, 20.0% black, 11.1% Hispanic, and 4.4% Asian. Short-gut syndrome was the etiology of intestinal failure in 78.3% of recipients, followed by functional bowel problems in 12.8%. Fifty-three percent of patients spent 60 days or fewer on the waiting list. At the time of transplant, 38.3% of patients had a body mass index (BMI) of less than 18.5 kg/m², and 39.4% had a BMI between 18.5 and 24.9 kg/m². Most patients (65.6%) were not hospitalized at the time of transplant. For 86.1% of transplant recipients, this was their first intestinal transplant.



outcomes There has been a decline in early graft failure, from 20.0% in 1998 to 8.3% in 2009 (Figure 4.1). Graft survival has continued to improve over the past decade. Among those transplanted in 2008-2009, 6-month graft survival was 81.1%. For patients transplanted in 2006-2007, 1-year graft survival was 71.3%; for patients transplanted in 2004-2005, 3-year graft survival was 60.3%; for patients transplanted 2002-2003, 5-year graft survival was 45.3%; and for patients transplanted 1996-1999, 10-year graft survival was 27.0% (Figure 4.2). However, graft half-life, conditional on 1-year survival, has remained relatively low and has not increased substantially over the past decade (Figure 4.3). Nevertheless, there

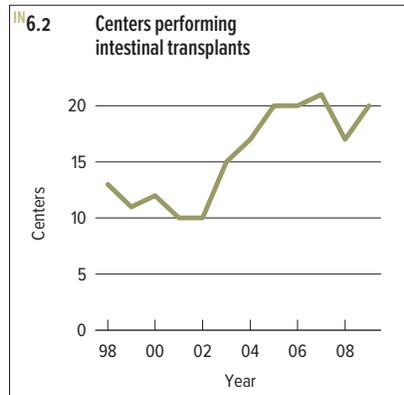
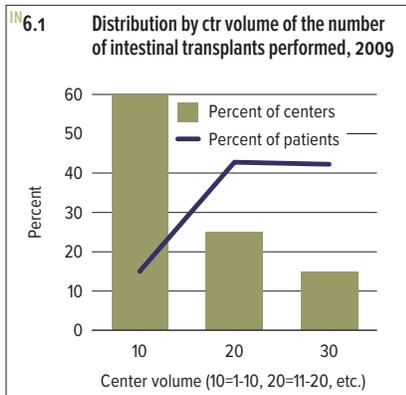
has been a steady increase in the number of recipients alive with a functioning intestinal graft over the past 12 years (Figure 4.4). Acute rejection and hospitalization were very common among intestinal transplant recipients. For patients transplanted in 2005-2009, the cumulative incidence of first acute rejection was 43.1% by 12 months post-transplant (Figure 4.5). Hospitalization occurred in 81.3% of patients by 6 months post-transplant and in all patients by 4 years post-transplant (Figure 4.6). For patients who underwent transplant in 2005-2009, the cumulative incidence of post-transplant lymphoproliferative disorder was 1.9% at 6 months, 4.5% at 1 year, 5.9% at 2 years, 6.4% at 3 years, 7.9% at 4 years, and 7.9% at 5 years after transplant (Figure 4.7).



immunosuppression

The most common initial immunosuppression regimen was tacrolimus alone, with or without corticosteroids, which was reported in 58.9% of patients transplanted in 2009. The second most common regimen was tacrolimus and mycophenolate, reported in 32.8% of patients (Figure 5.1). For induction therapy, 51.7% of patients received T-cell depleting agents, 43.3% received no induction, 3.3% received interleukin-2 (IL2-RA) receptor antagonists, and 1.7% received both T-cell depleting agents and IL-2 receptor antagonists (Figure 5.2). At one year post-transplant,

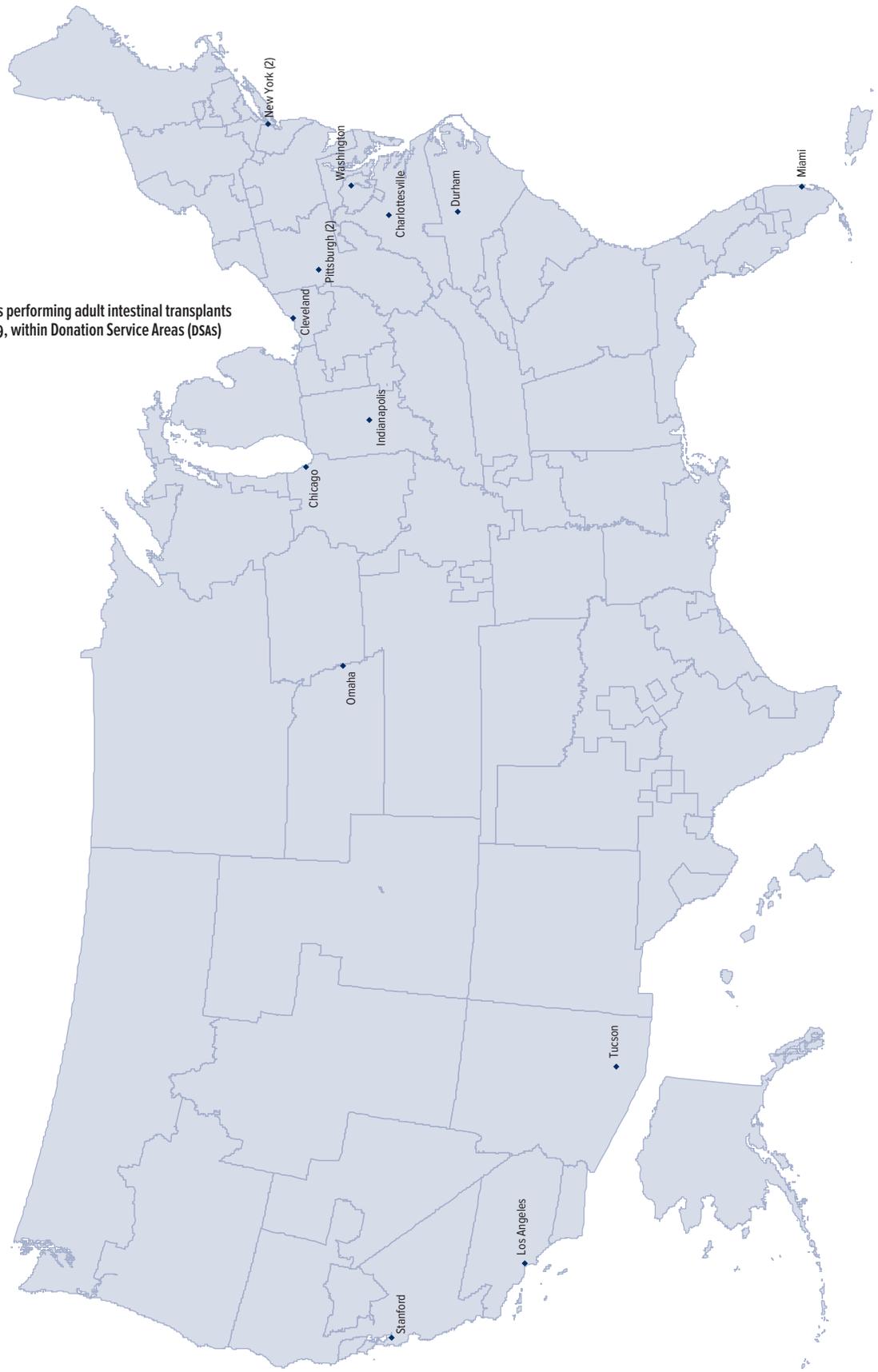
tacrolimus remained the most common immunosuppression regimen, reported in 74.6% of patients transplanted in 2008. The second most common regimen at one year post-transplant was tacrolimus and mycophenolate, reported in 13.0% of patients (Figure 5.3). Over the past decade, tacrolimus has been the main calcineurin inhibitor used; in 2009 it was used in 93.9% of patients (Figure 5.4). Mycophenolate use has increased to 33.3% in 2009, while mTOR inhibitor use has decreased from 36.6% in 2000 to 2.2% in 2009. Among patients transplanted in 2008, steroids were used in 75.7% at the time of transplant and 68.1% at 1-year post-transplant.



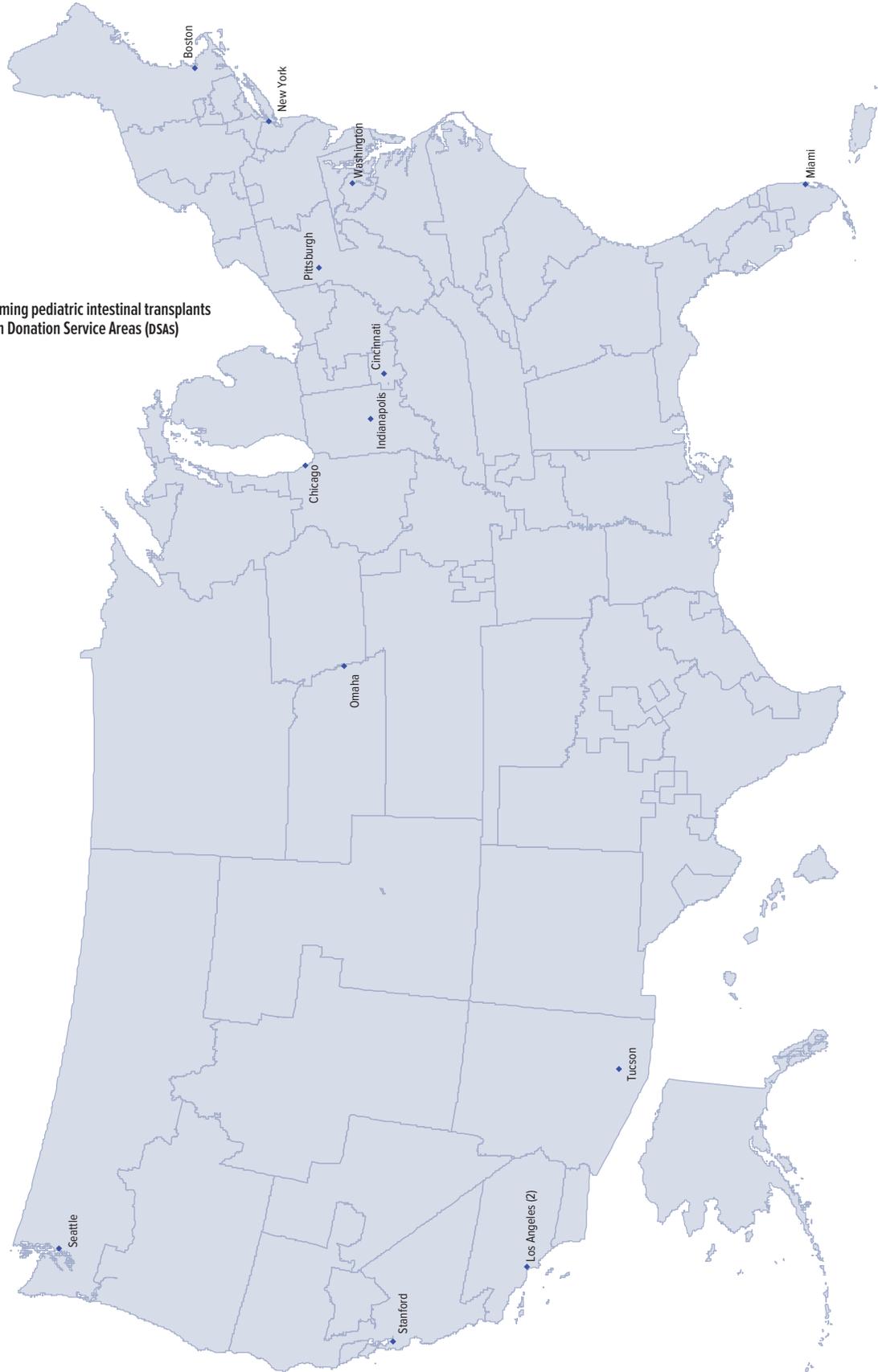
center characteristics

In 2009, 60.0% of centers performed between 1 and 10 intestinal transplants, 25.0% performed 11 to 20 transplants, and 15.0% performed 21 to 30 intestinal transplants (Figure 6.1). There has been an increase in the number of centers performing intestinal transplants, from 13 in 1998 to 20 in 2009 (Figure 6.2); 14 (70.0%) of these 20 centers performed intestinal transplants in children and adolescents.

7.1 Centers performing adult intestinal transplants in 2009, within Donation Service Areas (DSAs)



7.2 Centers performing pediatric intestinal transplants in 2009, within Donation Service Areas (DSAs)



7.3

Centers performing adult intestinal transplants in 2009, within OPTN regions

