OPTN/SRTR 2012 Annual Data Report:

deceased organ donation

ABSTRACT The status of deceased organ donation is assessed using several metrics, including donation/conversion rate (how often at least one organ is recovered for transplant from an eligible death), organ yield (ratio of observed/expected numbers of organs transplanted), and rate of organs discarded (number of organs discarded divided by the number of organs recovered for transplant). The 2012 donation/conversion rate was 72.5. eligible donors per 100 eligible deaths, slightly lower than the 2011 rate but higher than in previous years. The 2011-2012 yield ratio varied by donation service area from 0.91 (fewer organs transplanted per donor than expected) to 1.09 (more than expected), and also varied for specific organs. The mean number of organs transplanted per donor in 2012 was 3.02, lower than in 2011 and 2010; this number varied by donation service area from 2.04 to 3.76. The number of organs discarded is calculated by subtracting the number of organs transplanted from the number recovered for transplant; this number is used to calculate the discard rate. The discard rate in 2012 for all organs combined was 0.14 per recovered organ, slightly higher than in 2011 and 2011; it varied by donation service area and organ type.

KEY WORDS Deceased organ donation, donation/conversion rate, organ discard rate, organ yield.

Luke wore the "tree of life" symbol proudly on his arm and close to his heart. His awesome commitment of organ donation gave the gift of life to four people. His donation also enhanced the lives of over 40 others. Please consider organ donation.

Jo Anne & Tim, Luke's mother and father

Introduction

The status of deceased organ donation is assessed using several metrics, including donation/conversion rate, organ yield, and rate of organs discarded. These metrics have assumed increasing importance in light of decreasing numbers of eligible deaths over the past few years and fewer organs transplanted in 2012 than in the preceding two years. This chapter describes these metrics and compares them across the 58 donation service areas (DSAs).

Definitions of Terms Related to Deceased Organ Donation

- Eligible death: Death of a person aged 70 years or younger who is legally declared brain dead according to hospital policy and does not exhibit any of the exclusions listed in Figure 1.1.
- Donor: A person from whom at least one organ was procured for the purpose of transplant, regardless of whether the organ was transplanted.
- Eligible donor: A donor whose death met the definition of eligible death.
- Donation/conversion rate: Number of eligible donors per 100 eligible deaths.
- Organ-specific donation/conversion rate: Number of donors of each organ type who met eligibility criteria per 100 eligible deaths.
- Organs recovered per donor (ORPD): Total number of organs recovered divided by the number of donors, not limited to eligible deaths.
- Organs transplanted per donor (OTPD): Total number of organs transplanted divided by the number of donors, not limited to eligible deaths.
- Organ yield: Ratio of observed to expected numbers of organs transplanted; expected numbers based on national experience with similar donors.
- Rate of organs discarded: Number of organs discarded is calculated by subtracting the number of organs transplanted from the number of organs recovered for the purpose of transplant; the discard rate is then calculated by dividing the number of organs discarded by the number of organs recovered for the purpose of transplant.
- Expanded criteria donors (ECD): Donors aged 60 years or older, or aged 50-59 years with two of the following: hypertension, terminal creatinine >1.5mg/dL, or death from cerebrovascular accident. This definition was developed for kidney donors. However, we have used this to classify donors in general.

Eligible Deaths

Organ procurement organizations (OPOs) are required to report all eligible deaths to the Organ Procurement and Transplantation Network (OPTN). For reporting purposes, an eligible death is defined as the death of a person aged 70 years or younger who is legally declared brain dead according to hospital policy and does not exhibit any of the exclusions listed in OPTN policy (Figure 1.1). In 2012, 8944 eligible deaths were reported by OPOs, reduced from 9023 reported in 2011 and 9035 in 2010.

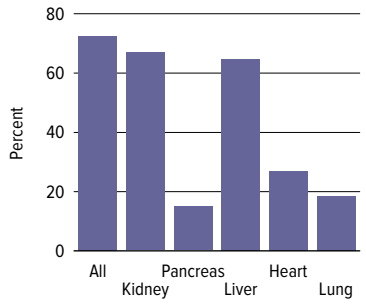
Donation/Conversion Rate

The donation/conversion rate is a measure of how often an eligible death becomes a donor (at least one organ recovered for the purpose of transplant). It is calculated as the number

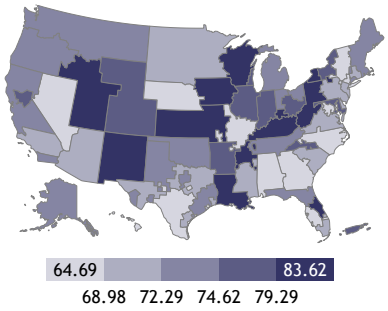
of eligible donors (donors whose deaths met the definition of eligible death) per 100 eligible deaths. In 2012, the donation/conversation rate was 72.5 eligible donors per 100 eligible deaths, a slight decline from 72.9 in 2011 (Figure 1.1), but higher than rates in 2009 (69.4) and 2010 (71.7). Organ-specific donation/conversion rates are calculated as the numbers of eligible donors of each specific organ type per 100 eligible deaths. In 2012, the donation/conversion rate for kidneys was 67.0 (1 or 2 kidneys recovered), higher than the rate of 64.7 for livers; both of these rates were higher than the rates for thoracic organs and pancreata. The heart donation/conversion rate was 27.0, higher than the rate of 18.5 for lung conversion (1 or 2 lungs recovered). Unadjusted donation/conversation rates varied by DSA (Figure 1.2).

Organs Recovered per Donor

The number of organs recovered per donor (ORPD) is calculated by dividing the total number of organs recovered by the number of donors. The number of ORPD was 3.50 in 2012, slightly lower than 3.54 in 2011 and 3.58 in 2010. Since 2000, this value has ranged from 3.48 to 3.60 (Figure 2.1). In 2012, ORPD varied substantially by DSA, ranging from 2.75 to 4.13 (Figures 2.2, 2.3). Numbers of kidneys recovered per donor ranged from 1.54 to 1.97; pancreata, from 0.06 to 0.40 (unlike in 2011, islets are no longer counted as organs); and livers,



DOD 1.1 **Overall & organ-specific donation rates per eligible deaths, 2012**



DOD 1.2 **Overall donation rates (per 100 eligible deaths), by DSA, 2012**

Donation rate is the number of deceased donors meeting eligibility criteria per 100 eligible deaths. Organ-specific rates represent the number of donors of each organ type meeting eligibility criteria per 100 eligible deaths. An eligible death is any hospital-reported death or imminent death that is evaluated and meets organ donor eligibility requirements: age 70 or younger, death by neurological criteria (based on the American Academy of Neurology Practice parameter for determining brain death), and without any of the following indications: tuberculosis, human immunodeficiency virus infection with specified conditions, Creutzfeldt-Jacob Disease, herpetic septicemia, rabies, reactive hepatitis B surface antigen, any retrovirus infection, active malignant neoplasms (except primary CNS tumors and skin cancers), Hodgkin's disease, multiple myeloma, leukemia, miscellaneous carcinomas, aplastic anemia, agranulocytosis, fungal and viral encephalitis, gangrene of bowel, extreme immaturity, or positive serological or viral culture findings for HIV.

from 0.61 to 0.96. Numbers of intestines recovered per donor ranged from 0.0 to 0.08; hearts, from 0.0 to 0.44; and lungs, from 0.07 to 0.78 (Figure 2.2). The number of ORPD represents a mix of donor types such as standard criteria donors (SCD), expanded criteria donors (ECD), or donation after circulatory death (DCD) donors.

Organs Transplanted per Donor and Organ Yield

The mean number of organs transplanted per donor (OTPD) was 3.02 in 2012, slightly lower than 3.07 in 2011 and 3.10 in 2010 (Figure 3.1). Since 2000, this value has ranged from 3.00 to 3.24. In an unadjusted analysis, not accounting for SCD, ECD, and DCD donor types, the number of OTPD varied substantially by DSA, ranging from 2.04 to 3.76 (Figures 3.2, 3.3).

The ratio of observed to expected organs transplanted, or yield, is the metric used by OPTN to identify OPOs that require review for quality improvement purposes. The aggregate and organ-specific yield metrics for each OPO are publically available on the Scientific Registry of Transplant Recipients website (http://www.srtr.org/opo/Default.aspx). This adjusted analysis based on a 2-year cohort also suggests opportunities to share best practices from DSAs with higher than expected organ-specific yields to improve the overall yield across the country. The yield metric shown compares the number of organs transplanted (observed) in 2011-2012 with the number of organs that would be expected to be transplanted in 2011-2012 based on the national experience with similar donors (expected). A ratio, expressed as observed/expected organs transplanted, of less than 1 indicates that fewer organs were transplanted than would be expected based on the national models for that organ. A ratio of greater than 1 indicates that more organs were transplanted than would be expected. In 2011-2012, the donor yield observed/expected ratio for total organs varied by DSA from 0.91 to 1.09 (Figure 3.4). The mean observed/expected ratio for kidneys varied from 0.89 to 1.14; for pancreata, from 0.24 to 2.71; for livers, from 0.77 to 1.16; for intestines, from 0 to 5.06; for hearts, from 0 to 1.22; and for lungs, from 0.38 to 1.43 (Figure 3.5).

As expected, the number of OTPD from SCDs was higher than the number from ECDs or DCD donors (Figure 3.6). Donors who are not ECD or DCD are considered SCD. In 2012, 3.65 organs were transplanted per donor from SCDs compared with 1.87 from ECDs and 1.91 from DCD donors. More kidneys were transplanted per donor from SCDs than from DCD donors or ECDs: 1.66, 1.60, and 0.89, respectively (Figure 3.7). As in past years, the numbers of kidneys transplanted per donor from DCD donors and from SCDs are similar. In contrast, for non-renal organs, the number of OTPD from SCDs was higher than the numbers for ECDs and DCD donors (Figure 3.8). The number of livers from ECD donors rose from 847 in 2000 to 1313 in 2012, and lungs from ECD donors rose from 74 in 2000 to 362 in 2012. Numbers of livers and lungs from DCD donors are smaller but increasing: 33 liver donors in 2000 and 253 in 2012; 0 lung donors in 2000 and 32 in 2012.

Discard Rate

The number of organs discarded is calculated by subtracting the number of organs transplanted from the number of organs recovered for the purpose of transplant. The discard rate is then calculated by dividing the number of organs discarded by the number of organs recovered for the purpose of transplant. The discard rate in 2012 for all organs combined was 0.14 per recovered organ, slightly higher than the rate of 0.13 in 2010 and 2011 (Figure 4.1). The pancreas discard rate remained

highest, but it declined to 0.25 in 2012 from 0.27 in 2011. The kidney discard rate increased slightly to 0.19 in 2012 from 0.18 in 2011. The liver discard rate was unchanged, at 0.10 for livers in 2012 and 2011 (Figure 4.1). Discard rates varied substantially by DSA (Figure 4.2) and by organ type.

In 2012, use of kidneys, livers, and lungs from ECDs and DCD donors varied by DSA (Figures 5.1 and 6.1). To quantify ECD use, the number of ECD organs transplanted is divided by the number of all organs (SCD+ECD+DCD) transplanted. This calculation was performed for each organ type (kidney, pancreas, liver, and lung). The largest variation occurred for livers; livers from ECD donors represented 2% to 46% of all livers transplanted by DSA (Figure 5.1). Variations for lungs and kidneys were next largest; lungs from ECD donors represented 0% to 38% of all lungs transplanted by DSA, and ECD kidneys 3% to 25% of all kidneys transplanted (Figure 5.1). Similarly, use of kidneys and livers from DCD donors varied by DSA. DCD kidneys represented 1% to 35% of all kidneys transplanted by DSA, and DCD livers represented 0% to 15% of all livers transplanted (Figure 6.1). Waiting times for deceased donor transplants also varied by DSA in 2012 (Figure 7.1). Average waiting times across the 58 DSAs were longest for kidney transplants, on average 26 months compared with 12 for pancreas, 10 for intestines, 4 for livers, 3 for hearts, and 3 for lungs. These average waiting times apply only to candidates who underwent transplant, and do not account for candidates who did not undergo transplant.

In 2012, at least one organ was procured for the purpose of transplant from 8144 donors, slightly more than the 8128 donors in 2011 (Figure 8.1). Of the 16,288 kidneys from these donors, 5720 left, 5617 right, and 328 *en bloc* kidneys were transplanted. This represents 74% of all kidneys, considering *en bloc* transplants as two kidneys. Reasons for not using donor kidneys are listed in Figure 8.1. The most common reason for not procuring a kidney was poor organ function. Of kidneys recovered, 1252 left, 1327 right, and 90 *en bloc* were not transplanted. The most common reason for not transplanting a procured left or right kidney was biopsy findings (Figure 8.1). From the 8144 donors, only 1046 pancreas allografts (12.84%) were transplanted; another 520 were recovered for the purpose of transplant but not transplanted (Figure 8.2). From the 8144 donors, only 5942 liver allografts (72.96%) were transplanted; another 691 were recovered but not transplanted (Figure 8.3). The most common reason for not transplanting recovered livers was biopsy findings. Reasons for not transplanting recovered livers differ from reasons for not procuring a liver. The most common reason for not procuring a liver was, "ruled out after evaluation in the operating room" (Figure 8.3). For remaining organs, the numbers procured for transplant and not used were smaller (Figure 8.4-8.6).

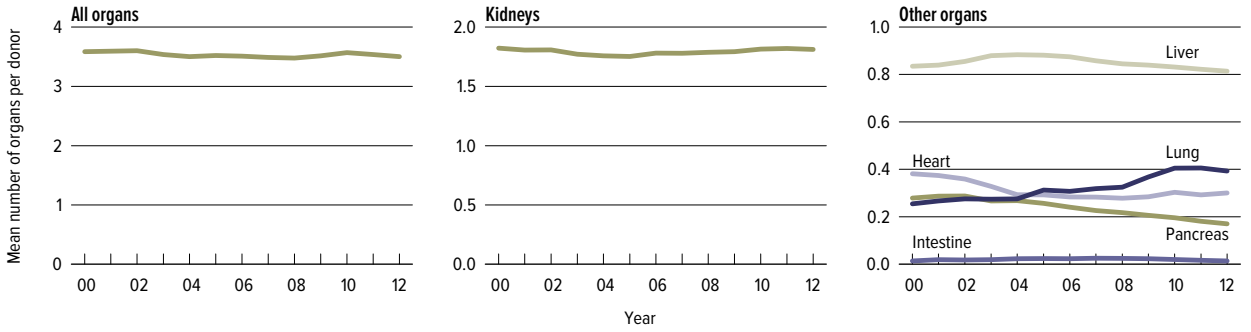
transplant programs

	Number of transplant programs in the country that transplanted at least one organ from the OPO						Number of transplant programs within the OPO service area					
DSA/OPO	KI	PA	LI	IN	HR	LU	KI	PA	LI	IN	HR	LU
ALOB	22	3	6	1	14	6	1	1	1		1	1
AROR	25	4	11		15	9	3		1		2	
AZOB	27	4	11		12	8	4	3	3		3	2
CADN	42	9	17	3	21	12	4	3	4	1	4	3
CAGS	18	6	15		15	5	2	1			1	
CAOP	49	13	14	1	17	11	10	7	5	1	5	3
CASD	19	5	8		7	3	4	3	3		2	1
CORS	28	2	12	1	17	4	4	2	3		2	1
CTOP	16	4	6		6	5	2		1		1	
DCTC	19	6	9		8	9	5	3	1	1	2	1
FLFH	25	11	13		15	8	2	1	1		1	1
FLMP	21	7	10	1	18	10	1	1	2	1	2	1
FLUF	29	4	17	4	18	6	2	1	2		2	2
FLWC	33	8	12	2	15	8	2	1	1		2	1
GALL	34	8	20	3	29	13	4	3	3		4	1
HIOP	27	4	4			1	1		1			
IAOP	17	3	10	2	11	2	4	1	1		1	1
ILIP	42	10	20	4	20	11	8	6	6	2	6	2
INOP	36	1	9	1	25	8	3	1	1	1	3	1
KYDA	19	3	10	2	8	4	3	2	2		2	2
LAOP	40	8	17	3	17	12	4	3	3		1	1
MAOB	44	8	10	3	9	9	12	6	6	1	5	3
MDPC	11	3	7		14	8	2	2	2		2	2
MIOP	39	9	16	4	25	13	7	3	3	1	4	2
MNOP	46	4	7	2	11	10	9	3	3	1	3	2
MOMA	23	4	16	1	19	11	4	2	4		3	2
MSOP	31	4	17	1	16	10	1				1	
MWOB	38	10	15	1	20	19	6	2	3		1	
NCCM	28	4	10	1	7	10	1	1	1		1	
NCNC	35	7	25	3	16	5	4	3	2	1	3	2
NEOR	6	3	6		3	5	1	1	1	1	1	
NJTO	28	5	15		9	9	5	3	1		2	1
NMOP	7	1	10		5	4	2					
NVLV	27	8	17	3	12	8	1					
NYAP	15	4	7	1	10	3	2	2				
NYFL	14	1	9		6	3	2	1	1		1	
NYRT	33	6	14	3	9	4	10	3	6	2	4	1
NYWN	5	2	8	1	6	5	1	1				
OHLB	15	3	11	1	17	5	2	2	2	1	2	2
OHLC	18	5	6		13	5	2					
OHLP	20	1	10		15	8	2	1	1		2	1
OHOV	24	1	7		13	5	3	2	2	1	1	
OKOP	34	3	12	3	17	8	6	2	3		1	1
ORUO	14	1	9		5	3	3	1	2		1	
PADV	62	11	24	2	27	12	15	9	10		7	3
PATF	35	3	18	2	16	6	5	3	4	2	3	2
PRLL	20	2	13		6	5	1	1	1		1	
SCOP	22	3	18	1	19	11	1	1	1		1	1
TNDS	42	13	29	4	27	12	6	1	1		1	1
TNMS	27	7	12	4	16	11	2	1	2		1	
TXGC	50	8	16		20	12	6	4	6		4	3
TXSA	28	4	6	1	10	4	5	1	2		2	1
TXSB	39	10	20	3	26	7	11	5	5		6	4
UTOP	22	4	12	3	10	5	3	2	3		3	1
VATB	34	7	14	2	18	15	5	3	2		4	1
WALC	31	8	13	1	13	1	5	3	3	1	3	1
WIDN	20	3	8	1	7	3	3	2	3		2	1
WIUW	13	2	10	1	15	4	1	1	1	1	1	1

DOD 1.3 Transplant program summary, 2012

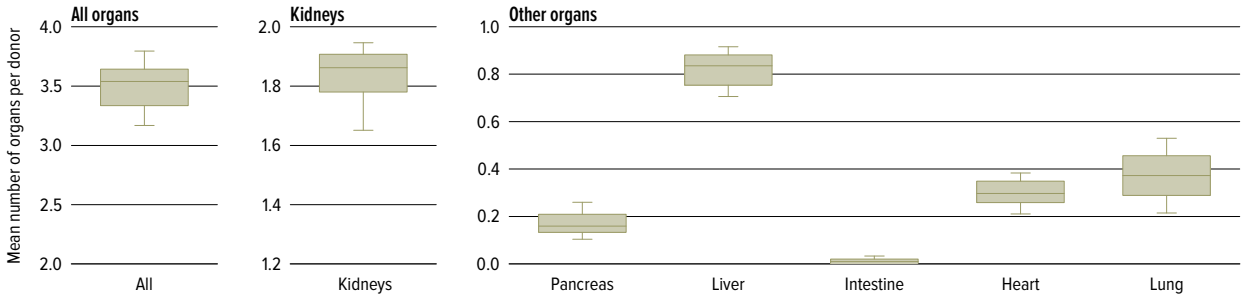
Organ specific transplant programs are defined based on one or more transplants of that organ type within 2012.

organs recovered per donor



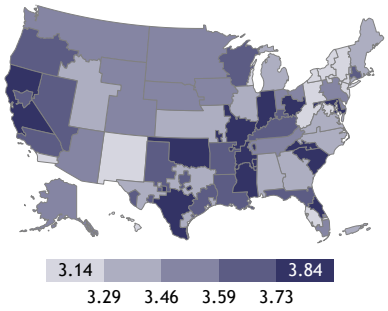
DOD 2.1 Organs recovered per donor (ORPD)

Organs recovered per donor is the average number of organs recovered per donor, calculated as the sum of recovered organs and by organ type, i.e., in the case of kidneys recovered, up to two kidneys can be recovered from an individual donor, while only one heart can be recovered from each donor. Pancreata recovered for islet transplantation are excluded.



DOD 2.2 Organs recovered per donor (ORPD), by DSA, 2012

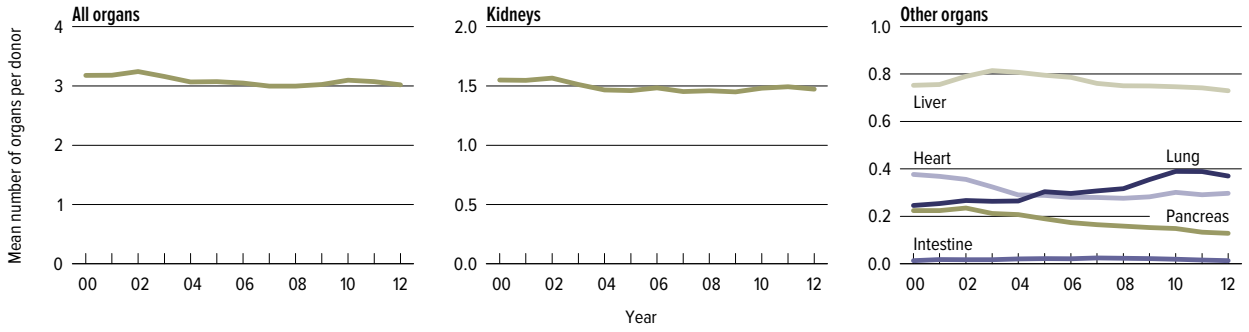
Organs recovered per donor is the average number of organs recovered per donor, calculated as the sum of recovered organs and by organ type, i.e., in the case of kidneys recovered, up to two kidneys can be recovered from an individual donor, while only one heart can be recovered from each donor. Means of DSA-level means are shown. Pancreata recovered for islet transplantation are excluded.



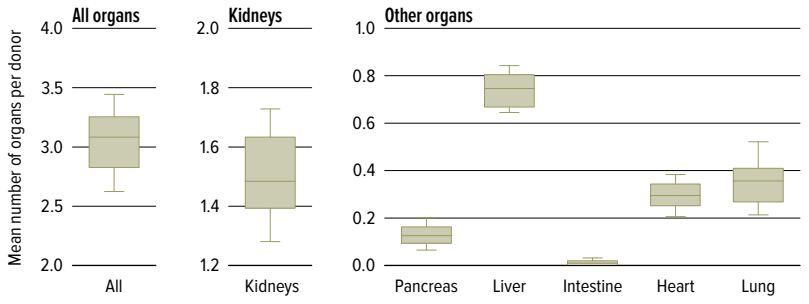
DOD 2.3 Organs recovered per donor (ORPD), by DSA, 2012

Organs recovered per donor is the average number of organs recovered per donor, calculated as the sum of recovered organs, i.e., in the case of kidneys recovered, up to two kidneys can be recovered from an individual donor, while only one heart can be recovered from each donor. Pancreata recovered for islet transplantation are excluded.

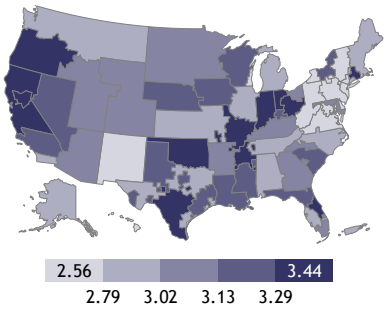
organs transplanted per donor



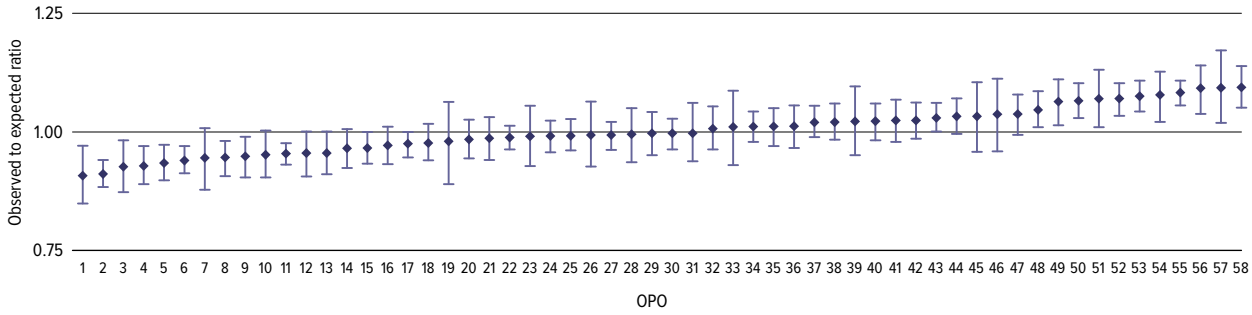
DOD 3.1 Organs transplanted per donor (OTPD)
Organs transplanted per donor is the average number of organs transplanted per donor. Organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, so the number transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from the number of transplant operations. Pancreata recovered for islet transplantation are excluded.



DOD 3.2 Organs transplanted per donor (OTPD), by DSA, 2012
Organs transplanted per donor is the average number of organs transplanted per donor. Organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, so the number transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from the number of transplant operations. Means of DSA-level means are shown. Pancreata recovered for islet transplantation are excluded.

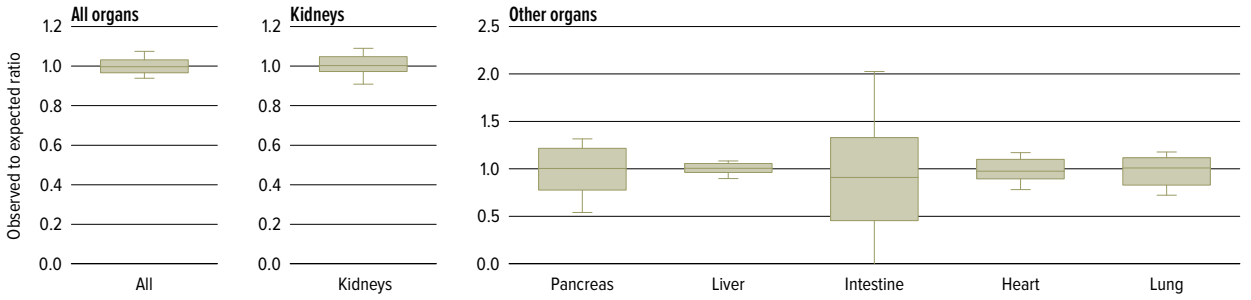


DOD 3.3 Organs transplanted per donor (OTPD), by DSA, 2012
Organs transplanted per donor is the average number of organs transplanted per donor. Organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, so the number transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from the number of transplant operations. Pancreata recovered for islet transplantation are excluded.

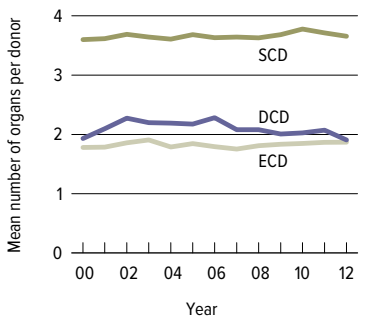


DOD 3.4 Donor yield: observed to expected ratio (O/E), 2011–2012: all organs
Donor yield provides a measure of organs transplanted per donor. Expected yield is estimated from statistical models. These models take into account various characteristics that are not under the control of the OPOs.

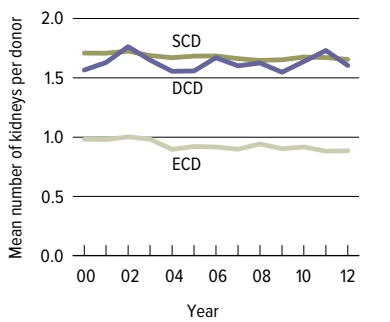
organs transplanted per donor



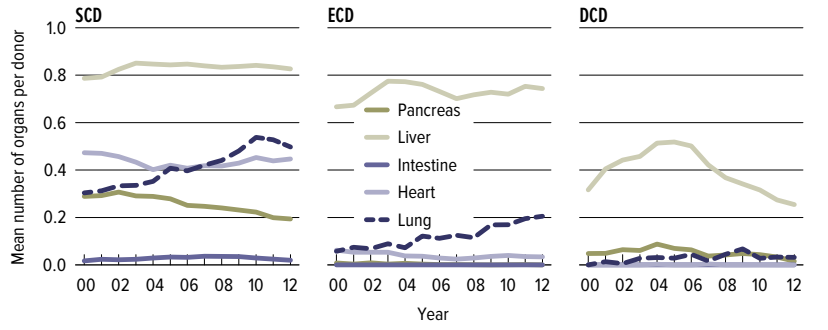
DOD 3.5 Donor yield: observed to expected ratio (O/E), by DSA & organ, 2011–2012
*See adjustments, below.



DOD 3.6 Organs transplanted per donor (OTPD), by SCD, DCD, & ECD status
Organs transplanted per donor is the average number of organs transplanted per donor. Organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, so the number transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from the number of transplant operations. Pancreata recovered for islet transplantation are excluded.



DOD 3.7 Kidneys transplanted per donor (OTPD), by SCD, DCD, & ECD status
Organs transplanted per donor is the average number of organs transplanted per donor. Organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, so the number transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from the number of transplant operations. Pancreata recovered for islet transplantation are excluded.



DOD 3.8 Other organs transplanted per donor (OTPD), by SCD, DCD, & ECD status
Organs transplanted per donor is the average number of organs transplanted per donor. Organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, so the number transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from the number of transplant operations. Pancreata recovered for islet transplantation are excluded.

*Models adjust for the following:

Kidney: age, gender, blood type, cause of death, circumstances of death, mechanism of death, clinical infection present, cigarette use, cocaine use, heavy alcohol consumption, cdc high risk donor, history of diabetes, insulin dependence, history of hypertension, history of cancer, DCD, cardiac arrest after brain death, hepatitis B surface antigen, hepatitis B core antibody, hepatitis C antibody, serum creatinine, organ recovered outside the contiguous 48 states?

Pancreas: age, BMI, race/ethnicity, blood type, cause of death, circumstances of death, mechanism of death, cocaine use, heavy alcohol consumption, CDC high risk donor, history of diabetes, insulin dependence, history of hypertension, history of cancer, dcd, lung pO_2 terminal value/FiO_2, hepatitis B surface antigen, hepatitis B core antibody, hepatitis C antibody, serum creatinine, organ recovered outside the contiguous 48 states?

Liver: age, BMI, race/ethnicity, blood type, cause of death, circumstances of death, clinical infection present, cigarette use, cocaine use, other drug use, heavy alcohol consumption, CDC high risk donor, history of diabetes, insulin dependence, DCD, DCD controlled, cardiac arrest after brain death, lung pO_2 terminal value/FiO_2, hepatitis B surface antigen, hepatitis B core antibody, hepatitis C antibody, organ recovered outside the contiguous 48 states?

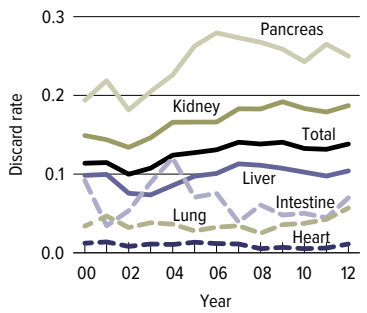
Intestine: history of diabetes, insulin dependence, dcd, hepatitis b surface antigen.

Heart: age, BMI, gender, race/ethnicity, blood type, cause of death, mechanism of death, clinical infection present, cigarette use, cocaine use, other drug use, CDC high risk donor, history of diabetes, history of hypertension, DCD, cardiac arrest after brain death, lung pO_2 terminal value/FiO_2, hepatitis B surface antigen, hepatitis B core antibody, hepatitis C antibody, serum creatinine, organ recovered outside the contiguous 48 states?

Lung: age, BMI, gender, race/ethnicity, blood type, cause of death, circumstances of death, mechanism of death, clinical infection present, cigarette use, cocaine use, other drug use, CDC high risk donor, insulin dependence, history of cancer, DCD, cardiac arrest after brain death, lung pO_2 terminal value/FiO_2, hepatitis B surface antigen, hepatitis B core antibody, hepatitis C antibody, serum creatinine, organ recovered outside the contiguous 48 states?

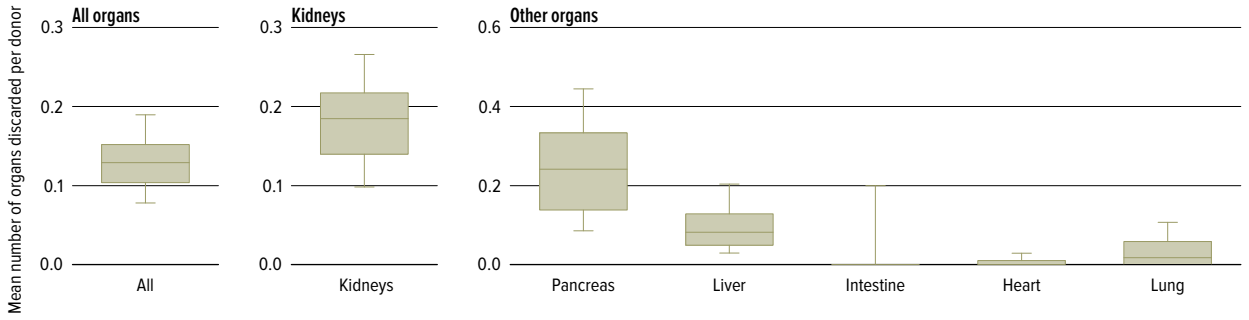
data behind the figures can be downloaded from our website, at srtr.tranplant.hrsa.gov

organ discards | expanded criteria donors



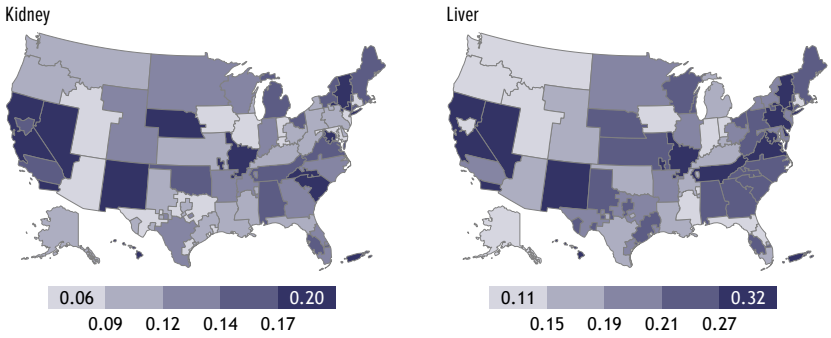
DOD 4.1 Organ discard rates for organs recovered for transplantation

Organ discard rate is calculated as the difference between the number of organs recovered and the number of organs transplanted, divided by the number of organs recovered. Pancreata recovered for islet transplantation are excluded.



DOD 4.2 Variation in organ discard rates, by DSA, 2012

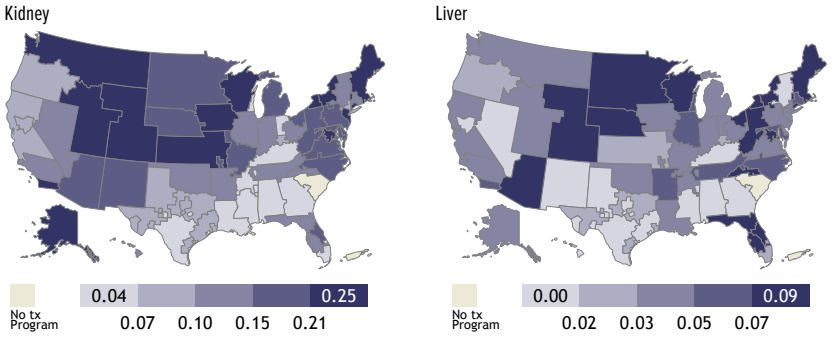
Organ discard rate is calculated as the difference between the number of organs recovered and the number of organs transplanted, divided by the number of organs recovered. Pancreata recovered for islet transplantation are excluded.



DOD 5.1 Variation in the use of ECD donors among deceased donor transplant recipients, 2012, by DSA

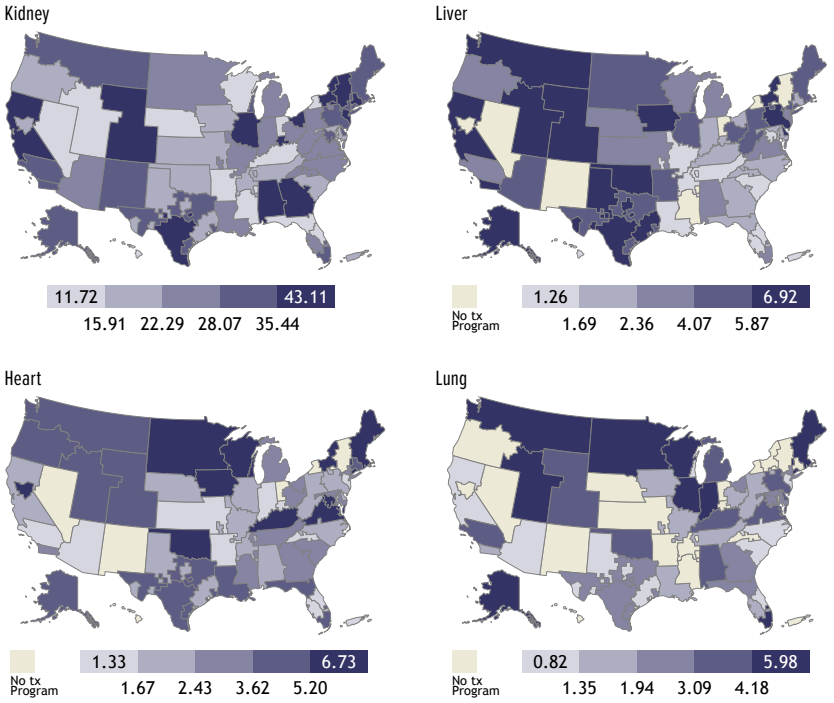
ECD donors for patients transplanted (as defined for Figures 3.1–3).

donations after cardiac death | waiting time



DOD 6.1 Variation in the use of DCD donors among deceased donor transplant recipients, 2012, by DSA

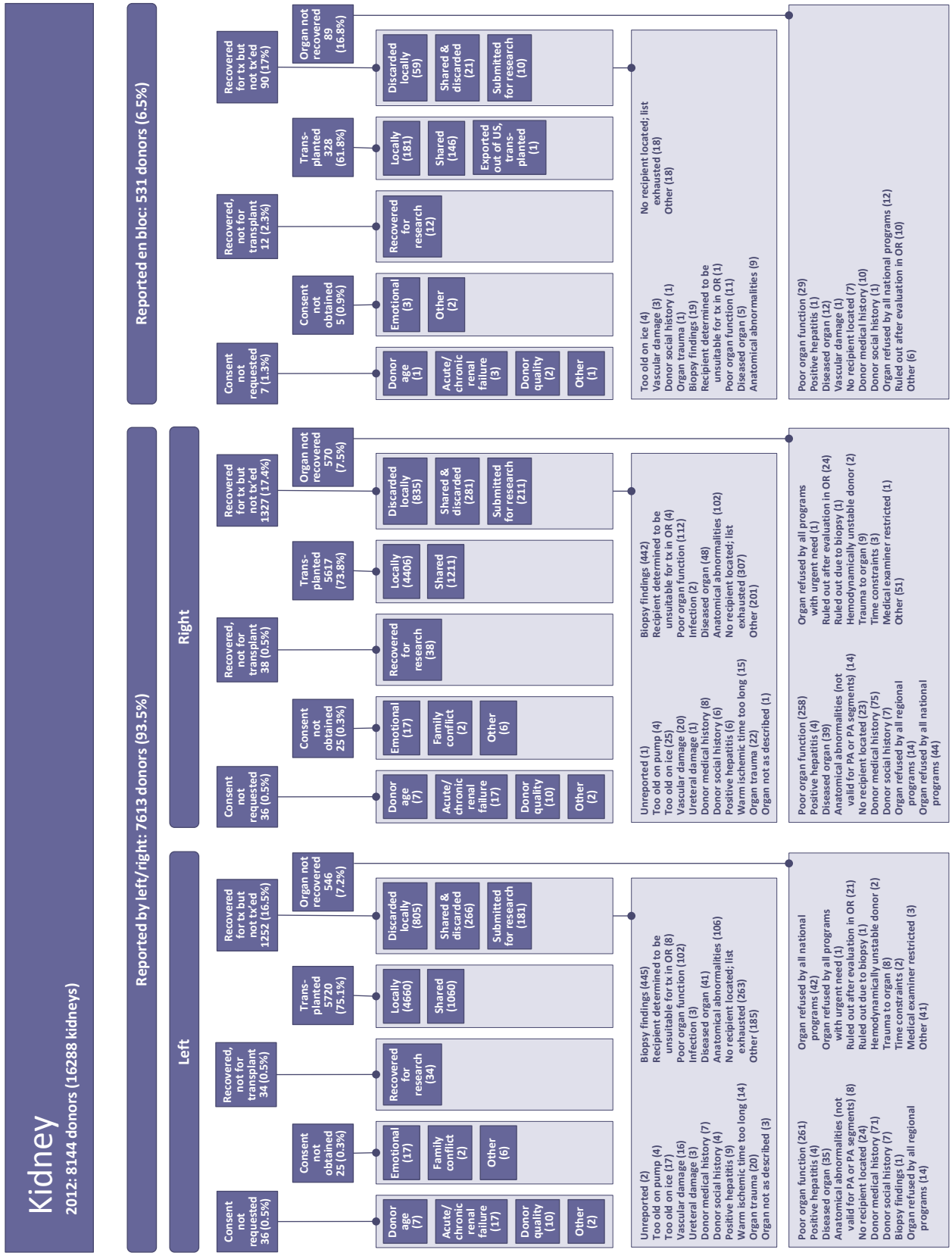
DCD donors for patients transplanted (as defined for Figures 3.1–3).



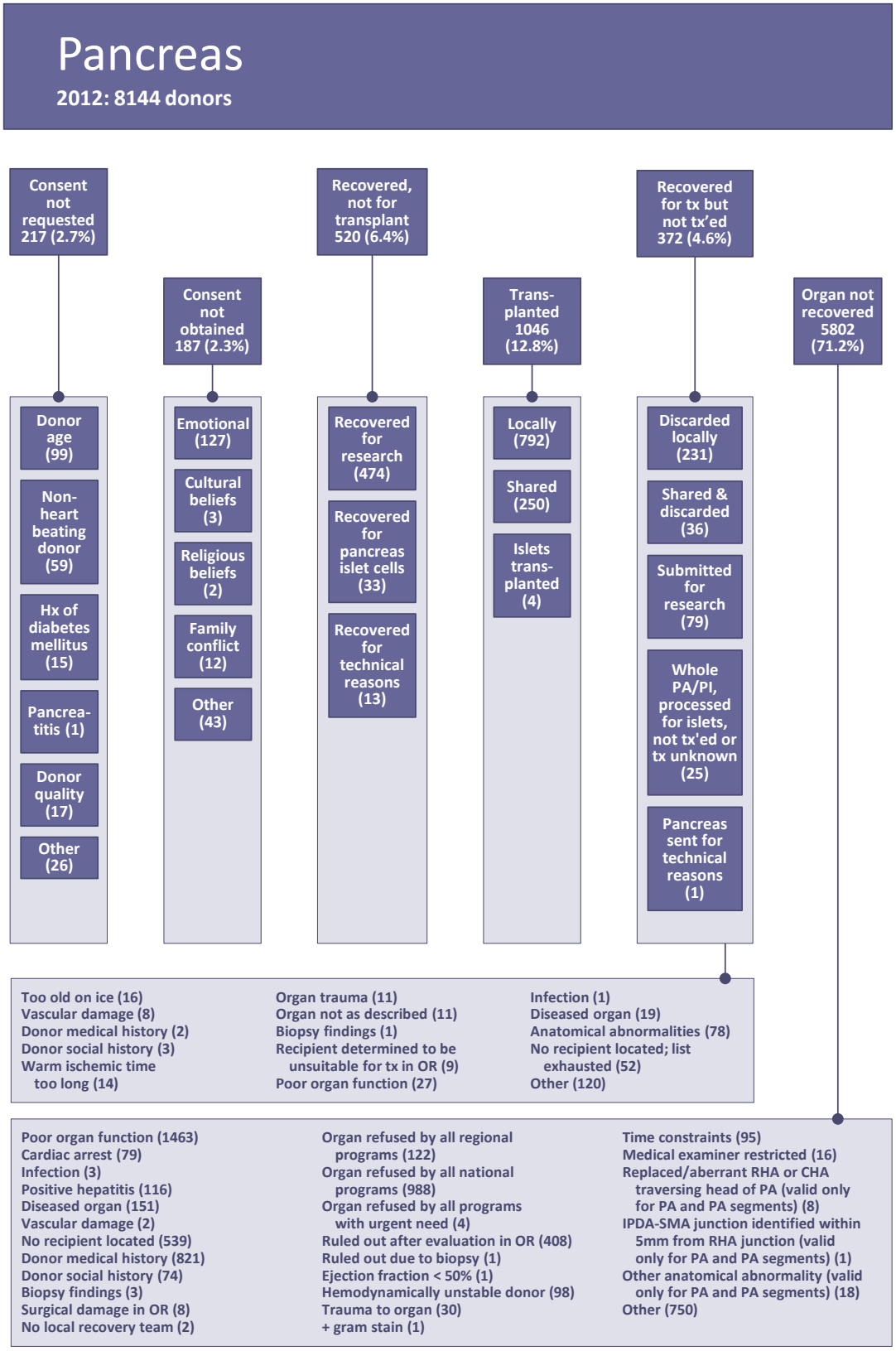
DOD 7.1 Variation in time waited (months) among deceased donor transplant recipients, 2012, by DSA

Median time waited among candidates transplanted in 2012. Time to transplant is calculated as months from listing date to transplant date.

DOD 8.1 organ use: kidney

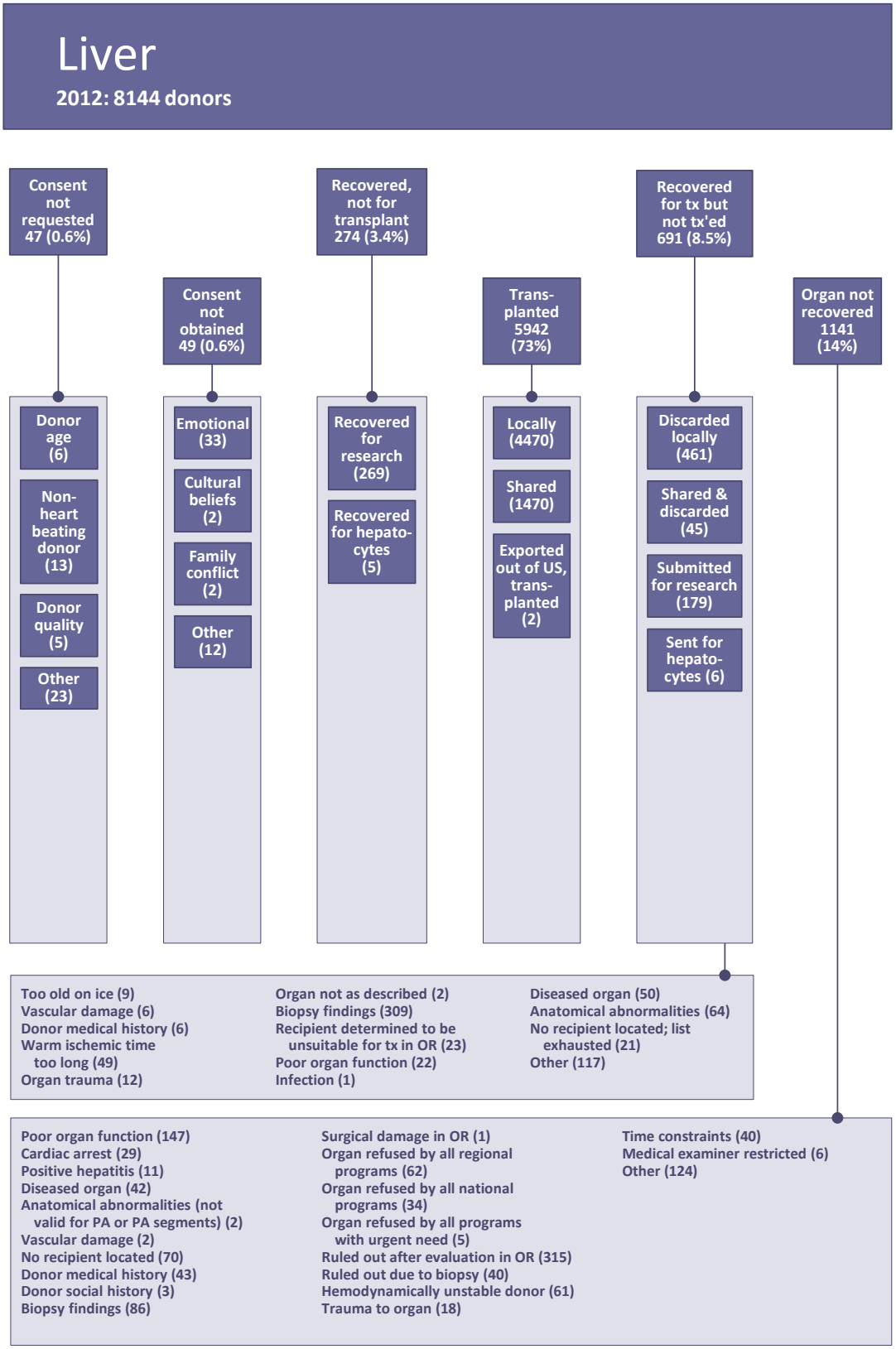


DOD 8.2 organ use: pancreas

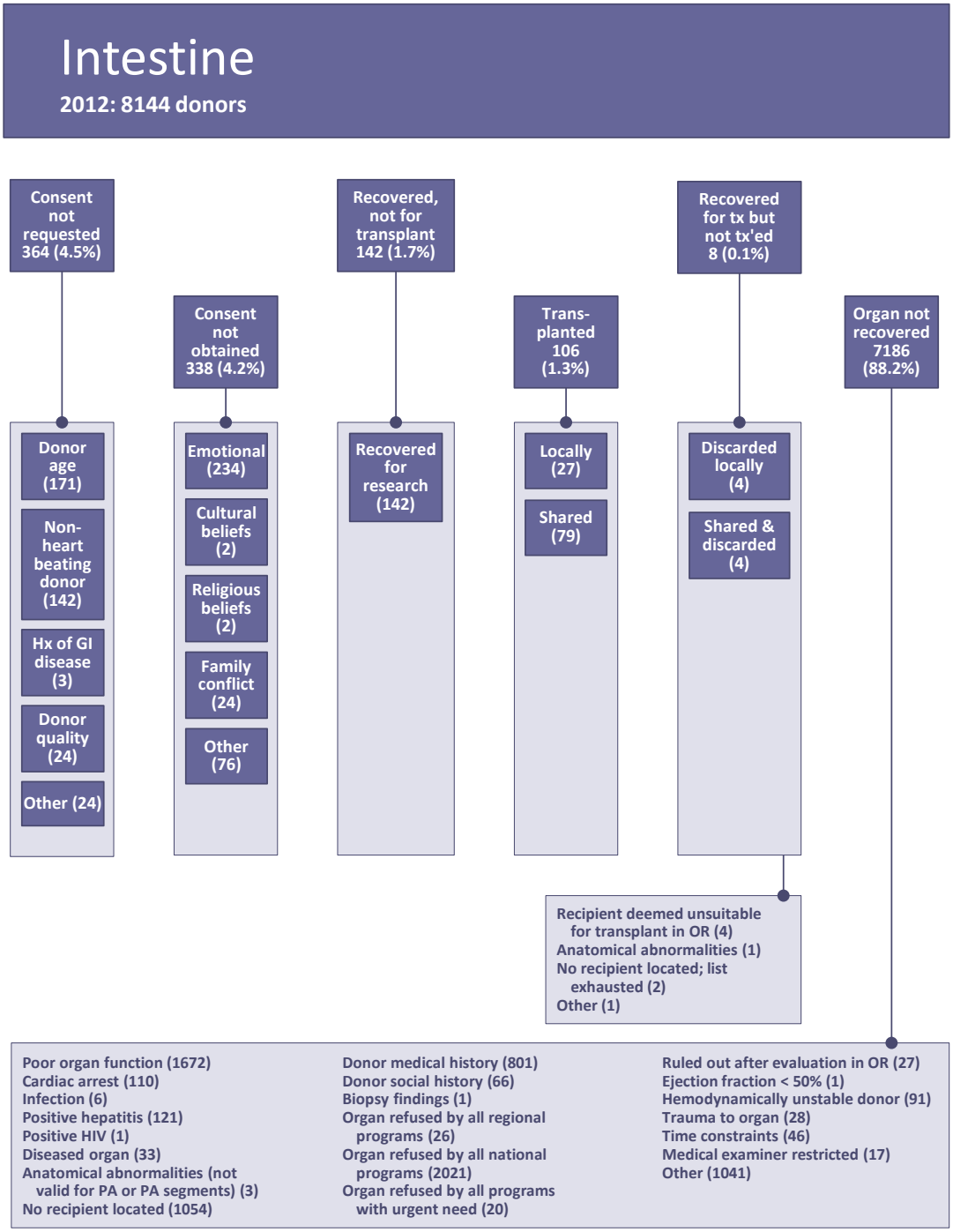


data behind the figures can be downloaded from our website, at srtr.tranplant.hrsa.gov

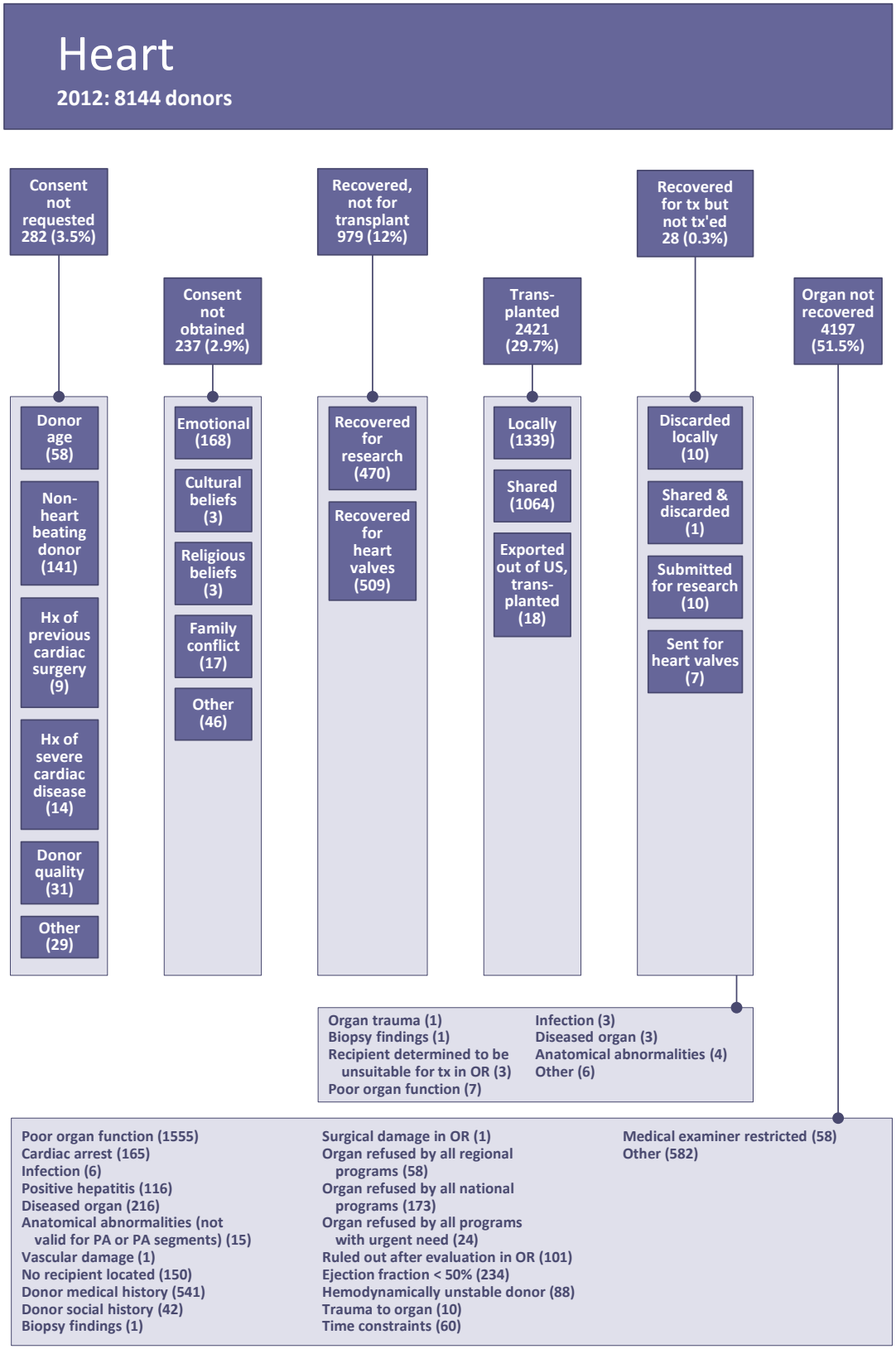
DOD 8.3 organ use: liver



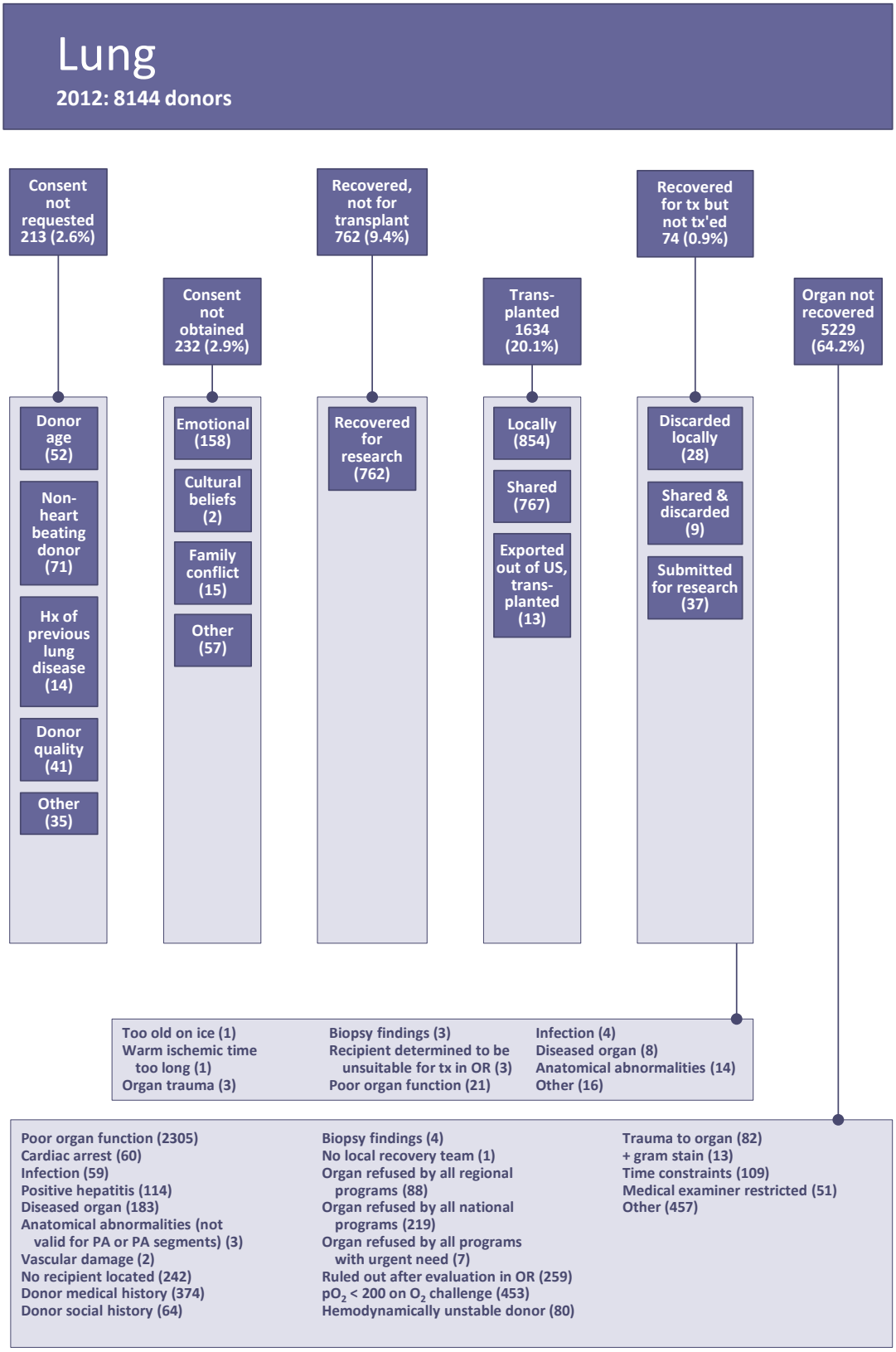
DOD 8.4 organ use: intestine



DOD 8.5 organ use: heart



DOD 8.6 organ use: lung



data behind the figures can be downloaded from our website, at srtr.tranplant.hrsa.gov