NHS
Blood and Transplant

INTERIM REPORT ON KIDNEY TRANSPLANTATION

5 YEAR REPORT
(1 OCTOBER 2011 – 30 SEPTEMBER 2016)

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PRODUCED IN COLLABORATION WITH NHS ENGLAND

Contents

Executive Summary

This report presents key figures about kidney transplantation in the UK. The period reported covers 5 years of transplant data, from 1 October 2011 to 30 September 2016. The report presents information on the number of transplants and survival analysis after first kidney only transplantation on a national and centre-specific basis.

Key findings

- On 30 September 2016, there were 5,055 adult patients on the UK active kidney transplant list which represents a 5% decrease in the number of patients a year earlier.

- There were 1,442 adult kidney only transplants performed in the UK between 1 April 2016 and 30 September 2016, a decrease of 6% compared to the previous 6 month period. Of these, 549 were from DBD donors, 433 were from DCD donors and 460 were from living donors.

- The national rate of graft survival five years after first adult deceased donor kidney only transplant is 86%. These rates vary between centres, ranging from 81% to 93% (risk-adjusted).

- The national rate of graft survival five years after first adult living donor kidney only transplant is 93%. These rates vary between centres, ranging from 87% to 97% (risk-adjusted).

Introduction

This report presents information on transplant activity between 1 October 2011 and 30 September 2016, for all 24 centres performing kidney transplantation in the UK. Data were obtained from the UK Transplant Registry, at NHS Blood & Transplant, that holds information relating to donors, recipients and outcomes for all kidney transplants performed in the UK.

Graft and patient survival estimates are reported at one-year post-transplant for the period 1 October 2011 to 30 September 2015 and five-year post-transplant for the period 1 October 2007 to 30 September 2011. Results are described separately according to the type of donor (deceased and living).

The centre specific results for survival estimates are adjusted for differences in risk factors between the centres. The risk models used are described in the Appendix.

Patients requiring multi-organ transplants are excluded from all analyses and all results are described for adult patients (aged≥18years) other than those presented in this Introduction section which also includes paediatric patients.

Throughout this report West London Renal and Transplant Centre is labeled as WLRTC.

Figure 2.1 shows the number of patients on the kidney transplant list at 31 March and 30 September each year between 2012 and 2016. The number of patients actively waiting for a kidney transplant decreased through each 6 monthly period from 6,633 at 31 March 2012 to 5,342 at 30 September 2016.

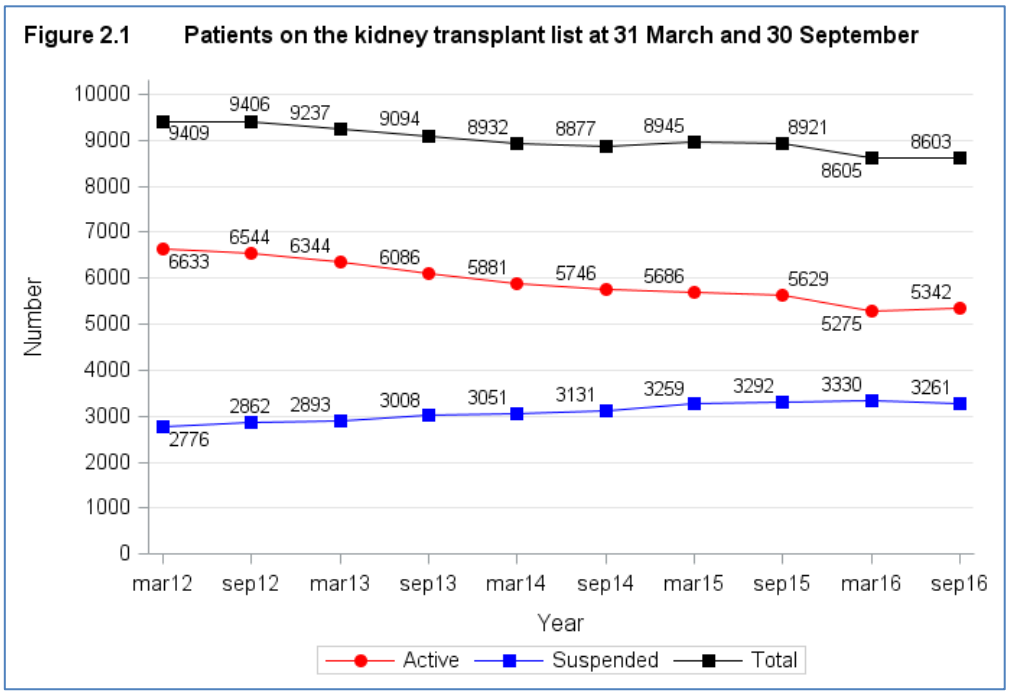


Figure 2.2 shows the number of patients on the kidney transplant list at 30 September 2016 for each transplant centre. WLRTC has the largest active transplant list with 436 patients registered for a kidney transplant.

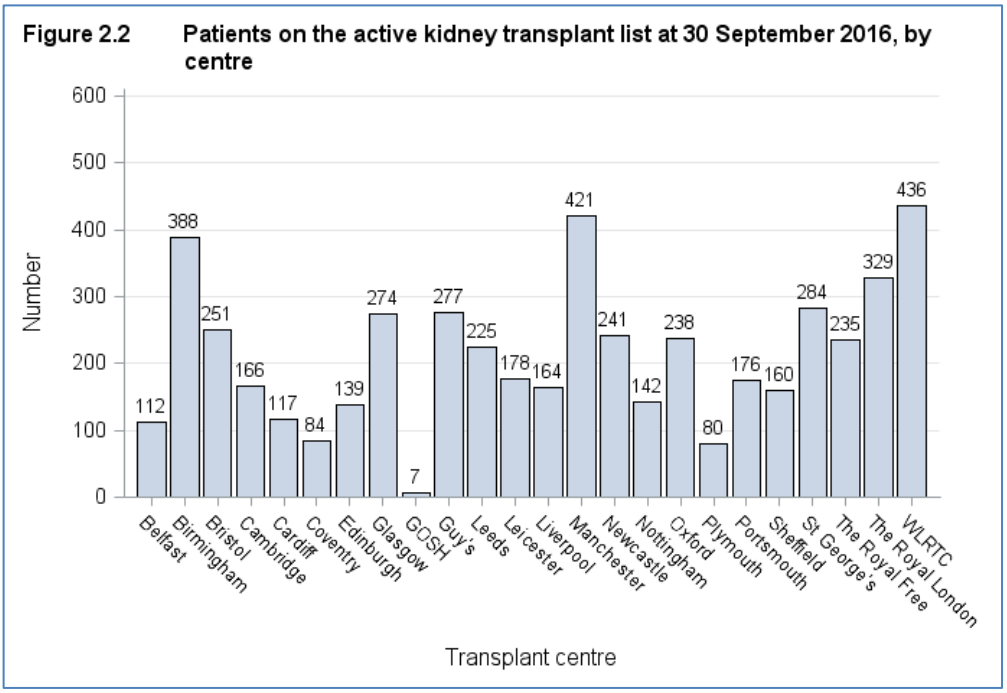


Figure 2.3 shows the total number of kidney transplants performed in the last five years, in 6 month periods. The number of transplants has increased over the last 5 years from 1,439 between 1 October 2011 and 31 March 2012 to 1,591 between 1 April and 30 September 2016.

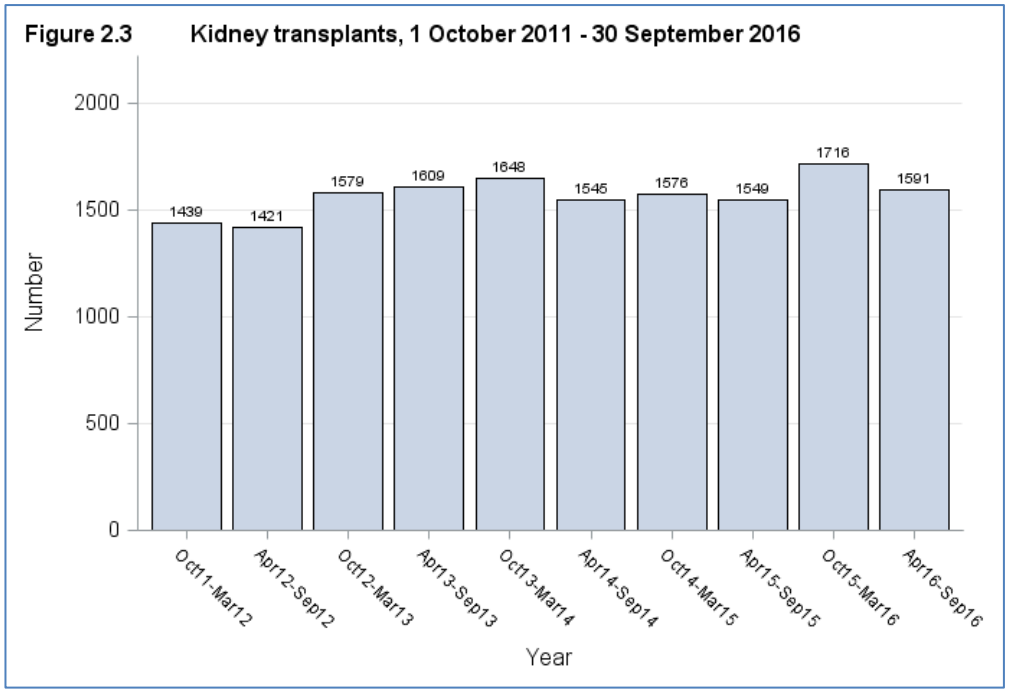


Figure 2.4 shows the total number of kidney transplants performed between 1 April 2016 and 30 September 2016 at each transplant centre. Manchester performed the most kidney transplants in this period with 158 patients receiving a transplant.

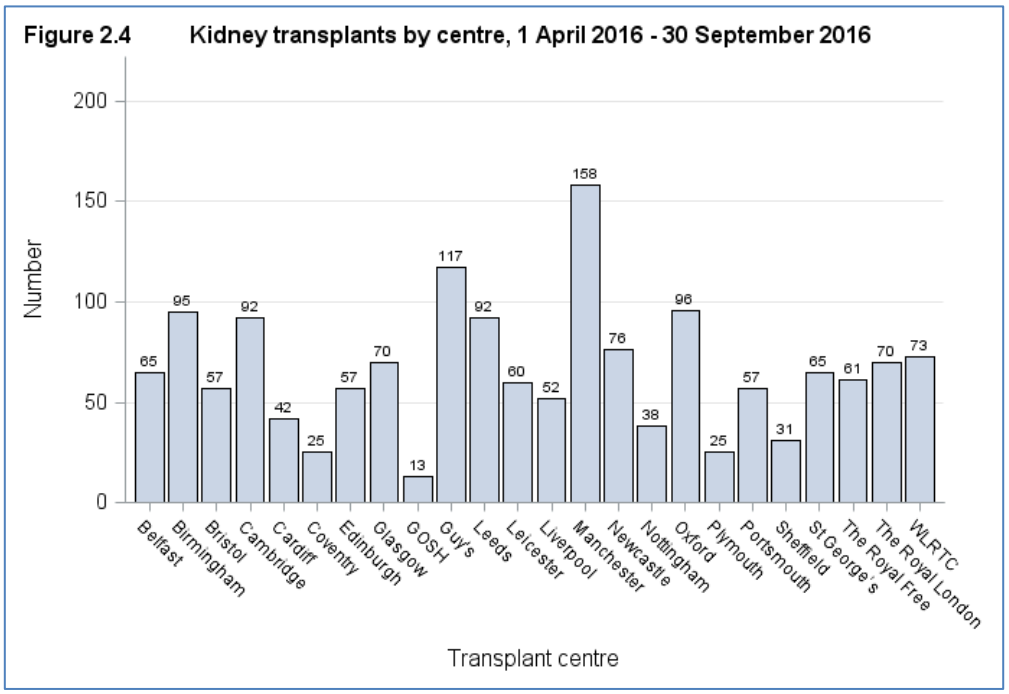
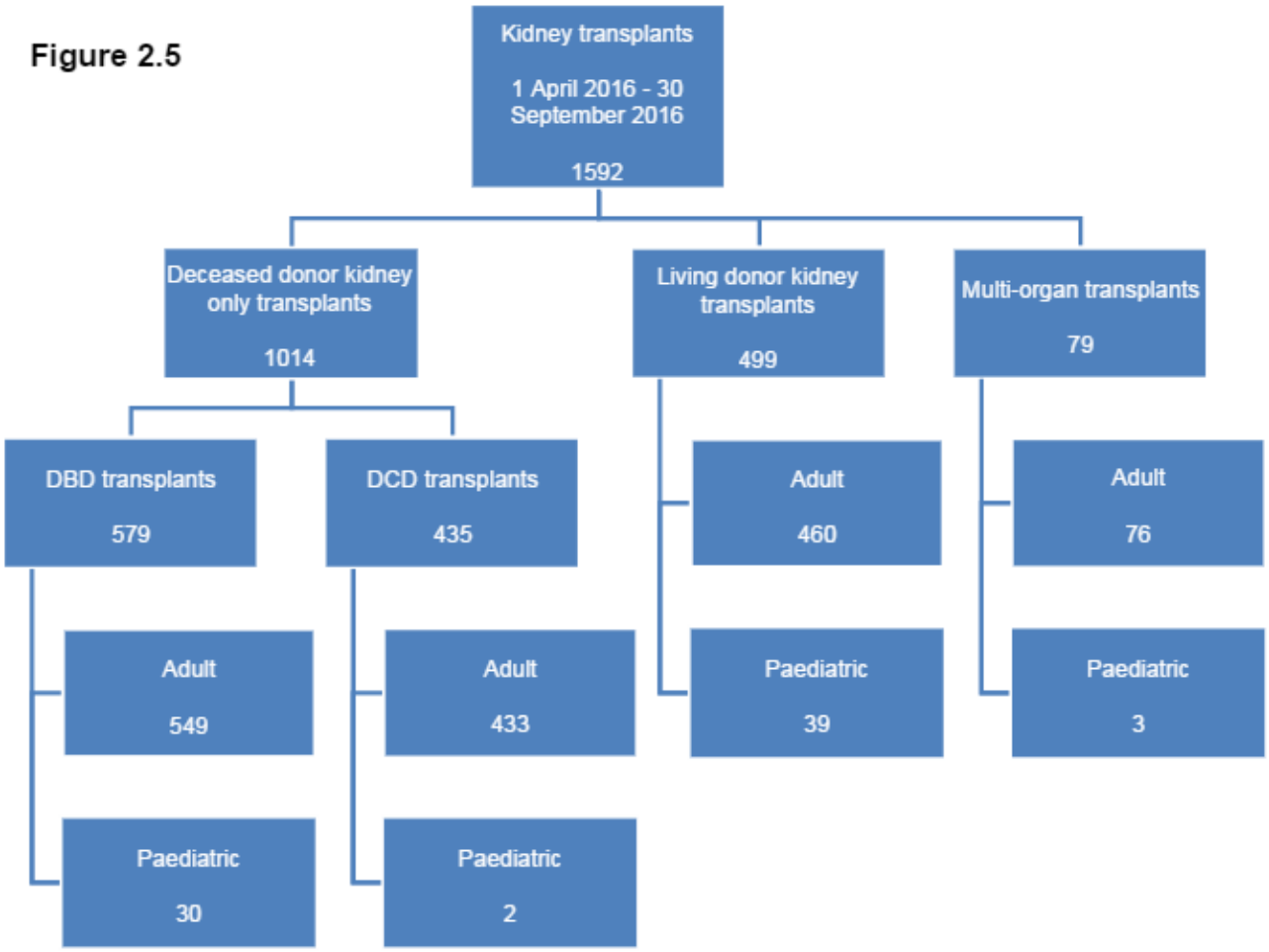


Figure 2.5 details the 1592 kidney transplants performed in the UK between 1 April 2016 and 30 September 2016. Of these, 1014 (64%) were deceased donor kidney only transplants and 499 (31%) were living donor kidney transplants. Of the 79 multi-organ transplants, 71 were simultaneous kidney and pancreas transplants and 7 were kidney and liver transplants.

Figure 2.5



Adult kidney transplant list

3.1 Patients on the kidney transplant list as at 31 March and 30 September, 2012 – 2016

Figure 3.1 shows the number of adult patients on the kidney only transplant list at 31 March and 30 September each year between 2012 and 2016. The number of patients actively waiting for a kidney transplant decreased across each 6 monthly period from 6,327 at 31 March 2012 to 5,055 at 30 September 2016.

Figure 3.1 Adult patients on the kidney only transplant list at 31 March and 30 September

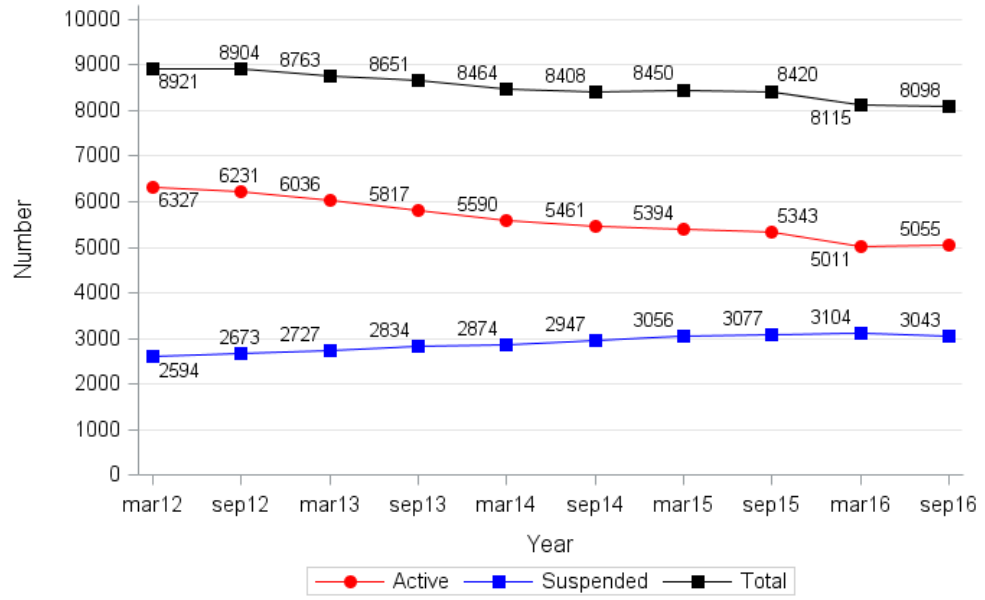
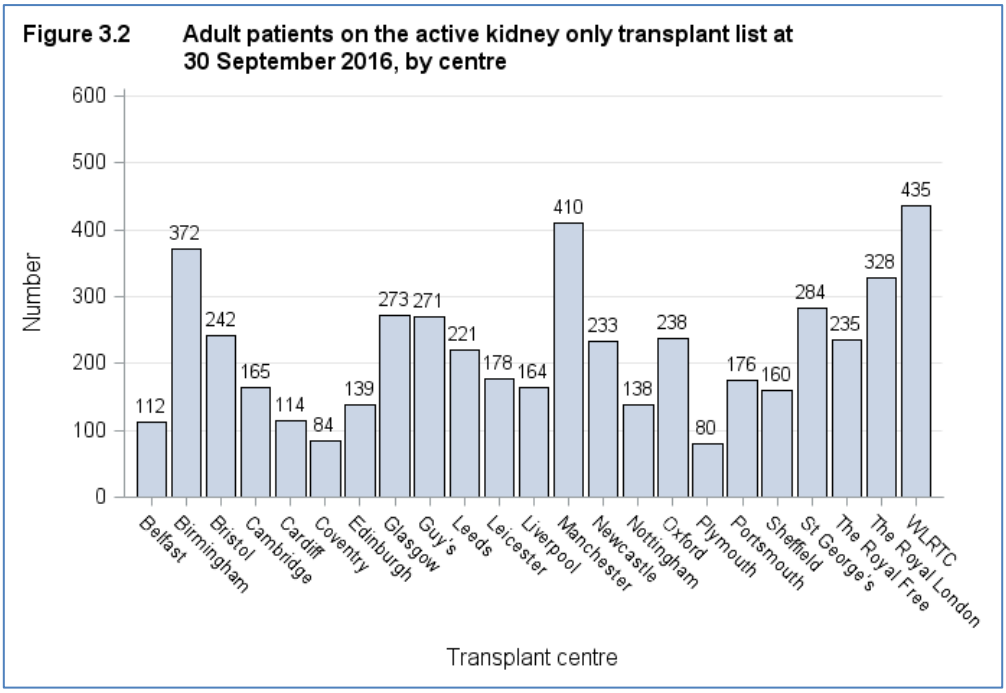


Figure 3.2 shows the number of adult patients on the active kidney only transplant list at 30 September 2016 by centre. In total, there were 5,052 adults patients. WLRTC had the largest proportion of the transplant list (9%) and Plymouth had the smallest (2%).

Figure 3.2 Adult patients on the active kidney only transplant list at 30 September 2016, by centre



3.2 Median waiting time to transplant, 1 October 2010 – 30 September 2013

The length of time a patient waits for a kidney transplant varies across the UK. The median waiting time for adult deceased donor kidney only transplantation is shown in **Figure 3.3** and **Table 3.1** for patients registered at each individual unit. During this period local allocation arrangements were in place for DCD kidneys while DBD kidneys were allocated via the National Kidney Allocation Scheme. The data shown are for all adult patients, joining the list within the time period shown, including those still awaiting a transplant on the day of analysis. Patients who received a live donor or multi-organ transplant are not included. The national allocation scheme introduced in April 2006 is slowly reducing the variability in deceased donor kidney waiting times across the country but currently some variability remains. Waiting times across centres continue to differ in a way that it is difficult for centres to control, given that the National Kidney Allocation Scheme determines allocation of all kidneys available for transplant from donors after brain death (DBD).

National Kidney Allocation Scheme
Only kidneys from donors after brain death were allocated via a national allocation scheme during the time period analysed. Kidneys from donations after circulatory death (DCD) were allocated to patients through local allocation arrangements and these vary across the country because some centres have a larger DCD programme than others. As of 3 September 2014 one kidney from DCD donors aged between 5 and 49 years will be allocated within four pre-defined regions using the 2006 DBD allocation principles and as such we should start to see further reductions in variability in waiting times across the country.

Kidneys from DBD are allocated to patients listed nationally through the Kidney Allocation Scheme. The Kidney Allocation Scheme introduced in April 2006 prioritises patients with ideal tissue matches (000 HLA mismatches) and then assigns points to patients based on the level of tissue match between donor and recipient, the length of time spent waiting for a transplant, age of the recipient (with a progressive reduction in points given after the age of thirty) and location points such that patients geographically close to the retrieval centre receive more points. The patients with the highest number of points for a donated kidney are preferentially offered the kidney, no matter where in the UK they receive their treatment.

The median waiting time to transplant for adult patients registered on the kidney only transplant list between 1 October 2010 and 30 September 2013 is 869 days. This ranged from 358 days at Cambridge to 1,226 days at Birmingham .

Figure 3.3 **Median waiting time to deceased donor transplant for adult patients registered on the kidney transplant list, 1 October 2010 - 30 September 2013**

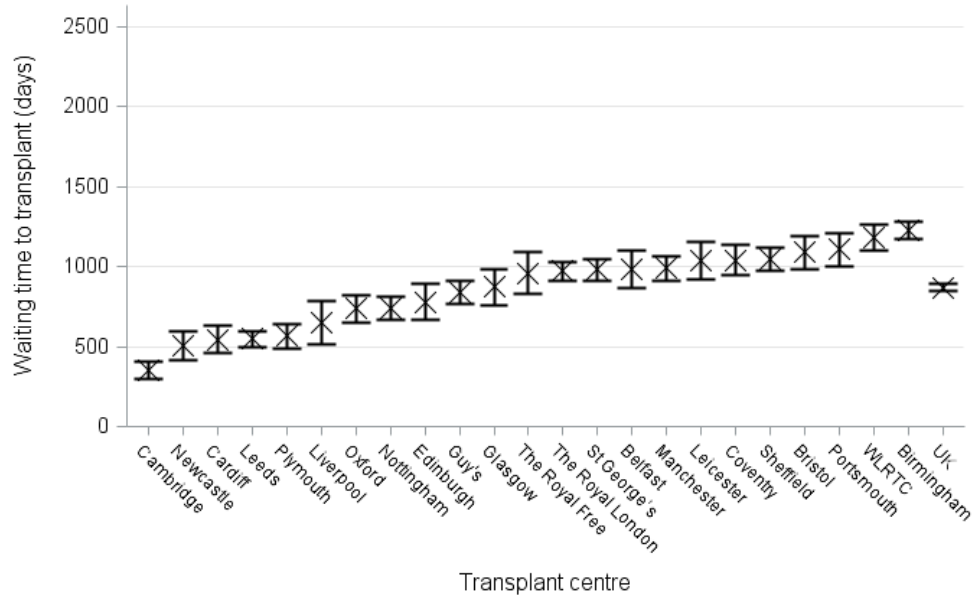


Table 3.1 **Median waiting time to kidney only transplant in the UK, for adult patients registered 1 October 2010 - 30 September 2013**

Transplant centre	Number of patients registered	Waiting time (days) Median	95% Confidence interval
Adult			
Cambridge	333	358	304 - 412
Newcastle	291	506	414 - 598
Cardiff	271	544	458 - 630
Leeds	424	549	500 - 598
Plymouth	150	567	491 - 643
Liverpool	234	650	513 - 787
Oxford	266	737	653 - 821
Nottingham	179	741	665 - 817
Edinburgh	187	780	666 - 894
Guy's	390	840	771 - 909
Glasgow	342	874	762 - 986
The Royal Free	317	962	830 - 1094
The Royal London	279	972	912 - 1032
St George's	321	983	916 - 1050
Belfast	125	984	870 - 1098
Manchester	522	993	917 - 1069
Leicester	230	1037	920 - 1154
Coventry	113	1041	948 - 1134
Sheffield	185	1050	978 - 1122
Bristol	306	1092	988 - 1196
Portsmouth	245	1107	1004 - 1210
WLRTC	506	1183	1102 - 1264
Birmingham	403	1226	1173 - 1279
UK	**6619**	**869**	**846 - 892**

Response to adult kidney offers

Offer decline rates

Kidney-only offers from DBD donors who had at least one kidney retrieved, offered directly and on behalf of a named individual patient and resulted in transplantation are included in the analysis. Any offers made through the reallocation of kidneys, declined kidney or fast track schemes were excluded, as were offers of kidneys from donations after circulatory death donors.

In order to understand centre practices more fully, data are presented separately for standard and extended criteria donors (SCD & ECD). ECD have been defined as DBD donors aged ≥60 years at the time of death OR aged 50 to 59 years with at least two or three donor characteristics: hypertension, creatinine > 130 µmol/l or death due to intracranial haemorrhage. SCD are DBD donors that did not meet the ECD criteria.

Funnel plots were used to compare centre specific offer decline rates and indicate how consistent the rates of the individual transplant centres are with the national rate. The overall national unadjusted offer decline rate is shown by the solid line while the 95% and 99.8% confidence lines are indicated via a thin and thick dotted line, respectively. Each dot in the plot represents an individual transplant centre. Centres that are positioned above the upper limits indicate an offer decline rate that is higher than the national rate, while centres positioned below the lower limits indicates an offer decline rate that is lower than the national rate. Patient case mix is known to influence the number of offers a centre may receive. In this analysis however only individual offers for named patients were considered which excluded any ABO- and HLA-incompatible patients. For this reason it was decided not to risk adjust for known centre differences in patient case mix.

4.1 Standard criteria offer decline rates, 1 April 2013 – 30 September 2016

Figure 4.1 compares individual centre offer decline rates with the national rate for SCD over the time period, 1 April 2013 and 30 September 2016. Centres can be identified by the information shown in **Table 4.1**. Leicester, Birmingham, Bristol, Nottingham and WLRTC have offer decline rates consistently higher than the national rate.

Figure 4.1 **Adult standard criteria DBD donor kidney offer decline rates for kidneys that resulted in a transplant, 1 April 2013 and 30 September 2016**

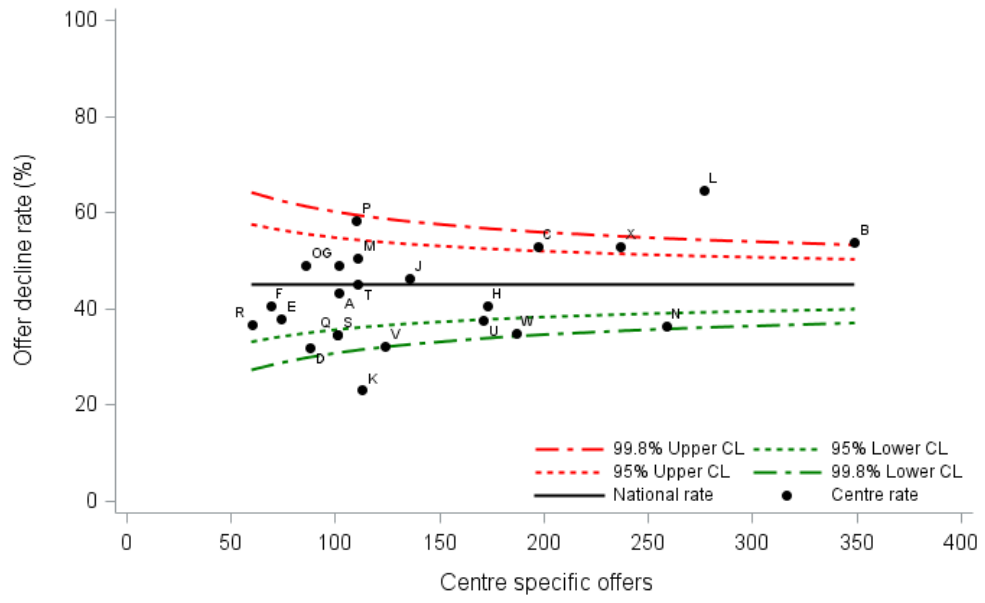


Table 4.1 compares individual centre offer decline rates for SCD over time. Leicester has had an offer decline rate that is consistently higher than national rate since 2013/14; however their offer decline rate has improved from 72% in 2013-2014 to 35% between 1 April and 30 September 2016.

Table 4.1 Adult standard criteria DBD donor kidney offer decline rates by transplant centre, 1 April 2013 and 30 September 2016

Centre	Code	2013/14		2014/15		2015/16		1 Apr - 30 Sep		Overall	
		N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Belfast	A	38	(53)	32	(41)	17	(41)	15	(27)	102	(43)
Birmingham	B	101	(58)	100	(48)	98	(52)	50	(60)	349	(54)
Bristol	C	60	(50)	58	(57)	44	(50)	35	(54)	197	(53)
Cambridge	D	23	(39)	32	(25)	19	(37)	14	(29)	88	(32)
Cardiff	E	16	(31)	23	(43)	24	(38)	11	(36)	74	(38)
Coventry	F	24	(50)	23	(35)	12	(42)	10	(30)	69	(41)
Edinburgh	G	29	(55)	26	(46)	39	(49)	8	(38)	102	(49)
Glasgow	H	41	(27)	44	(39)	57	(46)	31	(52)	173	(40)
Guy's	J	24	(58)	37	(46)	51	(43)	24	(42)	136	(46)
Leeds	K	25	(32)	32	(19)	39	(23)	17	(18)	113	(23)
Leicester	L	113	(72)	101	(68)	40	(53)	23	(35)	277	(65)
Liverpool	M	27	(44)	34	(59)	40	(55)	10	(20)	111	(50)
Manchester	N	85	(28)	83	(41)	59	(34)	32	(50)	259	(36)
Newcastle	O	17	(41)	23	(65)	32	(44)	14	(43)	86	(49)
Nottingham	P	38	(68)	28	(57)	27	(48)	17	(53)	110	(58)
Oxford	Q	31	(39)	24	(38)	27	(26)	19	(37)	101	(35)
Plymouth	R	19	(47)	18	(33)	16	(25)	7	(43)	60	(37)
Portsmouth	S	21	(38)	37	(43)	20	(35)	23	(17)	101	(35)
Sheffield	T	33	(42)	37	(43)	32	(47)	9	(56)	111	(45)
St George's	U	52	(40)	48	(27)	50	(40)	21	(48)	171	(37)
The Royal Free	V	27	(26)	52	(40)	32	(28)	13	(23)	124	(32)
The Royal London	W	48	(31)	58	(36)	56	(43)	25	(20)	187	(35)
WLRTC	X	67	(49)	78	(51)	55	(51)	37	(65)	237	(53)
UK		**959**	**(47)**	**1028**	**(46)**	**886**	**(43)**	**465**	**(43)**	**3338**	**(45)**

4.2 Extended criteria offer decline rates, 1 April 2013 – 30 September 2016

Figure 4.2 compares individual centre offer decline rates with the national rate for ECD over the time period, 1 April 2013 and 30 September 2016. Centres can be identified by the information shown in **Table 4.2**. Birmingham, Leicester, Cardiff, Sheffield and The Royal London have offer decline rates consistently higher than the national rate.

Figure 4.2 **Adult extended criteria DBD donor kidney offer decline rates for kidneys that resulted in a transplant, 1 April 2013 and 30 September 2016**

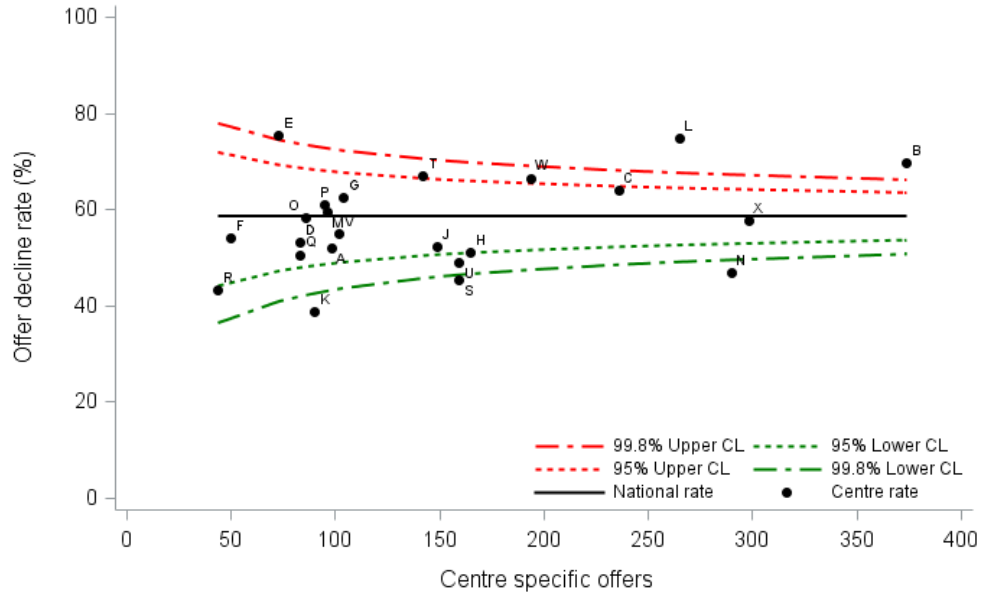


Table 4.2 compares individual centre offer decline rates for ECD over time. Leicester has shown improvements in their ECD offer decline rates over time. Leicester's ECD offer decline rate has decreased from 82% in 2013/14 to 46% between 1 April and 30 September 2016. Between 1 April 2015 and 31 March 2016, Leicester now has an offer decline rate that is in line with the national rate.

Table 4.2 Adult extended criteria DBD donor kidney offer decline rates by transplant centre, 1 April 2013 and 30 September 2016

Centre	Code	2013/14		2014/15		2015/16		1 Apr - 30 Sep		Overall	
		N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Belfast	A	36	(58)	19	(42)	27	(44)	14	(64)	96	(52)
Birmingham	B	137	(80)	96	(72)	98	(53)	43	(70)	374	(70)
Bristol	C	63	(62)	45	(51)	89	(67)	38	(74)	235	(64)
Cambridge	D	21	(52)	32	(56)	24	(50)	7	(57)	84	(54)
Cardiff	E	24	(75)	12	(67)	21	(71)	16	(88)	73	(75)
Coventry	F	17	(41)	18	(67)	11	(55)	4	(50)	50	(54)
Edinburgh	G	31	(52)	28	(64)	32	(72)	13	(62)	104	(63)
Glasgow	H	31	(39)	37	(49)	59	(53)	39	(59)	166	(51)
Guy's	J	36	(56)	31	(48)	56	(46)	26	(62)	149	(52)
Leeds	K	18	(28)	28	(39)	29	(38)	15	(53)	90	(39)
Leicester	L	103	(82)	94	(81)	42	(62)	26	(46)	265	(75)
Liverpool	M	21	(33)	29	(69)	33	(64)	13	(69)	96	(59)
Manchester	N	77	(47)	64	(61)	106	(41)	43	(42)	290	(47)
Newcastle	O	21	(67)	19	(58)	29	(59)	17	(47)	86	(58)
Nottingham	P	39	(69)	18	(67)	24	(50)	14	(50)	95	(61)
Oxford	Q	18	(50)	17	(47)	37	(54)	11	(45)	83	(51)
Plymouth	R	15	(67)	11	(36)	12	(25)	6	(33)	44	(43)
Portsmouth	S	48	(42)	45	(36)	40	(58)	26	(50)	159	(45)
Sheffield	T	41	(61)	42	(67)	37	(68)	22	(77)	142	(67)
St George's	U	42	(38)	38	(45)	57	(60)	22	(50)	159	(49)
The Royal Free	V	23	(65)	24	(46)	37	(57)	18	(50)	102	(55)
The Royal London	W	56	(71)	46	(54)	57	(75)	34	(62)	193	(67)
WLRTC	X	85	(58)	74	(58)	94	(53)	44	(66)	297	(58)
UK		**1003**	**(61)**	**867**	**(59)**	**1051**	**(56)**	**511**	**(59)**	**3432**	**(59)**

4.3 Reallocation of kidneys, 1 April 2013 – 30 September 2016

Since 3 April 2006 all kidneys from donation after brain death (DBD) donors have been allocated through the 2006 National Kidney Allocation Scheme (KAS). There are however certain situations when a kidney can be reallocated to an alternative patient of the centre's choice. This occurs when the kidney is accepted and dispatched to a named patient but is subsequently declined and there are no other patients listed nationally who fall within Tiers A to D of the kidney allocation scheme (000 mismatched adult and paediatric patients or favourably matched paediatric patients).

In this situation the centre in receipt of the kidney can reallocate the organ to a locally listed patient of their choice based on an individual centre matching run.

Funnel plots were used to compare centre specific reallocation rates and indicate how consistent the rates of the individual transplant centres are with the national rate. The overall national reallocation rate is shown by the solid line while the 95% and 99.8% confidence lines are indicated via a thin and thick dotted line, respectively. Each dot in the plot represents an individual transplant centre. Centres that are positioned above the upper limits indicate a reallocation rate that is higher than the national rate, while centres positioned below the lower limits indicates a reallocation rate that is lower than the national rate.

Figure 4.3 compares individual centre reallocation rates with the national rate over the time period, 1 April 2013 to 30 September 2016. Centres can be identified by the information shown in **Table 4.3**. Nationally 5% of all DBD kidney only transplants used kidneys that had been reallocated. Leicester and the WLRTC have reallocation rates consistently higher than the national rate.

Figure 4.3 **Local reallocation of DBD donor kidneys following an acceptance of an adult offer through the national allocation scheme**

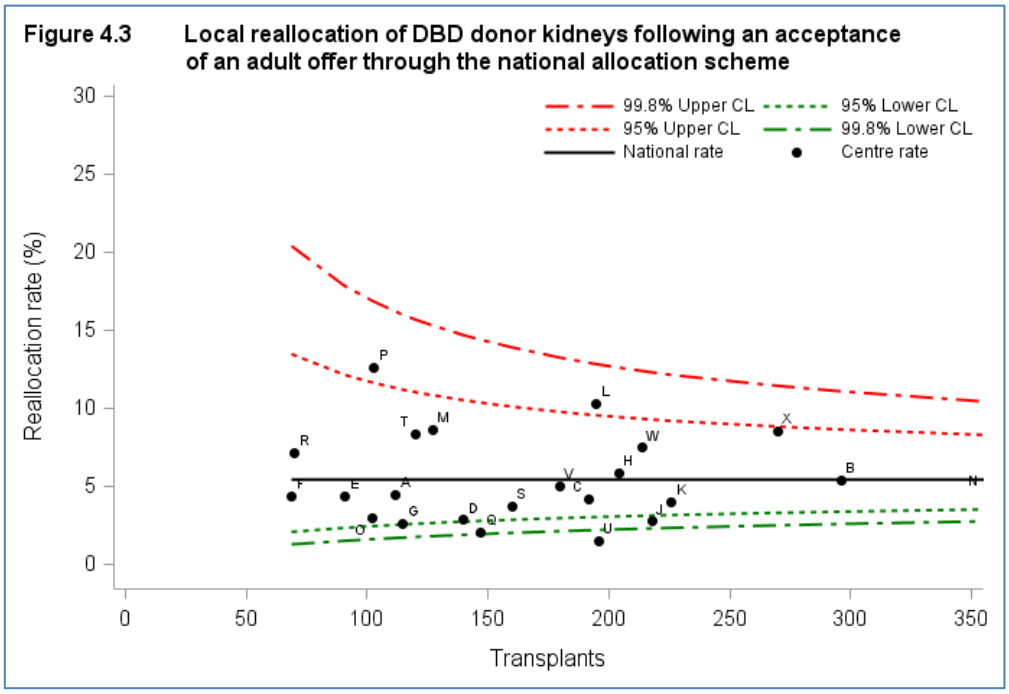


Table 4.3 compares individual reallocation rates over time by financial year. Birmingham, Cardiff and St. George's have all shown improvements in their reallocation rates over time. Since 2013-2014, all centres have a reallocation rate that is in line with the national rate.

Table 4.3 Local reallocation of DBD donor kidneys following an acceptance of an adult offer through the national allocation scheme

Centre	Code	2013/14		2014/15		2015/16		1 Apr - 30 Sep		Overall	
		N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Belfast	A	37	(8)	30	(0)	27	(7)	18	(0)	112	(4)
Birmingham	B	79	(10)	88	(8)	96	(1)	33	(0)	296	(5)
Bristol	C	61	(7)	50	(4)	55	(4)	26	(0)	192	(4)
Cambridge	D	41	(7)	50	(2)	29	(0)	20	(0)	140	(3)
Cardiff	E	31	(10)	20	(0)	28	(4)	12	(0)	91	(4)
Coventry	F	22	(0)	23	(9)	14	(7)	10	(0)	69	(4)
Edinburgh	G	33	(6)	32	(0)	39	(3)	11	(0)	115	(3)
Glasgow	H	58	(10)	53	(6)	62	(5)	31	(0)	204	(6)
Guy's	J	47	(4)	56	(4)	84	(1)	31	(3)	218	(3)
Leeds	K	52	(8)	62	(5)	73	(0)	39	(5)	226	(4)
Leicester	L	62	(11)	58	(16)	42	(7)	33	(3)	195	(10)
Liverpool	M	39	(8)	35	(11)	39	(8)	14	(7)	127	(9)
Manchester	N	111	(4)	91	(13)	108	(2)	48	(2)	358	(5)
Newcastle	O	27	(4)	20	(0)	35	(6)	20	(0)	102	(3)
Nottingham	P	30	(17)	27	(11)	30	(13)	16	(6)	103	(13)
Oxford	Q	34	(0)	41	(2)	50	(4)	22	(0)	147	(2)
Plymouth	R	18	(6)	22	(14)	22	(5)	8	(0)	70	(7)
Portsmouth	S	44	(5)	52	(4)	31	(3)	33	(3)	160	(4)
Sheffield	T	41	(10)	37	(5)	32	(9)	10	(10)	120	(8)
St George's	U	59	(2)	59	(0)	55	(2)	23	(4)	196	(2)
The Royal Free	V	37	(8)	68	(6)	49	(4)	26	(0)	180	(5)
The Royal London	W	58	(9)	65	(5)	57	(12)	34	(3)	214	(7)
WLRTC	X	80	(11)	82	(11)	77	(5)	31	(3)	270	(9)
UK		**1101**	**(7)**	**1121**	**(6)**	**1134**	**(4)**	**549**	**(2)**	**3905**	**(5)**

Adult kidney transplants

5.1 Kidney only transplants, 1 October 2011 – 30 September 2016

Figure 5.1 shows the total number of adult kidney only transplants performed in the last five years, by type of donor. The number of adult transplants from donors after circulatory death (DCD) increased from 342 between 1 October 2011 and 31 March 2012 to 481 between 1 October 2015 and 31 March 16, before decreasing by 10% to 433 between 1 April 2016 and 30 September 2016. The number of transplants from donors after brain death (DBD) increased from 452 between 1 October 2011 and 31 March 2012 to 584 between 01 October 2015 and 31 March 2016 before decreasing by 6% to 549 between 01 April 2016 and 30 September 2016. The number of adult living kidney transplants performed reached a high of 538 between 1 October 2013 and 31 March 2014 before decreasing by 15% to 459 between 1 April 2016 and 30 September 2016.

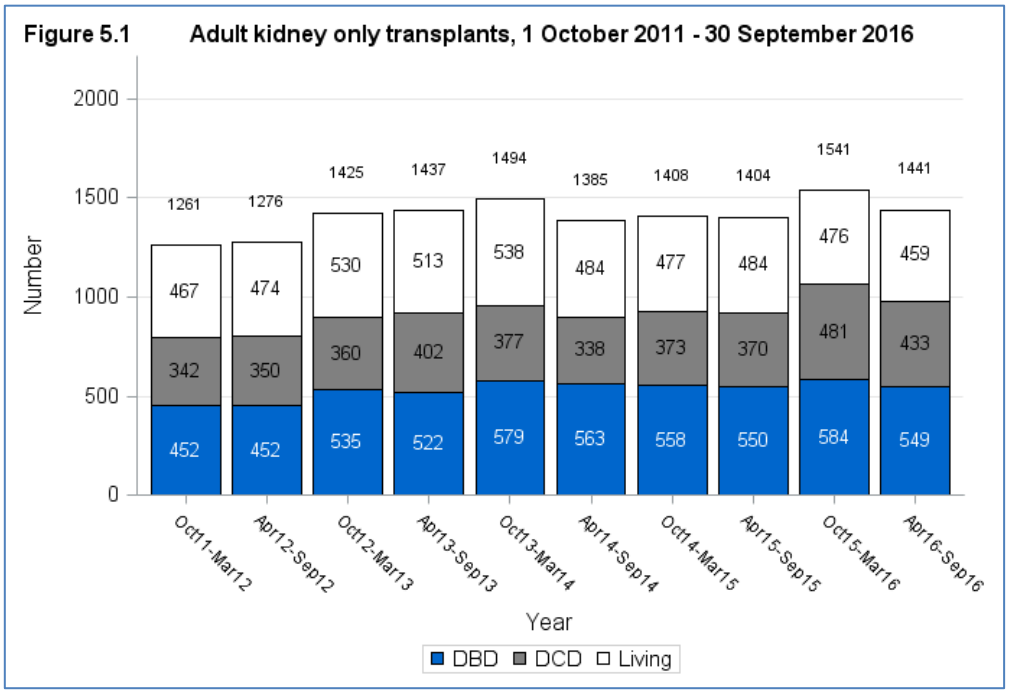
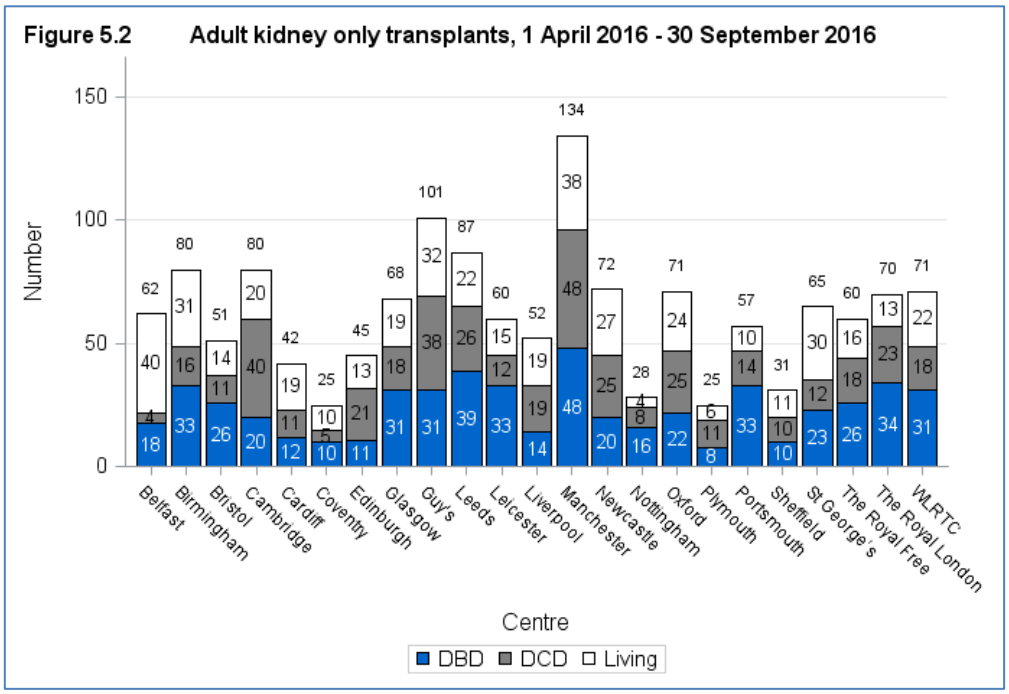
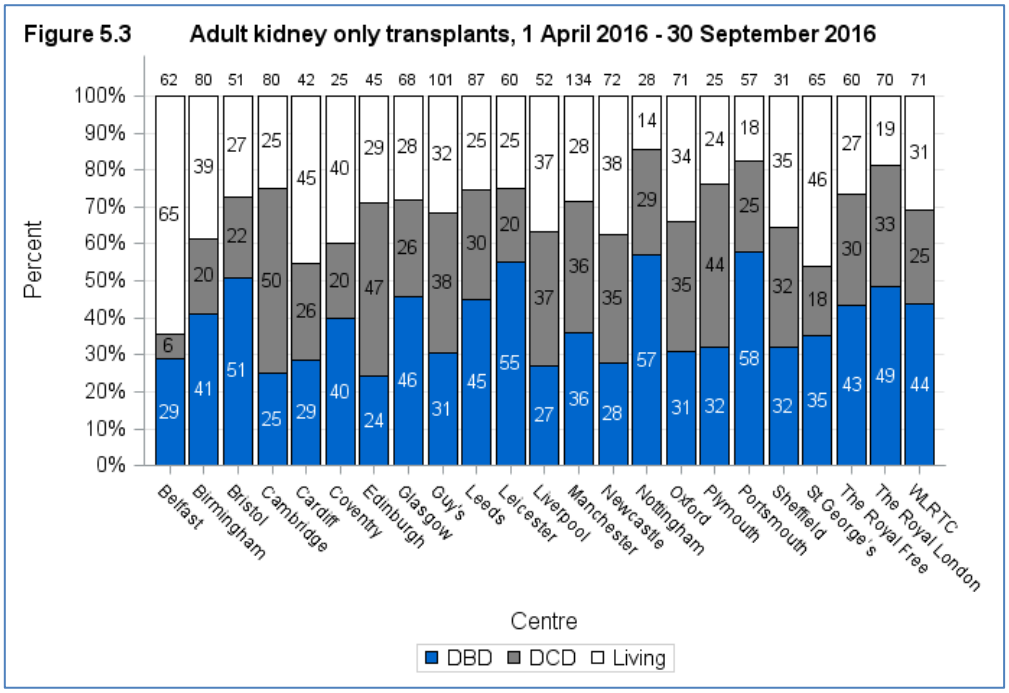


Figure 5.2 shows the total number of adult kidney only transplants performed between 1 April 2016 and 30 September 2016, by centre and type of donor. The same information is presented in **Figure 5.3** but this shows the proportion of DBD, DCD and living donor transplants performed at each centre.





5.2 Kidney donor risk-index[1], 1 April 2011 – 30 September 2016

The severe shortage of deceased donor (DD) organs available for transplantation has led to increased use of kidneys from suboptimal donors with potentially less good transplant outcome. Categorising such kidneys according to anticipated outcome is important because it enables clinicians to be better informed when making decisions about organ allocation and allows appropriate counselling of potential recipients. Kidneys from suboptimal donors are variously referred to as marginal, extended criteria, or expanded criteria organs. Although categorising DD kidneys as either standard or expanded criteria has the advantage of simplicity, it does not adequately reflect the wide spectrum of donor kidney quality, and this has led to the development of more refined approaches to assessing the quality of DD kidneys. A donor risk index was developed by determining the factors that influence transplant survival, the time from transplant to the earlier of graft failure or patient death. A UK donor risk index was derived from the parameter estimates of the donor factors in the Cox model developed for overall transplant survival. This gives the following index:

$$
\begin{aligned}
\text{UKKDRI} = \exp\{ & -0.245 \times (\text{donor age} < 40) + \\
& 0.396 \times (\text{donor age} \geq 60) + \\
& 0.265 \times (\text{history of hypertension}) + \\
& 0.0253 \times [\text{donor weight(kg)} - 75]/10) + \\
& 0.00461 \times (\text{days in hospital}) + \\
& 0.0465 \times (\text{adrenaline})\}
\end{aligned}
$$

Reference

1 Watson CJE, Johnson RJ, Birch R, Collett D, Bradley JA. A simplified donor risk index for predicting outcome after deceased donor kidney transplantation. *Transplantation*, 2012; 93: 314-318

Figure 5.4 shows the number of transplanted DBD donor kidneys over the last five years by kidney donor risk index group. Between 1 October 2011 and 31 March 2012, 35% of all transplants were performed using kidneys from donors categorised as high risk (UK Donor risk index ≥1.35) compared with 43% between 1 April and 30 September 2016.

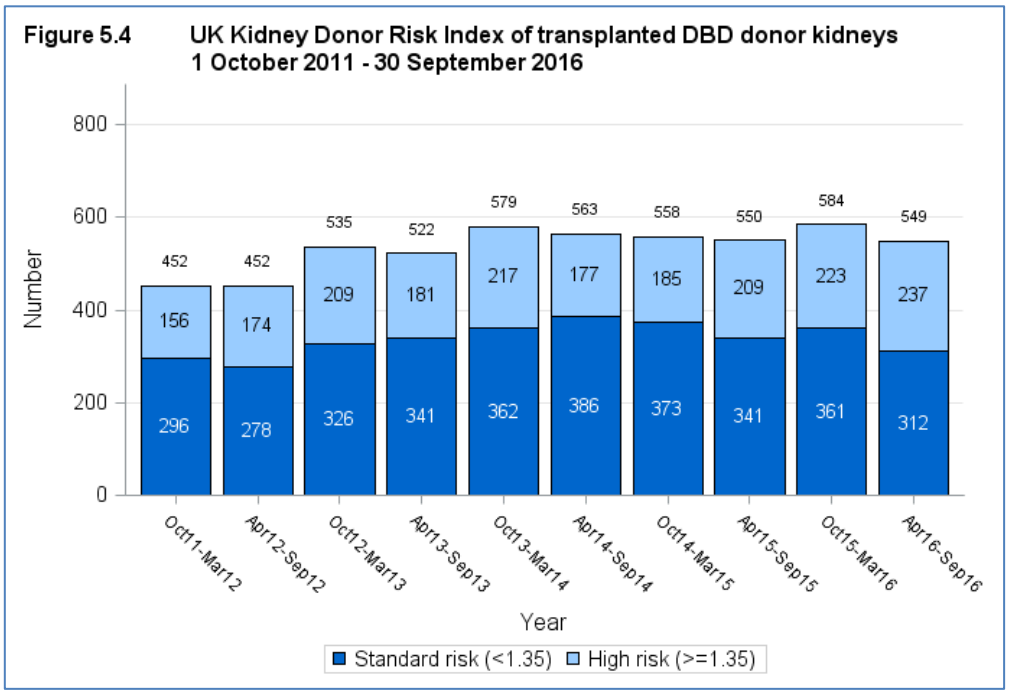


Figure 5.5 shows the number of transplanted DBD donor kidneys between 1 April 2016 and 30 September 2016 by kidney donor risk index group for each transplant centre. The same information is presented in **Figure 5.6** but this shows the proportion of standard risk and high risk donor transplants performed at each centre.

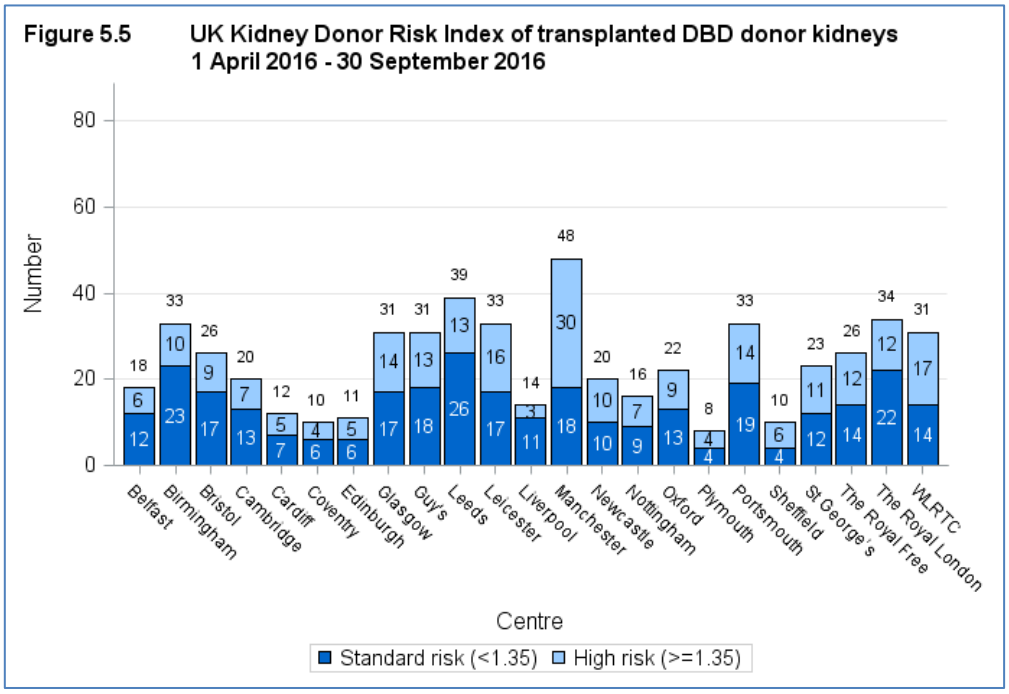
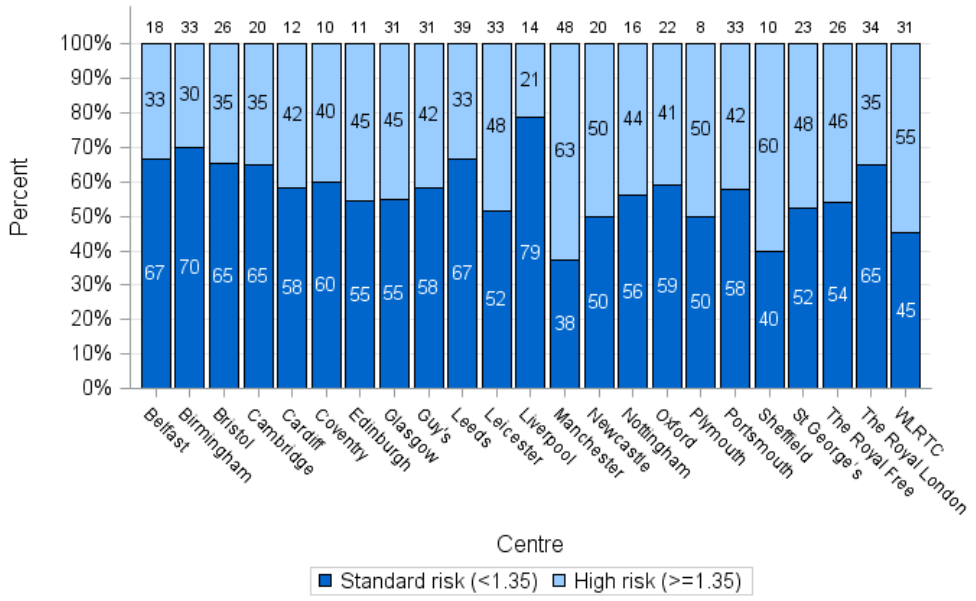


Figure 5.6 **UK Kidney Donor Risk Index of transplanted DBD donor kidneys 1 April 2016 - 30 September 2016**



5.3 Cold ischaemia time, 1 October 2011 – 30 September 2016

The length of time that elapses between a kidney being removed from the donor to its transplantation into the recipient is called the Cold Ischaemia Time (CIT). Generally, the shorter this time, the more likely the kidney is to work immediately and the better the long-term outcome. One of the reasons why live donor kidney transplantation is so successful is because the CIT is only one to two hours long. For deceased donor renal transplants, CIT can never be as short as this, but efforts are made to keep the time to a minimum. Evidence indicates that the outcome is only adversely affected when CIT is longer than 20 hours, although many deceased donor kidney transplants with a CIT of more than 20 hours have been very successful.

The factors which determine CIT include a) transportation of the kidney from the retrieval hospital to the hospital where the transplant is performed, b) the need to tissue type the donor and cross-match the donor and potential recipients, c) the occasional necessity of moving the kidney to another hospital if a transplant cannot go ahead, d) contacting and preparing the recipient for the transplant and e) access to the operating theatre.

Median CITs are shown in addition to inter-quartile ranges. Fifty percent of the transplants have a CIT within the inter-quartile range. There is some variation in average (median) CIT between different transplant centres although all centres continually try to reduce this time.

Figure 5.7 shows the median total ischaemia time in adult DBD donor kidney only transplants over the last 5 years. The median total ischaemia time has decreased from 15 hours between 1 October 2011 and 31 March 2012 to 13 hours between 1 April 2016 and 30 September 2016.

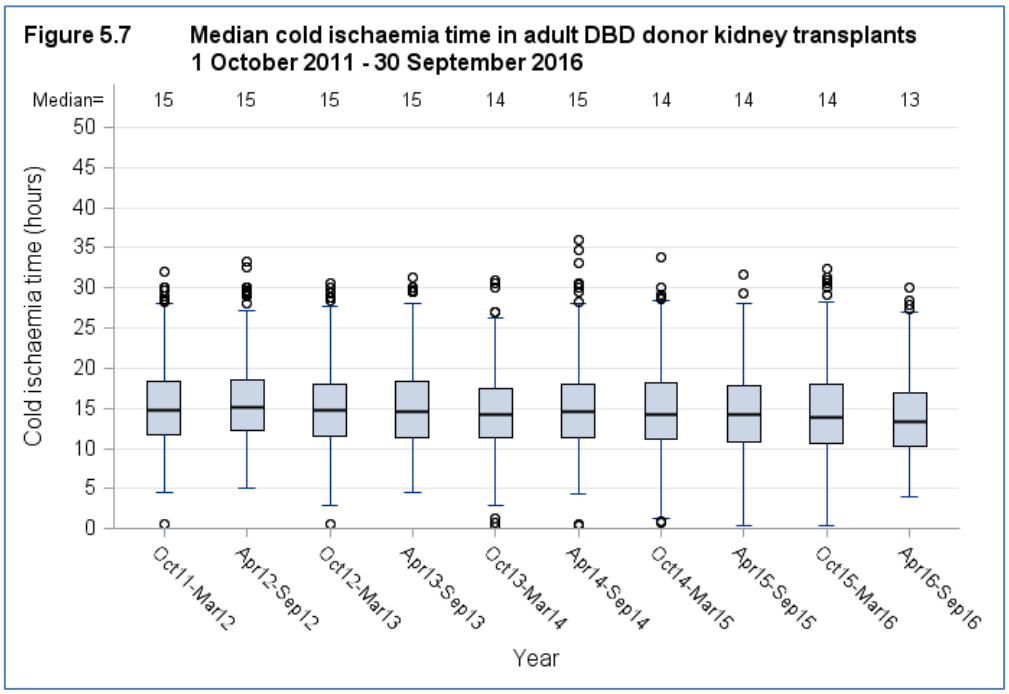


Figure 5.8 shows the median total ischaemia time in adult DBD donor kidney only transplants between 1 April 2016 and 30 September 2016 for each transplant centre. Sheffield had the longest median cold ischaemia time, 18 hours between 1 April and 30 September 2016 compared with St. George's who had the shortest, 9 hours.

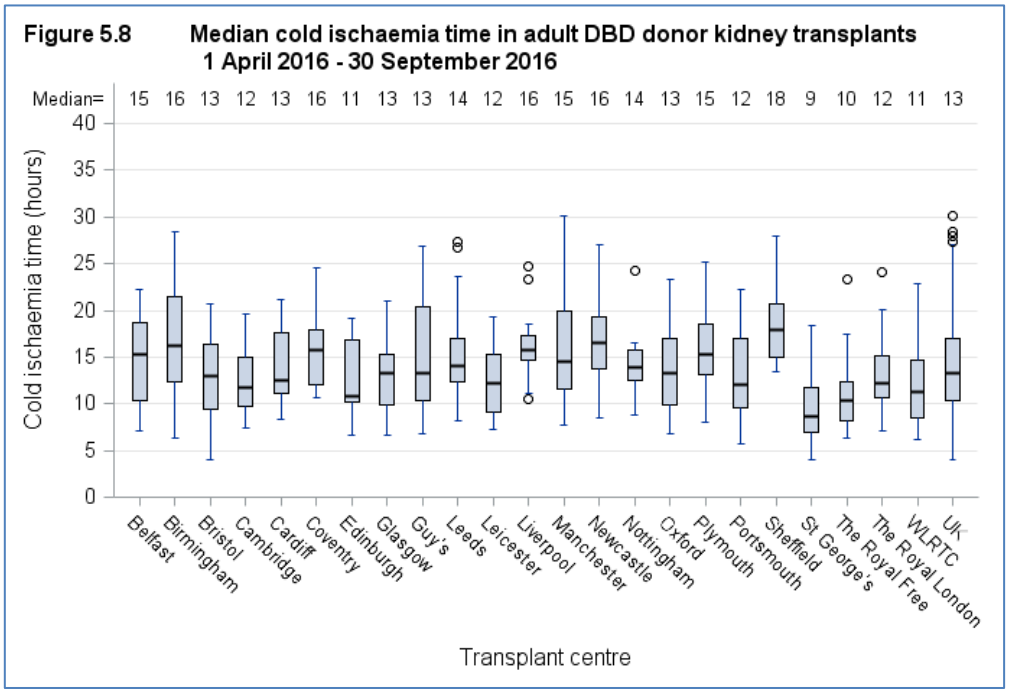


Figure 5.9 shows the median total ischaemia time in adult DCD donor kidney only transplants over the last 5 years. The median total ischaemia time has fallen over the last 5 years from 14 hours between 1 October 2011 and 31 March 2012 to 13 hours between 1 April 2016 and 30 September 2016.

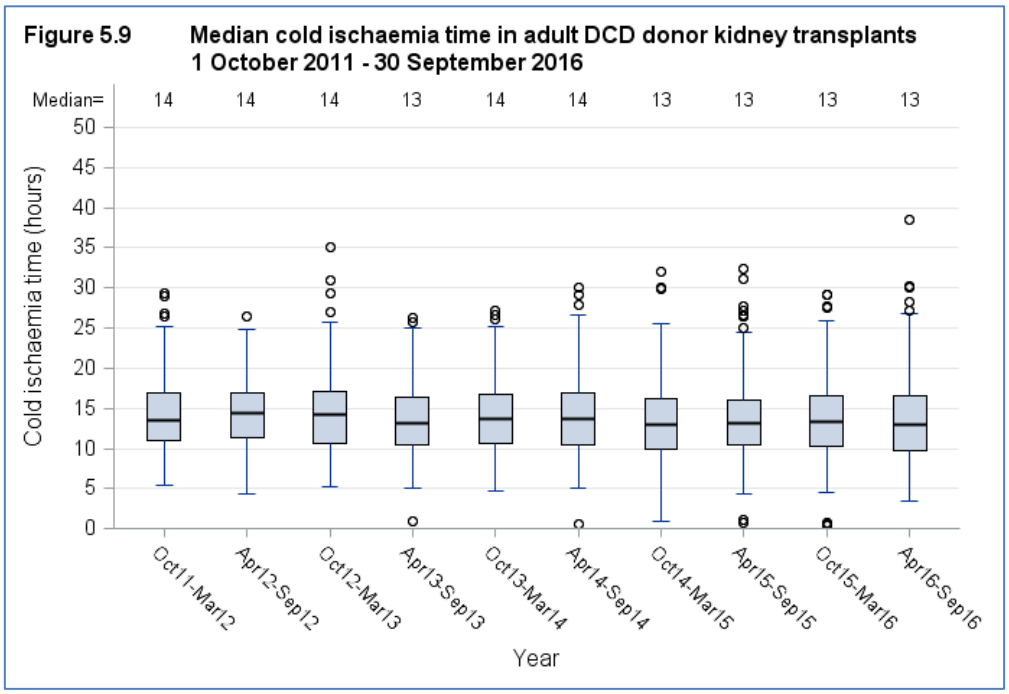


Figure 5.10 shows the median total ischaemia time in adult DCD donor kidney only transplants between 1 April 2016 and 30 September 2016 for each transplant centre. Plymouth had the longest median cold ischaemia time, 16 hours between April and September 2016 compared with Belfast who had the shortest, 8 hours.

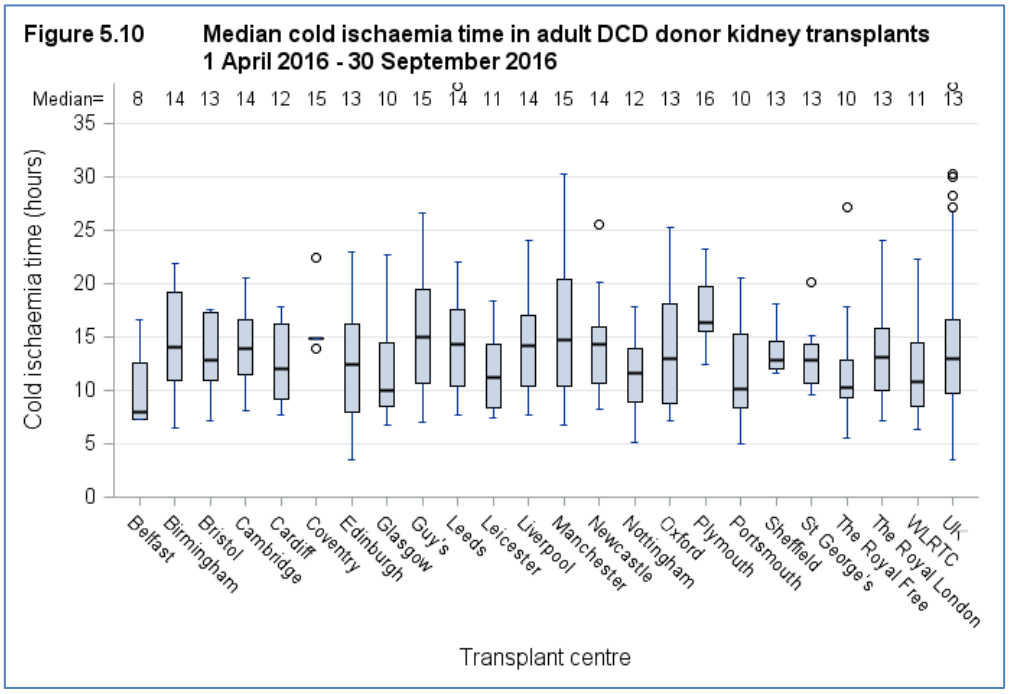


Figure 5.11 shows the median total ischaemia time in adult living donor kidney transplants over the last 5 years. The median total ischaemia time has remained stable over the last five years.

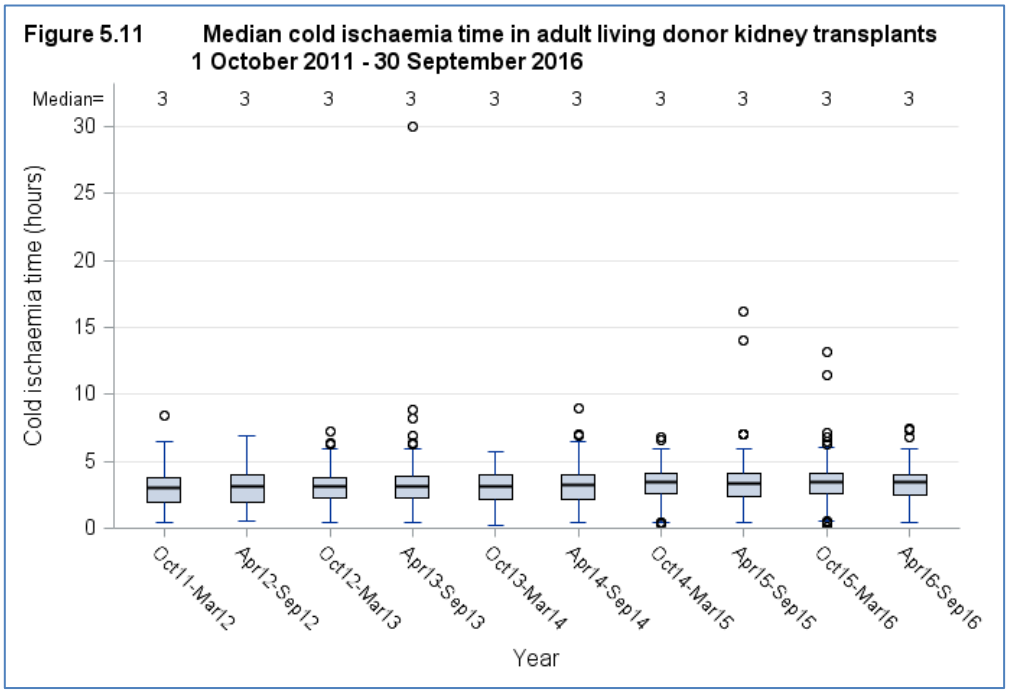
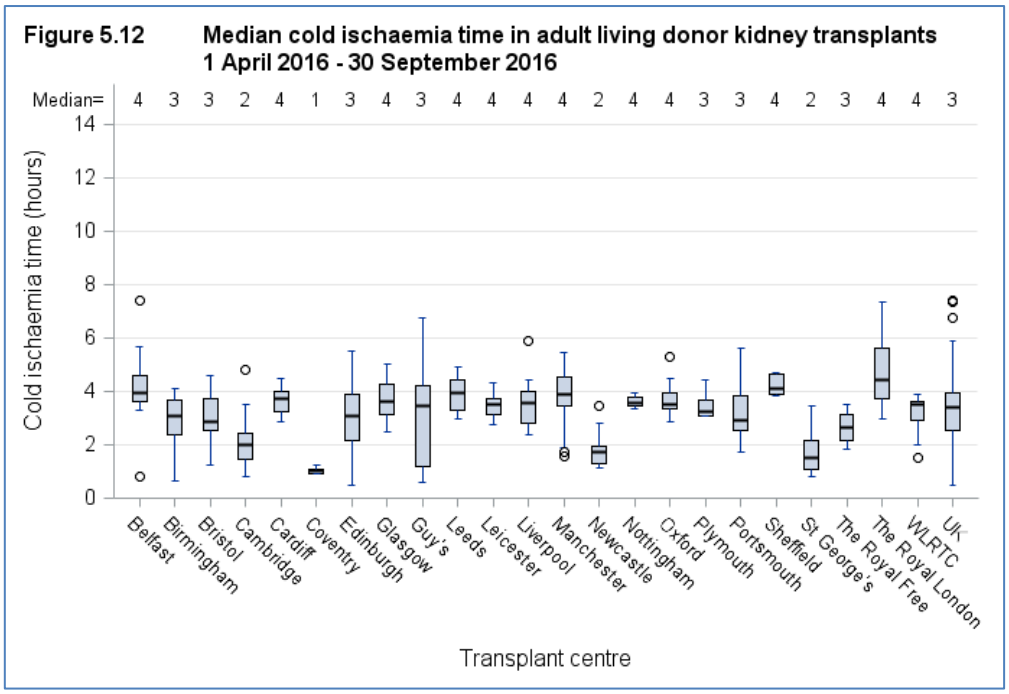


Figure 5.12 shows the median total ischaemia time in adult living donor kidney transplants between 1 April 16 and 30 September 16 for each transplant centre.



Adult kidney outcomes

We present a visual comparison of survival rates among centres that is based on a graphical display known as a funnel plot (1, 2). This display is used to show how consistent the rates of the different transplant units are with the national rate. Funnel plots show the risk-adjusted survival rate plotted against the number of transplants for each centre, with the overall national unadjusted survival rate (solid line), and its 95% (thin dotted lines) and 99.8% (thick dotted lines) confidence limits superimposed. Each dot in the plot represents one of the centres. Note that many patients return to local renal units for follow-up care after their transplant and although we report survival according to transplant unit, patients may in fact be followed up quite distantly from their transplant centre.

Interpreting the funnel plots

If a centre lies within all the limits, then that centre has a survival rate that is statistically consistent with the national rate. If a centre lies outside the 95% confidence limits, this serves as an alert that the centre may have a rate that is significantly different from the national rate. If a centre lies outside the 99.8% limits, then further investigations may be carried out to determine the reasons for the possible difference. When a centre lies above the upper limits, this indicates a survival rate that is higher than the national rate, while a centre that lies below the lower limits has a survival rate that is lower than the national rate. It is important to note that adjusting for patient mix through the use of risk-adjustment models may not account for all possible causes of centre differences. There may be other factors that are not taken into account in the risk-adjustment process that may affect the survival rate of a particular centre.

References

1. Tekkis PP, McCulloch P, Steger AC, Benjamin IS, Poloniecki JD. Mortality control charts for comparing performance of surgical units: validation study using hospital mortality data. British Medical Journal 2003; 326: 786 – 788.

2. Stark J, Gallivan S, Lovegrove J, Hamilton JRL, Monro JL, Pollock JCS, Watterson KG. Mortality rates after surgery for congenital heart defects in children and surgeons' performance. Lancet 2000; 355: 1004 – 1007.

6.1 Deceased donor graft and patient survival

The funnel plots show that, for the most part, the centres lie within the confidence limits. Some of the funnel plots show some centres to be above the upper 99.8% confidence limit. This suggests that these centres may have survival rates that are considerably higher than the national rate. Centres can be identified by the information shown in **Table 6.1**.

Figure 6.1 **Risk-adjusted one year graft (death censored) survival rates for first deceased donor kidney transplants in adult patients, between 1 October 2011 and 30 September 2015**

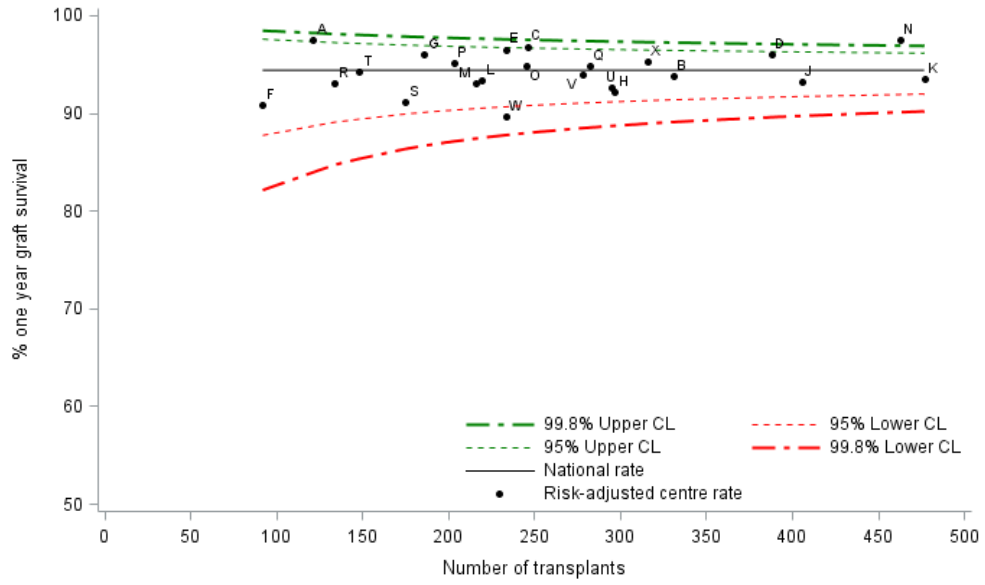


Figure 6.2 **Risk-adjusted one year patient survival rates for first deceased donor kidney transplants in adult patients, between 1 October 2011 and 30 September 2015**

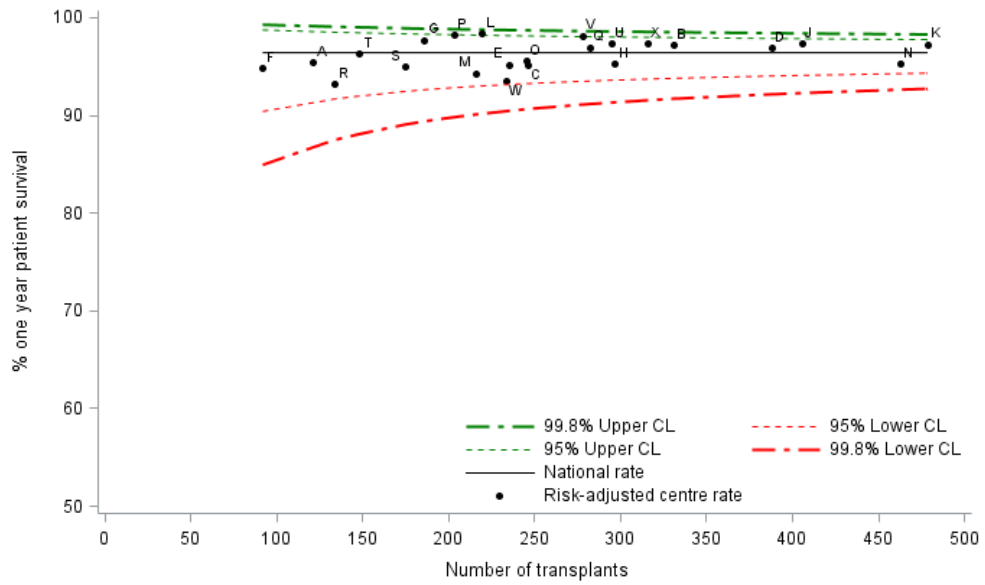


Figure 6.3 **Risk-adjusted five year graft (death censored) survival rates for first deceased donor kidney transplants in adult patients, between 1 October 2007 and 30 September 2011**

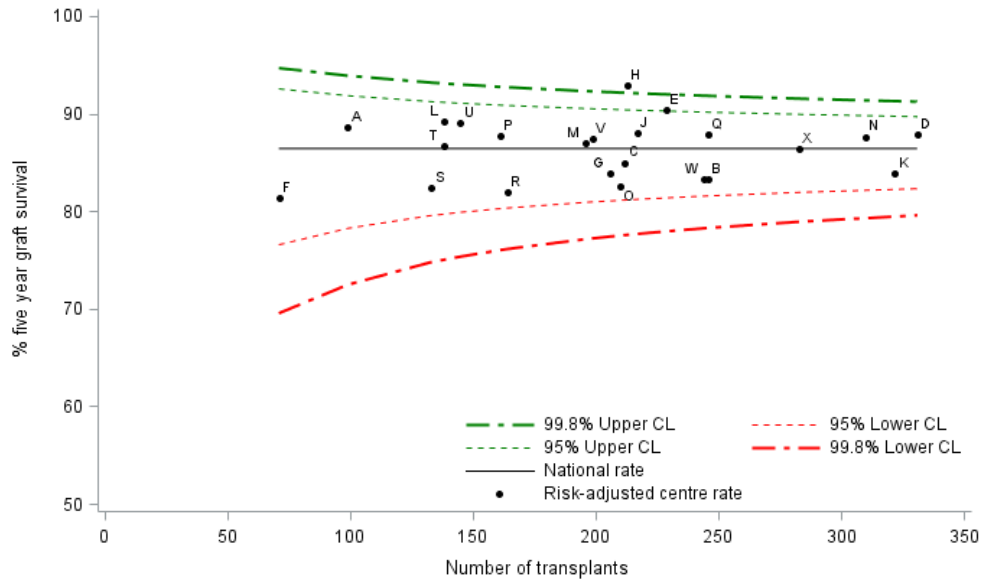


Figure 6.4 **Risk-adjusted five year patient survival rates for first deceased donor kidney transplants in adult patients, between 1 October 2007 and 30 September 2011**

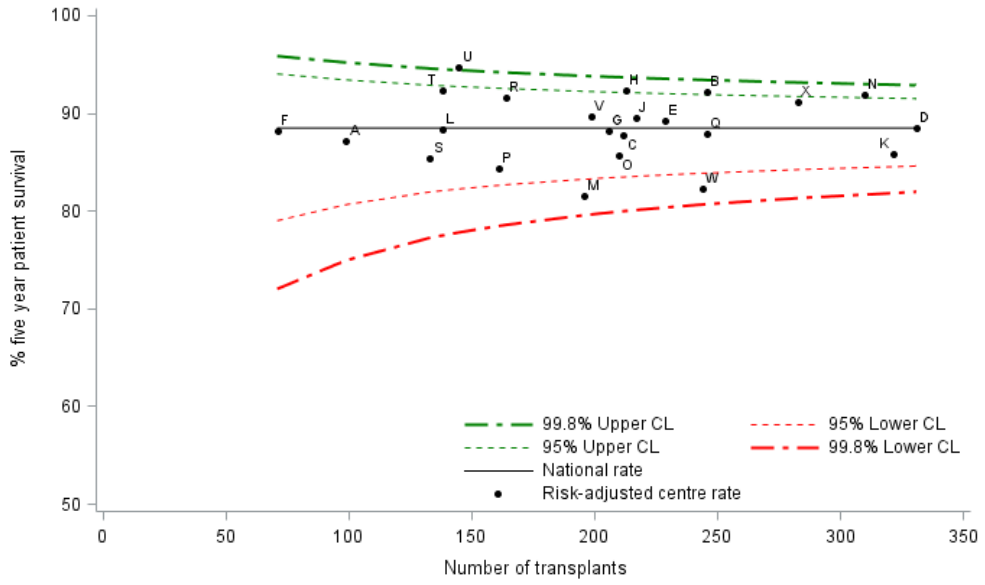


Table 6.1 One and five year first adult kidney-only graft and patient survival using kidneys from deceased donors

		Kidney graft survival				Patient survival			
		One-year*		Five-year**		One-year*		Five-year**	
Centre	Code	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Belfast	A	97	(93 - 99)	89	(79 - 95)	95	(90 - 98)	87	(76 - 94)
Birmingham	B	94	(91 - 96)	83	(77 - 88)	97	(95 - 99)	92	(87 - 96)
Bristol	C	97	(93 - 99)	85	(78 - 90)	95	(91 - 98)	88	(82 - 92)
Cambridge	D	96	(93 - 98)	88	(84 - 91)	97	(94 - 98)	88	(84 - 92)
Cardiff	E	96	(93 - 98)	90	(85 - 94)	95	(92 - 97)	89	(84 - 93)
Coventry	F	91	(81 - 96)	81	(68 - 90)	95	(87 - 99)	88	(77 - 95)
Edinburgh	G	96	(91 - 99)	84	(77 - 89)	98	(93 - 100	88	(82 - 93)
Glasgow	H	92	(88 - 95)	93	(88 - 96)	95	(92 - 98)	92	(87 - 96)
Guy's	J	93	(90 - 95)	88	(82 - 92)	97	(95 - 99)	89	(84 - 94)
Leeds	K	94	(91 - 96)	84	(79 - 88)	97	(95 - 99)	85	(80 - 89)
Leicester	L	93	(89 - 96)	89	(82 - 94)	98	(96 - 100	88	(81 - 93)
Liverpool	M	93	(88 - 96)	87	(81 - 92)	94	(90 - 97)	81	(74 - 87)
Manchester	N	97	(95 - 99)	88	(83 - 91)	95	(93 - 97)	92	(88 - 95)
Newcastle	O	95	(91 - 97)	83	(76 - 88)	96	(92 - 98)	86	(79 - 90)
Nottingham	P	95	(91 - 98)	88	(80 - 93)	98	(95 - 100	84	(77 - 90)
Oxford	Q	95	(92 - 97)	88	(82 - 92)	97	(94 - 99)	88	(83 - 92)
Plymouth	R	93	(86 - 97)	82	(74 - 88)	93	(87 - 97)	92	(86 - 95)
Portsmouth	S	91	(85 - 95)	82	(73 - 89)	95	(91 - 98)	85	(78 - 91)
Sheffield	T	94	(89 - 97)	87	(79 - 92)	96	(92 - 99)	92	(86 - 96)
St George's	U	93	(88 - 96)	89	(82 - 94)	97	(94 - 99)	95	(89 - 98)
The Royal Free	V	94	(90 - 96)	87	(82 - 92)	98	(96 - 99)	90	(84 - 93)
The Royal London	W	90	(84 - 93)	83	(77 - 88)	93	(88 - 97)	82	(75 - 88)
WLRTC	X	95	(92 - 97)	86	(81 - 90)	97	(95 - 99)	91	(87 - 94)
UK		**94**	**(94 - 95)**	**86**	**(85 - 87)**	**96**	**(96 - 97)**	**88**	**(87 - 89)**

* Includes transplants performed between 1 October 2011 - 30 September 2015
** Includes transplants performed between 1 October 2007 - 30 September 2011

6.2 Living donor graft and patient survival

The funnel plots show that, for the most part, the centres lie within the confidence limits. Some of the funnel plots show some centres to be above the upper 99.8% confidence limit. This suggests that these centres may have survival rates that are considerably higher than the national rate. Centres can be identified by the information shown in **Table 6.2**.

Figure 6.5 **Risk-adjusted one year graft (death censored) survival rates for first live donor kidney transplants in adult patients, between 1 October 2011 and 30 September 2015**

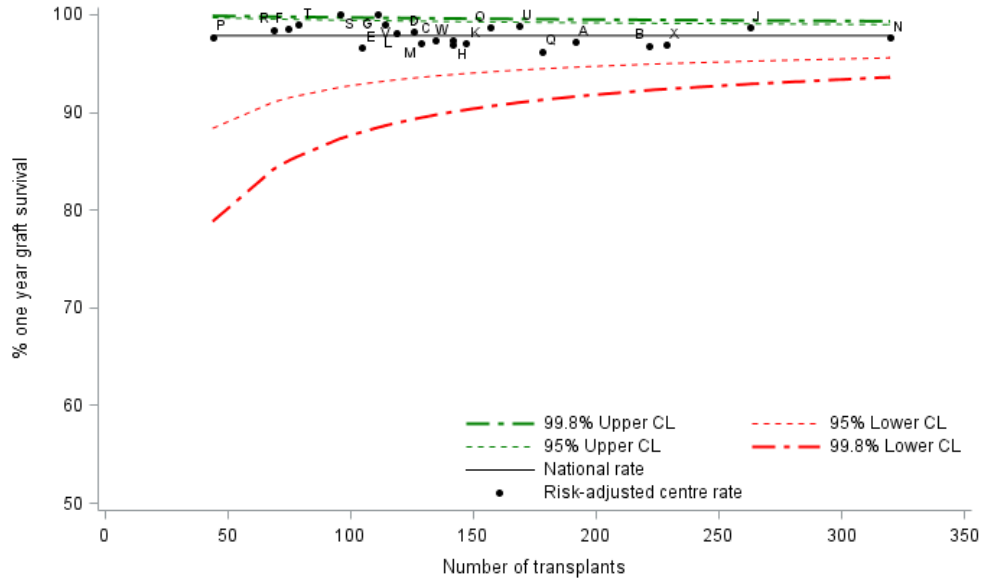


Figure 6.6 **Risk-adjusted one year patient survival rates for first live donor kidney transplants in adult patients, between 1 October 2011 and 30 September 2015**

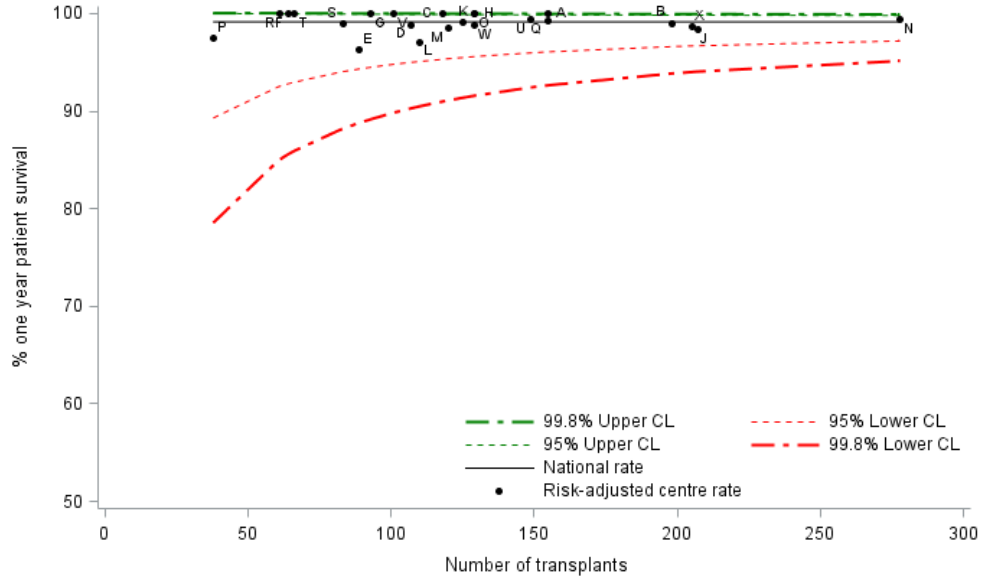


Figure 6.7 **Risk-adjusted five year graft (death censored) survival rates for first live donor kidney transplants in adult patients, between 1 October 2007 and 30 September 2011**

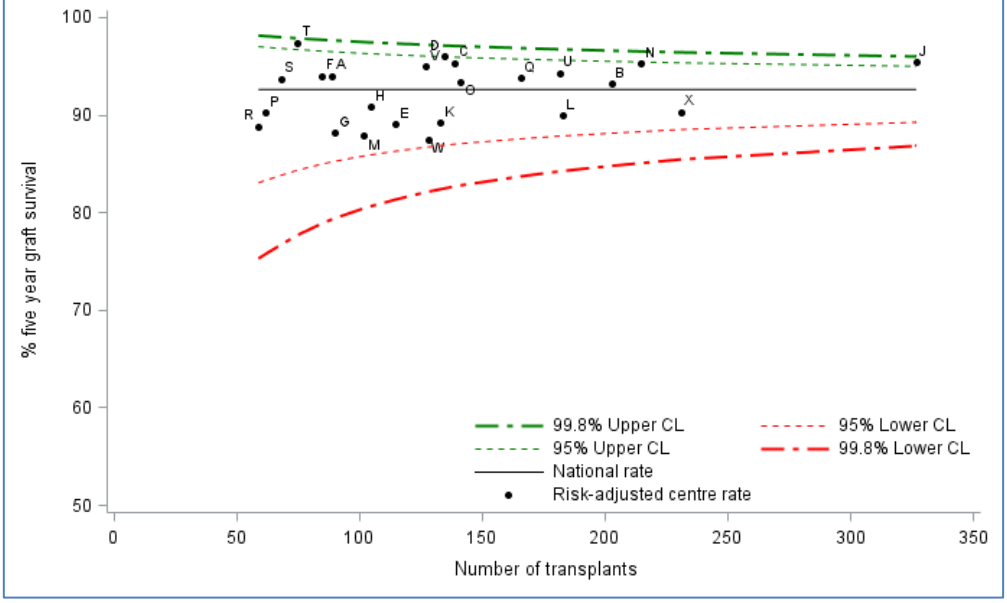


Figure 6.8 **Risk-adjusted five year patient survival rates for first live donor kidney transplants in adult patients, between 1 October 2007 and 30 September 2011**

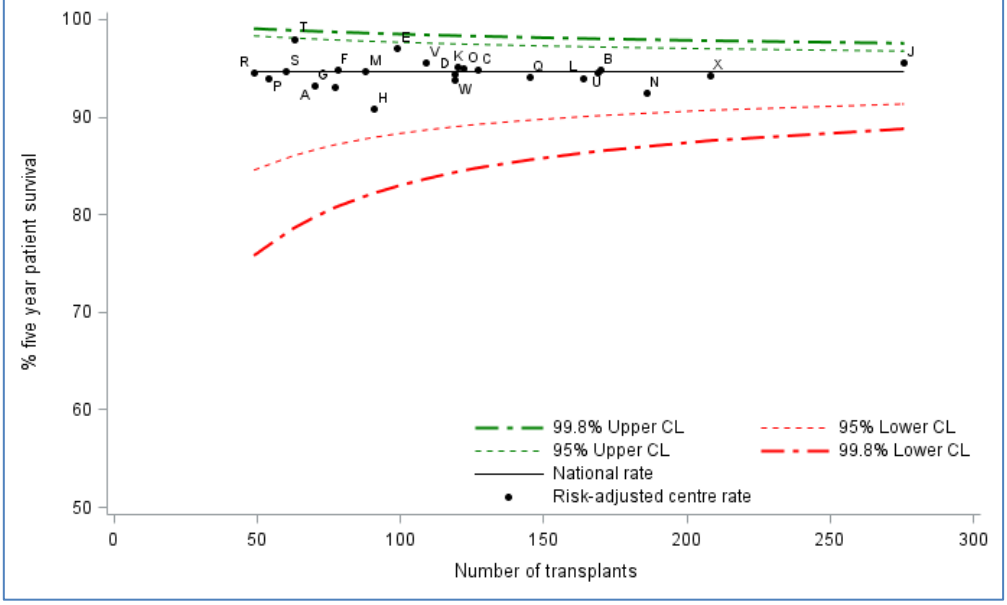


Table 6.2 One and five year first adult kidney-only graft and patient survival using kidneys from living donors

		Kidney graft survival				Patient survival			
		One-year*		Five-year**		One-year*		Five-year**	
Centre	Code	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Belfast	A	97	(93 - 99)	94	(86 - 98)	100	N/A	93	(83 - 98)
Birmingham	B	97	(94 - 99)	93	(89 - 96)	99	(96 - 100	95	(89 - 98)
Bristol	C	97	(92 - 99)	95	(90 - 98)	100	N/A	95	(89 - 98)
Cambridge	D	98	(93 - 100	96	(91 - 99)	99	(94 - 100	94	(88 - 98)
Cardiff	E	97	(91 - 99)	89	(81 - 94)	96	(89 - 99)	97	(91 - 99)
Coventry	F	99	(92 - 100	94	(86 - 98)	100	N/A	95	(87 - 99)
Edinburgh	G	100	N/A	88	(78 - 94)	100	N/A	93	(84 - 98)
Glasgow	H	97	(92 - 99)	91	(83 - 96)	100	N/A	91	(80 - 97)
Guy's	J	98	(95 - 99)	95	(92 - 97)	98	(95 - 100	96	(92 - 98)
Leeds	K	97	(92 - 99)	88	(81 - 93)	99	(95 - 100	95	(89 - 98)
Leicester	L	98	(94 - 100	90	(84 - 94)	97	(91 - 99)	94	(89 - 97)
Liverpool	M	97	(91 - 99)	88	(79 - 94)	98	(95 - 100	95	(86 - 99)
Manchester	N	98	(95 - 99)	95	(91 - 98)	99	(98 - 100	92	(87 - 96)
Newcastle	O	99	(95 - 100	93	(88 - 97)	100	N/A	95	(89 - 98)
Nottingham	P	98	(87 - 100	90	(79 - 96)	97	(86 - 100	94	(82 - 99)
Oxford	Q	96	(92 - 99)	94	(89 - 97)	99	(96 - 100	94	(88 - 97)
Plymouth	R	98	(91 - 100	89	(76 - 96)	100	N/A	94	(84 - 99)
Portsmouth	S	100	N/A	94	(84 - 98)	99	(94 - 100	95	(84 - 99)
Sheffield	T	99	(94 - 100	97	(91 - 100	100	N/A	98	(89 - 100
St George's	U	99	(96 - 100	94	(89 - 97)	99	(96 - 100	94	(90 - 97)
The Royal Free	V	99	(94 - 100	95	(89 - 98)	100	N/A	96	(90 - 99)
The Royal London	W	97	(94 - 99)	87	(80 - 93)	99	(93 - 100	94	(84 - 98)
WLRTC	X	97	(94 - 99)	90	(85 - 94)	99	(96 - 100	94	(90 - 97)
UK		**98**	**(97 - 98)**	**93**	**(92 - 93)**	**99**	**(99 - 99)**	**95**	**(94 - 95)**

* Includes transplants performed between 1 October 2011 - 30 September 2015
** Includes transplants performed between 1 October 2007 - 30 September 2011

Appendix

A1 Glossary of terms

ABO
The most important human blood group system for transplantation is the ABO system. Every human being is of blood group O, A, B or AB, or of one of the minor variants of these four groups. ABO blood groups are present on other tissues and, unless special precautions are taken, a group A kidney transplanted to a group O patient will be rapidly rejected.

Active transplant list
When a patient is registered for a transplant, they are registered on what is called the 'active' transplant list. This means that when a donor kidney becomes available, the patient is included among those who are matched against the donor to determine whether or not the kidney is suitable for them. It may sometimes be necessary to take a patient off the transplant list, either temporarily or permanently. This may be done, for example, if someone becomes too ill to receive a transplant. The patient is told about the decision to suspend them from the list and is informed whether the suspension is temporary or permanent. If a patient is suspended from the list, they are not included in the matching of any donor kidneys that become available.

Case mix
The types of patients treated at a unit for a common condition. This can vary across units depending on the facilities available at the unit as well as the types of people in the catchment area of the unit. The definition of what type of patient a person is depends on the patient characteristics that influence the outcome of the treatment. For example the case mix for patients registered for a kidney transplant is defined in terms of various factors such as the blood group, tissue type and age of the patient. These factors have an influence on the chance of a patient receiving a transplant.

Confidence interval (CI)
When an estimate of a quantity such as a survival rate is obtained from data, the value of the estimate depends on the set of patients whose data were used. If, by chance, data from a different set of patients had been used, the value of the estimate may have been different. There is therefore some uncertainty linked with any estimate. A confidence interval is a range of values whose width gives an indication of the uncertainty or precision of an estimate. The number of transplants or patients analysed influences the width of a confidence interval. Smaller data sets tend to lead to wider confidence intervals compared to larger data sets. Estimates from larger data sets are therefore more precise than those from smaller data sets. Confidence intervals are calculated with a stated probability, usually 95%. We then say that there is a 95% chance that the confidence interval includes the true value of the quantity we wish to estimate.

Confidence limit
The upper and lower bounds of a confidence interval.

Cox Proportional Hazards model
A statistical model that relates the instantaneous risk (hazard) of an event occurring at a given time point to the risk factors that influence the length of time it takes for the event to occur. This model can be used to compare the hazard of an event of interest, such as graft failure or patient death, across different groups of patients.

Cross-match
A cross-match is a test for patient antibodies against donor antigens. A positive cross-match shows that the donor and patient are incompatible. A negative cross-match means there is no reaction between donor and patient and that the transplant may proceed.

Donor after brain death (DBD)
A donor whose heart is still beating when their entire brain has stopped working so that they cannot survive without the use of a ventilator. Organs for transplant are removed from the donor while their heart is still beating, but only after extensive tests determine that the brain cannot recover and they have been certified dead.

Donor after circulatory death (DCD)
A donor whose heart stops beating before their brain stops working and who is then certified dead. The organs are then removed.

Funnel plot
A graphical method that shows how consistent the survival rates of the different transplant units are compared to the national rate. The graph shows for each unit, a survival rate plotted against the number of transplants undertaken, with the national rate and confidence limits around this national rate superimposed. In this report, 95% and 99.8% confidence limits were used. Units that lie within the confidence limits have survival rates that are statistically consistent with the national rate. When a unit is close to or outside the limits, this is an indication that the centre may have a rate that is considerably different from the national rate.

Graft survival rate
The percentage of patients whose grafts are still functioning. This is usually specified for a given time period after transplant. For example, a five-year transplant survival rate is the percentage of transplants still functioning five years after transplant.

HLA mismatch
Human Leucocyte Antigen (HLA) antigens are carried on many cells in the body and the immune system can distinguish between those that can be recognised as ‘self’ (belonging to you or identical to your own) and those that can be recognised as ‘nonself’. The normal response of the immune system is to attack foreign/non-self material by producing antibodies against the foreign material. This is one of the mechanisms that provide protection against infection. This is unfortunate from the point of view of transplantation as the immune system will see the graft as just another ‘infection’ to be destroyed, produce antibodies against the graft and rejection of the grafted organ will take place. To help overcome this response, it is recognised that ‘matching’ the recipient and donor on the basis of HLA (and blood group) reduces the chances of acute rejection and, with the added use of immunosuppressive drugs, very much improves the chances of graft survival. ‘Matching’ refers to the similarity of the recipient HLA type and donor HLA type. HLA mismatch refers to the number of mismatches between the donor and the recipient at the A, B and DR (HLA) loci. There can only be a total of two mismatches at each locus. For example, an HLA mismatch value of 000, means that the donor and recipient are identical at all three loci, while an HLA mismatch value of 210 means that the donor and recipient differ completely at the A locus, are partly the same at the B locus and are identical at the DR locus.

Inter-quartile range
The values between which the middle 50% of the data fall. The lower boundary is the lower quartile, the upper boundary the upper quartile.

Kaplan-Meier method
A method that allows patients with incomplete follow-up information to be included in estimating survival rates. For example, in a cohort for estimating one year patient survival rates, a patient was followed up for only nine months before they relocated. If we calculated a crude survival estimate using the number of patients who survived for at least a year, this patient would have to be excluded as it is not known whether or not the patient was still alive at one year after transplant. The Kaplan-Meier method allows information about such patients to be used for the length of time that they are followed-up, when this information would otherwise be discarded. Such instances of incomplete follow-up are not uncommon and the Kaplan-Meier method allows the computation of estimates that are more meaningful in these cases.

Live donor
A donor who is a living person and who is usually, but not always, a relative of the transplant patient. For example, a parent may donate one of their kidneys to their child.

Median
The midpoint in a series of numbers, so that half the data values are larger than the median, and half are smaller.

Multi-organ transplant
A transplant in which the patient receives more than one organ. For example, a patient may undergo a transplant of a kidney and liver.

National Kidney Allocation Scheme
A nationally agreed set of rules for sharing and allocating kidneys for transplant between transplant centres in the UK. The scheme is administered by NHS Blood and Transplant.

Patient survival rate
The percentage of patients who are still alive (whether the graft is still functioning or not). This is usually specified for a given time period after transplant. For example, a five-year patient survival rate is the percentage of patients who are still alive five years after their first transplant.

p value
In the context of comparing survival rates across centres, the p value is the probability that the differences observed in the rates across centres occurred by chance. As this is a probability, it takes values between 0 and 1. If the p value is small, say less than 0.05, this implies that the differences are unlikely to be due to chance and there may be some identifiable cause for these differences. If the p value is large, say greater than 0.1, then it is quite likely that any differences seen are due to chance.

Pre-emptive
Patients that are placed on the kidney transplant list or receive a transplant prior to the need for dialysis are termed as pre-emptive. Patients listed pre-emptively will usually require dialysis within six months of being placed on the transplant list.

Risk-adjusted survival rate
Some transplants have a higher chance than others of failing at any given time. The differences in expected survival times arise due to differences in certain factors, the risk factors, among patients. A risk-adjusted survival rate for a centre is the expected survival rate for that centre given the case mix of their patients. Adjusting for case mix in estimating centre-specific survival rates allows valid comparison of these rates across centres and to the national rate.

Risk factors
These are the characteristics of a patient, transplant or donor that influence the length of time that a graft is likely to function or a patient is likely to survive following a transplant. For example, when all else is equal, a transplant from a younger donor is expected to survive longer than that from an older donor and so donor age is a risk factor.

Unadjusted survival rate
Unadjusted survival rates do not take account of risk factors and are based only on the number of transplants at a given centre and the number and timing of those that fail within the post-transplant period of interest. In this case, unlike for risk-adjusted rates, all transplants are assumed to be equally likely to fail at any given time. However, some centres may have lower unadjusted survival rates than others simply because they tend to undertake transplants that have increased risks of failure. Comparison of unadjusted survival rates across centres and to the national rate is therefore inappropriate.

A2 Statistical methodology and risk-adjustment for survival rate estimation

Unadjusted and risk-adjusted estimates of patient and graft survival are given for each centre. Unadjusted rates give an estimate of what the survival rate at a centre is, assuming that all patients at the centre have the same chance of surviving a given length of time after transplant. In reality, patients differ and a risk-adjusted rate that allows for these differences would give a more meaningful estimate of survival.

Computing unadjusted survival rates

Unadjusted survival rates were calculated using the Kaplan-Meier method, which allows patients with incomplete follow-up information to be included in the computation. For example, in a cohort for estimating one-year patient survival rates, a patient was followed up for only nine months before they relocated. If we calculated a crude survival estimate using the number of patients who survived for at least a year, this patient would have to be excluded, as it is not known whether or not the patient was still alive one year after transplant. The Kaplan-Meier method allows information about such patients to be used for the length of time that they are followed-up, when this information would otherwise be discarded. Such instances of incomplete follow-up are not uncommon in the analysis of survival data and the Kaplan-Meier method therefore allows the computation of survival estimates that are more meaningful.

Computing risk-adjusted survival rates

A risk-adjusted survival rate is an estimate of what the survival rate at a centre would have been if they had had the same mix of patients as that seen nationally. The risk-adjusted rate therefore presents estimates in which differences in patient mix across centres have been removed as much as possible. For that reason, it is valid to only compare centres using risk-adjusted rather than unadjusted rates, as differences among the latter can be attributed to differences in patient mix.

Risk-adjusted survival estimates were obtained through indirect standardisation. A Cox Proportional Hazards model was used to determine the probability of survival for each patient based on their individual risk factor values. The sum of these probabilities for all patients at a centre gives the number, E, of patients or grafts expected to survive at least one year or five years after transplant at that centre. The number of patients who actually survive the given time period is given by O. The risk-adjusted estimate is then calculated by multiplying the ratio O/E by the overall unadjusted survival rate across all centres.

The risk-adjustment models used were based on results from previous studies that looked at factors affecting the survival rates of interest. The factors included in the models are shown in the table below.

Risk adjustment factors

Adult patient transplants

First transplants from deceased donors

1 year graft survival	Donor age, donor type, donor cause of death, recipient age, waiting time to transplant, primary renal disease, HLA mismatch group, cold ischaemic time*, recipient ethnicity
1 year patient survival	Donor age, recipient age, waiting time to transplant, primary renal disease, HLA mismatch group, cold ischaemic time*
5 year graft survival	Graft year, donor age, donor type, donor cause of death, recipient age, waiting time to transplant, primary renal disease, HLA mismatch group, recipient ethnicity
5 year patient survival	Graft year, donor age, recipient age, waiting time to transplant, primary renal disease

Transplants from live donors

1 year graft survival	Donor age, recipient age, primary renal disease, number of HLA mismatches
1 year patient survival	Recipient age
5 year graft survival	Graft year, donor age, recipient age, primary renal disease, number of HLA mismatches
5 year patient survival	Recipient age, primary renal disease

*Time between retrieval of kidney from the donor and time of transplant in the patient.

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