nephron
Clinical Practice

Nephron 2018;139(suppl1):75–104
DOI: 10.1159/000490961

Published online: July 11, 2018

UK Renal Registry 20th Annual Report: Chapter 3 Demographic and Biochemistry Profile of Kidney Transplant Recipients in the UK in 2016: National and Centre-specific Analyses

Rhodri Pyart[a], Esther Wong[a], Edward Sharples[b], Anna Casula[a], Catherine Byrne[c]

[a]UK Renal Registry, Bristol, UK; [b]Oxford University Hospitals NHS Foundation Trust, Oxford, UK; [c]Nottingham University Hospitals NHS Trust, Nottingham, UK

Keywords

Blood pressure · Bone metabolism · Chronic kidney disease · Clinical Commissioning Group · Deceased donor · eGFR · Epidemiology · Ethnicity · Graft function · Haemoglobin · Live donor · Outcomes · Renal transplantation · Survival

Summary

- There was a 5% increase in overall renal transplant numbers from 2015 to 2016, with an increase in kidney transplants from donors after brainstem death (9%), donors after cardiac death (13%) but a fall from living donors (−3%).
- In 2016, death-censored renal transplant failure rates in prevalent patients were similar to previous years at 2.4% per annum. Transplant patient death rates were similar at 2.5 per 100 patient years.
- The median age of incident and prevalent renal transplant patients in the UK was 51.4 and 54.3 years respectively.
- The median eGFR of prevalent renal transplant recipients was 52.2 ml/min/1.73 m^2.
- The median eGFR of patients one year after transplantation was 57.2 ml/min/1.73 m^2 post live transplant, 52.4 ml/min/1.73 m^2 post brainstem death transplant and 48.4 ml/min/1.73 m^2 post circulatory death transplant.
- In 2016, 13.1% of prevalent transplant patients had eGFR <30 ml/min/1.73 m^2.
- The median decline in eGFR slope beyond the first year after transplantation was −0.7 ml/min/1.73 m^2/year.
- In 2016, malignancy (23%) replaced infection (22%) as the commonest cause of death in patients with a functioning renal transplant.
- Data completeness for attainment of blood pressure targets remained variable between centres.

KARGER

Fax +41 61 306 12 34
E-Mail karger@karger.com
www.karger.com/nef

Rhodri Pyart
UK Renal Registry, Southmead Hospital, Southmead Road, Bristol, BS10 5NB, UK
Email: renalregistry@renalregistry.nhs.uk

Introduction

This chapter includes independent analyses regarding renal transplant activity and survival data from the UK Transplant Registry, held by the Organ Donation and Transplantation Directorate (ODT) of NHS Blood and Transplant (NHSBT). The UK Renal Registry (UKRR) has performed additional analyses of renal transplant recipient follow-up data examining demographics, clinical and biochemical variables. NHSBT records all information regarding the episode of transplantation (donor and recipient details) and the UKRR holds additional information on key clinical and biochemical variables in renal transplant recipients. The co-operation between these two organisations results in a comprehensive database describing the clinical care delivered to renal transplant patients within the UK. This allows for the comparison of key quality measures between centres and provides insight into the processes involved in the care of such patients in the UK.

This chapter is divided into six sections: (1) transplant activity, waiting list and survival data; (2) transplant demographics; (3) clinical and laboratory outcomes; (4) analysis of prevalent patients by chronic kidney disease (CKD) stage; (5) estimated glomerular filtration rate (eGFR) slope analysis; and (6) cause of death in transplant recipients. Methodology, results and discussion of these analyses are provided in detail for all six sections separately.

The UKRR methodology has previously been described [1]. The UKRR collects quarterly clinical data via an electronic data extraction process from hospital based renal IT systems on all patients receiving renal replacement therapy. Throughout the chapter, the number preceding the centre name in each figure indicates the percentage of missing data for that centre for that variable.

In previous years, this chapter has used the Modification of Diet in Renal Disease (MDRD) study equation to estimate GFR from serum creatinine. In line with NICE recommendations and for consistency across the UKRR report, the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation is used this year [2]. There is conflicting evidence as to whether either equation is superior in the transplant population although the EPI formula is felt to be more accurate at higher levels of eGFR [3–6]. In light of this change, the authors advise caution in comparing eGFR results with previous published editions of this chapter. The NICE guidelines further recommend that laboratories using the MDRD equation to calculate eGFR consider changing their practice to using CKD-EPI.

Unless otherwise specified, prevalent transplant patients were defined as patients with a functioning renal transplant on 31 December 2016.

A list of the Renal Association recommended audit measures which were relevant to the transplant population in 2016 are given in appendix 1 of this chapter [7]. Several of the audit measures are not currently reported by the UKRR in the annual report; the reasons behind this are varied, but predominantly relate to a high proportion of incomplete data or that the relevant variable is not currently within the specified UKRR dataset. Updated guidelines were published in 2017 with some revised audit standards although the same reporting challenges will persist [8]. Over time it is hoped to work with the renal community to improve reporting across the range of recommended standards.

The data were analysed using SAS 9.3.

Transplant activity, waiting list activity and survival data

Introduction

NHSBT prospectively collects donor and recipient data at the time of transplantation. They also request that transplant centres provide an annual paper based data return on the status of the recipient including graft function. This enables ODT to generate comprehensive analyses of renal transplant activity and graft survival statistics, albeit on a financial year basis rather than a calendar year basis as is used in the UKRR report [9].

NHSBT attributes a patient to the centre that performed the transplant operation irrespective of where the patient was cared for before or after the procedure and hence only reports on transplant centre performance.

Methods

In 2016, there were 23 UK adult renal transplant centres, 19 in England, two in Scotland and one each in Northern Ireland and Wales.

Annual organ-specific updates and five-year reports with comprehensive data concerning the number of patients on the transplant waiting list, percentage of pre-emptive listing, the number of transplants performed, the number of deceased kidney donors (donor after brainstem death (DBD) and donor after circulatory death (DCD)), living kidney donors, patient survival and graft survival are available on the NHSBT website (https://www.organdonation.nhs.uk/statistics/).

Results

During 2016, 3,328 kidney or kidney plus transplants were performed (table 3.1). The absolute number of living kidney donors showed a small decline in 2016, but still represented 30.6 % of all transplants performed. Deceased kidney-only transplants from both DBD and DCD increased 9% and 13% respectively. The number of kidney plus other organ transplants remained at a similar level, apart from a fall in kidney and pancreas transplant (−16%).

There were small differences in one- and five-year risk adjusted patient and graft survival rates amongst UK kidney transplant centres (table 3.2). These graft survival rates include grafts with primary non-function, which are excluded from analysis by some registries.

Using data from the UKRR on prevalent renal transplant patients on 1 January 2016, the death rate during 2016 was 2.5 per 100 patient years (CI 2.3–2.7) when censored for return to dialysis, and 2.6 per 100 patient years (CI 2.5–2.8) without censoring for dialysis. These death rates were similar to those observed over the last five years and have not shown any impact from the increasing age or comorbidity of the transplanted cohort.

During 2016, 2.4% of prevalent transplant patients experienced graft failure and returned to dialysis (censored at death for patients who died with a functioning graft), which is slightly below the mean rate from 2010–2015 (2.5%) and a fall from the 2015 rate (2.7%).

Discussion

During 2016, there was a 5% increase in overall kidney transplant numbers due to increases in both types of deceased donor kidney transplants, partially offset by a further fall in the number of living kidney donors. Despite a small fall in 2015, there has been a steady increasing trend in total transplant numbers over the last decade. In the prevalent transplant population, the graft failure rate of 2.4% per annum and the patient death rate of 2.5 per 100 patient years has remained stable over recent years despite changes in the demographics of the transplanted cohort.

Transplant demographics

Introduction

Since 2008, all UK renal centres have established electronic linkage to the UKRR or Scottish Renal Registry, giving the UKRR complete coverage of individual patient level data across the UK.

The following sections should be interpreted in the context of centre-specific variations in repatriation policies; some transplant centres continued to follow up and report on all patients they transplanted, whereas others referred patients back to non-transplanting centres at some point post-transplant. Some transplant centres only referred back patients when their graft was failing. The time post-transplantation that a patient was referred back to their local centre varied between transplant centres, but the UKRR can detect duplicate patients (being reported from both transplant and referring centres) and in such situations care is usually attributed to the referring centre (see appendix B for allocation procedure). This process may result in some discrepancies in transplant numbers particularly in Oxford/Reading and Clwyd/Liverpool Royal.

Table 3.1. UK kidney and kidney plus other organ transplant numbers in the UK (including paediatric), 1/1/2014–31/12/2016

Organ	2014	2015	2016	% change 2015–2016
Donor after brainstem death (DBD)[a]	1,205	1,130	1,234	9
Donor after circulatory death (DCD)[b]	713	802	909	13
Living donor kidney	1,096	1,045	1,018	−3
Kidney and liver[c]	12	21	18	
Kidney and heart	1	0	1	
Kidney and pancreas[d]	171	175	147	−16
Kidney and lung	1	0	0	
Small bowel (inc kidney)	1	2	1	
Total kidney transplants	**3,200**	**3,175**	**3,328**	**5**

[a]Includes en bloc kidney transplants (3 in 2014, 4 in 2015, 6 in 2016) and double kidney transplants (22 in 2014, 15 in 2015, 15 in 2016)
[b]Includes en bloc kidney transplants (4 in 2014, 8 in 2015, 8 in 2016) and double kidney transplants (51 in 2014, 31 in 2015, 39 in 2016)
[c]Includes DCD transplants (47 in 2014, 50 in 2015, 44 in 2016)
[d]Includes DCD transplants (1 in 2016)

Table 3.2. Risk-adjusted first adult kidney transplant only, graft and patient survival percentage rates for UK transplanting centres*

	Deceased donor 1 year survival		Deceased donor 5 year survival		Living kidney donor 1 year survival		Living kidney donor 5 year survival	
Centre	Graft	Patient	Graft	Patient	Graft	Patient	Graft	Patient
B QEH	93	97	85	92	97	99	93	95
Belfast	98	98	89	87	97	100	91	95
Bristol	96	96	86	87	96	100	96	96
Camb	95	95	88	89	98	100	96	95
Cardff	97	97	89	89	97	98	88	97
Covnt	90	90	88	87	99	100	95	96
Edin	95	95	83	85	99	100	87	93
Glasgw	93	93	93	93	97	100	91	90
L Barts	90	90	83	82	97	99	88	92
L Guy's	94	94	87	90	99	99	93	95
L Rfree	94	94	88	90	99	100	97	96
L St.G	93	93	89	95	98	99	95	93
L West	95	95	86	91	97	99	88	95
Leeds	94	94	84	86	97	99	88	95
Leic	93	93	90	83	98	96	90	94
Liv Roy	93	93	87	84	97	98	86	93
M RI	97	97	87	91	98	99	95	94
Newc	95	95	81	86	99	100	93	95
Nottm	95	95	85	86	98	97	92	94
Oxford	95	95	88	89	96	99	95	93
Plymth	89	89	83	90	98	100	86	93
Ports	91	91	81	85	100	98	89	96
Sheff	96	96	84	91	99	100	95	98
All centres	**94**	**94**	**86**	**88**	**98**	**99**	**92**	**95**

Cohorts for survival rate estimation: 1 year survival: 1/4/2011–31/03/2015; 5 year survival: 1/4/2007–31/3/2011; first grafts only – re-grafts excluded for patient survival estimation. Since the cohorts to estimate 1- and 5-year survival are different, some centres may appear to have 5 year survival better than 1 year survival

*Information courtesy of NHSBT: number of transplants, patients and 95% CI for each estimate; statistical methodology for computing risk-adjusted estimates can be obtained from the NHSBT website (see http://odt.nhs.uk/pdf/organ_specific_report_kidney_2016.pdf)

Methods

Cambridge renal centre (Addenbrooke's) has been unable to submit their 2015 and 2016 data. The centre was able to submit summary numbers of patients still on renal replacement therapy (RRT) at the end of 2016, by treatment modality, and incident numbers. Cambridge renal centre is therefore excluded from all centre level prevalent analyses. However their data have been included in the transplant rates calculation in England and UK, where only summary numbers are needed. For the calculation of transplant rates by Clinical Commissioning Groups (CCG) or Health Board/Social Care Areas (HB), where patient-level information are needed for age/sex standardisation, areas covered by Cambridge have been excluded. Based on prevalent transplant 2014 data, the percentage of patients resident in each CCG that was under the care of Cambridge renal centre at the end of 2014 was calculated. CCGs with >15% prevalent transplant patients seen in Cambridge were excluded from the analysis of the transplant prevalent rate by CCG in 2015 and 2016.

As Colchester did not have any transplant patients they were excluded from some of the analyses, although their dialysis patients were included in the relevant dialysis population denominators.

For the analysis of primary renal diagnosis (PRD) in transplant recipients, a few centres were excluded from some of the incidence years because of concerns relating to the reliability of PRD coding (with these centres submitting a high percentage of uncertain or missing aetiology codes).

Information on patient demographics (age, sex, ethnicity, PRD) for patients in a given renal centre was obtained from the UKRR patient registration data fields. Individual patients were assigned to the centre that returned data for them during 2016. The prevalence of transplant patients in areas covered by individual CCG or HB was estimated based on the postcode of the registered address for patients on RRT. Data on ethnic origin, supplied as Patient Administration System (PAS) codes, were retrieved from fields within renal centre IT systems. For the purpose of this analysis, patients were grouped into White, South Asian, Black, Other and Unknown categories. The details of ethnicity regrouping into the above categories are provided in appendix H: Coding www.renalreg.org/publications-reports/.

Results and Discussion

Prevalent transplant numbers across the UK are described in table 3.3.

Table 3.3. The prevalence per million population (pmp) of renal transplants in adults in the UK on 31/12/2016, by country

	England	N Ireland	Scotland	Wales	UK
Number of prevalent transplant patients	28,698	1,069	2,821	1,698	34,286
Total population, mid–2016 estimates* (millions)	55.3	1.9	5.4	3.1	65.6
Prevalence transplant rate (pmp)	519	574	522	545	522

*Data from the Office of National Statistics, National Records of Scotland and the Northern Ireland Statistics and Research Agency – based on the 2011 census

The prevalence of renal transplant recipients in each CCG in England, Northern Ireland (Health and Social Care Trust Areas), Scotland (Health Boards) and Wales (Local Health Boards) and the proportion of prevalent patients according to modality in the renal centres across the UK are described in tables 3.4 and 3.5 respectively.

After standardisation for age and sex, unexplained variability was evident in the prevalence of renal

Table 3.4. The prevalence per million population (pmp) of patients with a renal transplant and standardised rate ratio in the UK, as on 31 December 2012–2016, by CCG/HB

CCG/HB – CCG in England, Health and Social Care Areas in Northern Ireland, Local Health Boards in Wales and Health Boards in Scotland
O/E – age and sex standardised transplant prevalence rate ratio
LCL – lower 95% confidence limit
UCL – upper 95% confidence limit
pmp – per million population
CCG/HBs with significantly high average rate ratios are bold in darker greyed areas
CCG/HBs with significantly low average rate ratios are italicised in lighter greyed areas
Mid-2016 population data at CCG/HB level was obtained from the Office for National Statistics, National Records of Scotland and the Northern Ireland Statistics and Research Agency – based on the 2011 Census
% non-White – percentage of the CCG/HB population that is non-White, from 2011 Census

			O/E				2016				
UK area	**CCG/HB**	**Total population**	**2012**	**2013**	**2014**	**2015**	**O/E**	**95% LCL**	**95% UCL**	**Crude rate pmp**	**% non-White**
Cheshire, Warrington and Wirral	NHS Eastern Cheshire	196,900	0.88	0.87	0.87	0.86	0.90	0.74	1.10	513	3.7
	NHS South Cheshire	179,800	0.90	0.93	0.97	0.99	1.04	0.86	1.26	573	2.9
	NHS Vale Royal	103,700	0.74	0.77	0.75	0.79	0.79	0.59	1.05	434	2.1
	NHS Warrington	208,800	0.89	0.96	0.94	0.89	0.89	0.73	1.08	479	4.1
	NHS West Cheshire	232,000	0.96	0.96	0.95	0.87	0.89	0.74	1.07	487	2.8
	NHS Wirral	*321,200*	*0.80*	*0.77*	*0.73*	*0.73*	*0.78*	*0.66*	*0.93*	*423*	*3.0*
Durham, Darlington and Tees	NHS Darlington	105,600	0.97	1.01	1.03	1.00	0.97	0.75	1.27	521	3.8
	NHS Durham Dales, Easington and Sedgefield	274,600	1.03	1.06	1.09	1.03	1.02	0.87	1.19	564	1.2
	NHS Hartlepool and Stockton-on-Tees	288,500	1.00	0.98	1.00	1.00	0.99	0.85	1.16	520	4.4
	NHS North Durham	*247,500*	*0.94*	*0.90*	*0.86*	*0.85*	*0.79*	*0.65*	*0.95*	*420*	*2.5*
	NHS South Tees	**275,800**	**1.40**	**1.31**	**1.31**	**1.29**	**1.23**	**1.06**	**1.43**	**638**	**6.7**
Greater Manchester	**NHS Bolton**	**283,100**	**1.29**	**1.24**	**1.20**	**1.23**	**1.22**	**1.06**	**1.42**	**622**	**18.1**
	NHS Bury	188,700	1.01	0.95	0.99	1.04	1.05	0.86	1.27	546	10.8
	NHS Heywood, Middleton & Rochdale	216,200	1.10	1.10	0.97	1.02	1.14	0.95	1.35	574	18.3
	NHS Manchester	541,300	0.92	0.95	1.00	1.06	1.08	0.95	1.22	453	33.5
	NHS Oldham	232,700	1.01	1.07	1.01	1.06	1.08	0.90	1.28	529	22.5
	NHS Salford	248,700	1.02	0.97	0.99	1.02	1.03	0.86	1.22	499	9.9
	NHS Stockport	290,600	0.95	0.94	0.91	0.93	0.95	0.81	1.11	506	7.9
	NHS Tameside and Glossop	256,400	1.07	1.04	1.05	1.04	1.12	0.96	1.31	597	8.2
	NHS Trafford	234,700	0.89	0.90	0.94	0.96	0.96	0.80	1.15	499	14.5
	NHS Wigan Borough	323,100	1.08	1.10	1.07	1.06	1.08	0.93	1.24	585	2.7

Table 3.4. Continued

UK area	CCG/HB	Total population	O/E 2012	O/E 2013	O/E 2014	O/E 2015	2016 O/E	2016 95% LCL	2016 95% UCL	2016 Crude rate pmp	% non-White
Lancashire	NHS Blackburn with Darwen	147,000	1.01	1.03	1.08	1.07	1.02	0.81	1.28	496	30.8
	NHS Blackpool	139,200	0.91	1.00	1.01	0.99	0.99	0.79	1.25	539	3.3
	NHS Chorley and South Ribble	174,300	0.91	0.95	0.93	0.94	0.95	0.78	1.17	522	2.9
	NHS East Lancashire	375,800	1.06	1.07	1.05	1.07	1.07	0.93	1.22	564	11.9
	NHS Fylde & Wyre	169,000	0.81	0.82	0.77	0.84	0.83	0.66	1.03	473	2.1
	NHS Greater Preston	203,500	0.86	0.84	0.86	0.86	0.84	0.68	1.04	427	14.7
	NHS Morecombe Bay	*348,500*	*0.87*	*0.87*	*0.84*	*0.84*	*0.85*	*0.73*	*1.00*	*471*	*4.0*
	NHS West Lancashire	113,400	0.92	0.88	0.83	0.86	0.80	0.61	1.06	432	1.9
Merseyside	NHS Halton	126,900	1.03	1.00	1.03	1.03	0.98	0.77	1.25	520	2.2
	NHS Knowsley	147,900	0.96	0.97	0.94	0.88	0.89	0.70	1.13	460	2.8
	NHS Liverpool	484,600	0.97	1.00	1.00	0.96	0.92	0.81	1.05	448	11.1
	NHS South Sefton	158,900	0.94	0.90	0.87	0.85	0.88	0.70	1.10	478	2.2
	NHS Southport and Formby	*115,400*	*0.65*	*0.75*	*0.73*	*0.70*	*0.67*	*0.50*	*0.90*	*373*	*3.1*
	NHS St Helens	178,500	0.82	0.85	0.91	0.91	0.84	0.67	1.04	454	2.0
Cumbria, Northumberland, Tyne and Wear	*NHS Cumbria North*	*318,200*	*0.89*	*0.88*	*0.90*	*0.92*	*0.82*	*0.70*	*0.97*	*468*	*1.5*
	NHS Newcastle Gateshead	498,100	0.99	0.94	0.92	0.90	0.92	0.81	1.05	452	10.1
	NHS North Tyneside	203,300	1.32	1.24	1.11	1.09	1.07	0.89	1.28	585	3.4
	NHS Northumberland	316,000	0.93	0.93	0.92	0.86	0.86	0.73	1.00	497	1.6
	NHS South Tyneside	149,400	1.16	1.20	1.06	0.97	1.02	0.82	1.26	555	4.1
	NHS Sunderland	278,000	1.14	1.11	1.08	1.02	1.05	0.90	1.23	565	4.1
North Yorkshire and Humber	NHS East Riding of Yorkshire	315,900	0.96	1.02	0.98	0.96	0.92	0.79	1.07	535	1.9
	NHS Hambleton, Richmondshire and Whitby	153,200	0.75	0.79	0.92	0.94	0.86	0.68	1.07	490	2.7
	NHS Harrogate and Rural District	156,300	1.17	1.09	1.08	1.09	1.06	0.86	1.29	595	3.7
	NHS Hull	260,200	1.03	1.04	1.03	1.09	1.10	0.94	1.30	542	5.9
	NHS North East Lincolnshire	159,100	1.01	0.98	0.92	0.92	0.94	0.75	1.17	496	2.6
	NHS North Lincolnshire	*170,800*	*0.64*	*0.63*	*0.67*	*0.68*	*0.72*	*0.57*	*0.92*	*398*	*4.0*
	NHS Scarborough and Ryedale	111,400	1.16	1.04	1.03	1.05	1.01	0.79	1.29	575	2.5
	NHS Vale of York	357,900	1.07	1.06	1.06	1.05	1.03	0.89	1.18	545	4.0
South Yorkshire and Bassetlaw	NHS Barnsley	241,200	0.93	0.91	0.95	0.94	0.96	0.80	1.14	518	2.1
	NHS Bassetlaw	114,800	0.70	0.67	0.72	0.80	0.80	0.61	1.05	453	2.6
	NHS Doncaster	306,400	0.91	0.87	0.90	0.93	0.93	0.79	1.09	493	4.7
	NHS Rotherham	261,900	1.03	1.04	1.08	1.05	1.03	0.87	1.21	550	6.4
	NHS Sheffield	575,400	0.99	0.97	0.96	0.94	0.92	0.81	1.04	440	16.3
West Yorkshire	NHS Airedale, Wharfedale and Craven	160,000	1.05	1.04	1.01	1.06	1.02	0.83	1.26	556	11.1
	NHS Bradford City	**84,900**	**1.55**	**1.64**	**1.64**	**1.87**	**2.05**	**1.61**	**2.61**	**777**	**72.2**
	NHS Bradford Districts	**339,700**	**1.30**	**1.31**	**1.29**	**1.30**	**1.31**	**1.15**	**1.50**	**633**	**28.7**
	NHS Calderdale	209,800	1.21	1.12	1.03	1.01	1.01	0.84	1.22	543	10.3
	NHS Greater Huddersfield	245,000	1.06	1.03	1.06	1.07	1.09	0.92	1.28	567	17.4
	NHS Leeds North	201,200	1.04	0.99	1.02	1.04	1.00	0.83	1.21	522	17.4
	NHS Leeds South and East	253,700	1.00	1.05	0.99	1.01	0.98	0.82	1.18	457	18.3
	NHS Leeds West	326,900	0.99	1.04	1.07	1.05	1.04	0.89	1.21	480	10.8
	NHS North Kirklees	**192,000**	**1.18**	**1.29**	**1.36**	**1.37**	**1.28**	**1.08**	**1.53**	**641**	**25.3**
	NHS Wakefield	336,800	0.85	0.85	0.85	0.84	0.87	0.74	1.02	469	4.6

Table 3.4. Continued

UK area	CCG/HB	Total population	O/E 2012	O/E 2013	O/E 2014	O/E 2015	2016 O/E	2016 95% LCL	2016 95% UCL	2016 Crude rate pmp	% non-White
Arden, Herefordshire and Worcester-shire	NHS Coventry and Rugby	456,700	1.05	1.02	1.07	1.08	1.08	0.95	1.23	510	22.2
	NHS Herefordshire	*189,300*	*0.71*	*0.68*	*0.69*	*0.72*	*0.74*	*0.59*	*0.92*	*417*	*1.8*
	NHS Redditch and Bromsgrove	181,700	0.86	0.81	0.84	0.81	0.86	0.70	1.07	468	6.0
	NHS South Warwickshire	262,700	1.05	1.03	1.00	1.02	0.94	0.80	1.12	514	7.0
	NHS South Worcestershire	*301,400*	*0.78*	*0.77*	*0.76*	*0.73*	*0.74*	*0.62*	*0.88*	*408*	*3.7*
	NHS Warwickshire North	190,200	1.05	1.02	0.97	0.96	0.96	0.79	1.17	526	6.5
	NHS Wyre Forest	99,900	0.81	0.83	0.75	0.69	0.77	0.57	1.03	430	2.8
Birmingham and the Black Country	**NHS Birmingham CrossCity**	**748,300**	**1.04**	**1.05**	**1.07**	**1.08**	**1.13**	**1.02**	**1.24**	**509**	**35.2**
	NHS Birmingham South and Central	204,000	0.97	1.05	1.11	1.11	1.16	0.95	1.40	505	40.4
	NHS Dudley	*317,600*	*0.68*	*0.70*	*0.70*	*0.73*	*0.75*	*0.63*	*0.89*	*394*	*10.0*
	NHS Sandwell and West Birmingham	495,100	1.00	1.09	1.04	1.04	1.13	1.00	1.27	517	45.3
	NHS Solihull	*211,800*	*0.76*	*0.72*	*0.74*	*0.74*	*0.71*	*0.57*	*0.88*	*378*	*10.9*
	NHS Walsall	278,700	1.05	1.08	1.10	1.05	1.07	0.91	1.26	535	21.1
	NHS Wolverhampton	256,600	0.78	0.88	0.87	0.84	0.85	0.71	1.03	421	32.0
Derbyshire and Nottingham-shire	NHS Erewash	96,700	0.65	0.83	0.87	0.83	0.83	0.61	1.12	445	3.2
	NHS Hardwick	*111,400*	*0.54*	*0.47*	*0.55*	*0.59*	*0.60*	*0.43*	*0.82*	*332*	*1.8*
	NHS Mansfield & Ashfield	197,900	1.04	1.04	1.03	0.96	0.95	0.79	1.16	515	2.5
	NHS Newark & Sherwood	119,700	1.11	1.11	1.11	1.03	0.95	0.74	1.21	526	2.4
	NHS North Derbyshire	*273,200*	*0.89*	*0.82*	*0.78*	*0.78*	*0.80*	*0.67*	*0.95*	*458*	*2.5*
	NHS Nottingham City	325,300	0.93	0.96	0.95	0.97	0.98	0.83	1.15	421	28.5
	NHS Nottingham North & East	150,300	0.91	0.94	0.83	0.85	0.86	0.68	1.08	466	6.2
	NHS Nottingham West	112,700	1.04	1.02	1.04	1.08	1.06	0.83	1.35	577	7.3
	NHS Rushcliffe	*115,200*	*0.89*	*0.96*	*0.87*	*0.80*	*0.75*	*0.56*	*0.99*	*408*	*6.9*
	NHS Southern Derbyshire	527,400	0.95	0.96	0.95	0.95	0.99	0.88	1.11	518	11.0
East Anglia	NHS Cambridgeshire and Peterborough[a]	884,600	0.96	0.95	0.94						9.5
	NHS Great Yarmouth & Waveney[a]	215,700	0.83	0.95	1.00						2.7
	NHS Ipswich and East Suffolk[b]	*401,000*	*0.86*	*0.91*	*0.90*	*0.79**	*0.77**	*0.67**	*0.90**	*424**	*5.6*
	NHS North Norfolk	171,900	0.82	1.02	0.92	0.90	0.89	0.72	1.09	524	1.5
	NHS Norwich[b]	216,800	0.75	0.93	0.94	0.90*	0.88*	0.72*	1.08*	434*	7.3
	NHS South Norfolk[a]	229,900	0.84	0.95	0.90						2.6
	NHS West Norfolk[a]	175,100	0.87	0.81	0.84						2.6
	NHS West Suffolk[a]	227,800	0.99	0.94	0.89						4.6
Essex	NHS Basildon and Brentwood	259,800	0.90	1.03	0.91	0.83	0.86	0.71	1.03	443	7.1
	NHS Castle Point, Rayleigh and Rochford	175,400	0.83	0.87	0.96	0.85	0.80	0.65	1.00	450	3.0
	NHS Mid Essex[a]	388,400	0.94	0.99	0.96						4.4
	NHS North East Essex[a]	329,200	0.93	0.95	0.99						5.5
	NHS Southend	179,800	0.88	0.95	0.94	0.88	0.89	0.72	1.10	467	8.4
	NHS Thurrock	167,000	0.83	0.79	0.79	0.82	0.79	0.62	1.00	389	14.1
	NHS West Essex[a]	302,500	0.89	0.85	0.89						8.2
Hertfordshire and the South Midlands	NHS Bedfordshire[a]	447,700	1.06	1.03	1.04						11.2
	NHS Corby[b]	68,200	0.75	0.67	0.60	0.82*	0.84*	0.59*	1.21*	425*	4.5
	NHS East and North Hertfordshire[a]	565,700	0.99	1.00	1.00						10.4
	NHS Herts Valleys	591,800	0.96	0.97	0.99	1.02	1.04	0.93	1.16	531	14.6
	NHS Luton[a]	216,800	1.19	1.22	1.33						45.3
	NHS Milton Keynes	270,500	1.01	0.95	1.05	1.07	1.09	0.93	1.29	547	19.6
	NHS Nene	648,600	0.91	0.91	0.96	0.92	0.95	0.85	1.06	504	9.1

Table 3.4. Continued

UK area	CCG/HB	Total population	O/E 2012	O/E 2013	O/E 2014	O/E 2015	2016 O/E	2016 95% LCL	2016 95% UCL	2016 Crude rate pmp	% non-White
Leicestershire and Lincolnshire	NHS East Leicestershire and Rutland	328,600	0.93	0.89	0.92	0.90	0.93	0.80	1.08	511	9.8
	NHS Leicester City	**348,300**	**1.45**	**1.50**	**1.57**	**1.58**	**1.61**	**1.43**	**1.83**	**718**	**49.5**
	NHS Lincolnshire East	233,400	0.88	0.89	0.89	0.86	0.88	0.74	1.06	510	2.0
	NHS Lincolnshire West	*236,900*	*0.81*	*0.84*	*0.87*	*0.79*	*0.77*	*0.63*	*0.94*	*405*	*3.0*
	NHS South Lincolnshire[a]	147,800	0.66	0.61	0.70						2.3
	NHS South West Lincolnshire	*125,200*	*0.73*	*0.70*	*0.69*	*0.69*	*0.68*	*0.52*	*0.91*	*383*	*2.3*
	NHS West Leicestershire	393,000	1.03	1.03	1.01	0.99	1.01	0.88	1.16	542	6.9
Shropshire and Staffordshire	*NHS Cannock Chase*	*135,100*	*0.74*	*0.77*	*0.73*	*0.70*	*0.72*	*0.55*	*0.94*	*392*	*2.4*
	NHS East Staffordshire	*126,400*	*0.60*	*0.68*	*0.63*	*0.68*	*0.73*	*0.56*	*0.97*	*396*	*9.0*
	NHS North Staffordshire	218,300	0.91	0.94	0.87	0.89	0.90	0.74	1.08	495	3.5
	NHS Shropshire	*313,400*	*0.76*	*0.74*	*0.73*	*0.76*	*0.70*	*0.58*	*0.83*	*396*	*2.0*
	NHS South East Staffs and Seisdon and Peninsular	*225,200*	*0.79*	*0.82*	*0.82*	*0.82*	*0.82*	*0.67*	*0.99*	*457*	*3.6*
	NHS Stafford and Surrounds	154,000	0.90	0.90	0.92	0.95	0.91	0.73	1.14	513	4.7
	NHS Stoke on Trent	261,400	1.03	0.97	0.98	0.94	0.95	0.79	1.13	482	11.0
	NHS Telford & Wrekin	*173,000*	*0.69*	*0.72*	*0.69*	*0.76*	*0.67*	*0.52*	*0.86*	*347*	*7.3*
London	NHS Barking & Dagenham	206,500	1.01	1.11	1.14	1.12	1.19	0.99	1.44	509	41.7
	NHS Barnet	**386,100**	**1.40**	**1.38**	**1.34**	**1.35**	**1.30**	**1.15**	**1.47**	**627**	**35.9**
	NHS Camden	246,200	1.12	1.06	1.01	1.02	1.03	0.86	1.23	483	33.7
	NHS City and Hackney	282,900	0.78	0.82	0.91	0.97	1.07	0.90	1.26	474	44.6
	NHS Enfield	**331,400**	**1.37**	**1.33**	**1.38**	**1.44**	**1.50**	**1.32**	**1.70**	**709**	**39.0**
	NHS Haringey	**278,500**	**1.17**	**1.17**	**1.23**	**1.31**	**1.37**	**1.18**	**1.59**	**646**	**39.5**
	NHS Havering	*252,800*	*0.76*	*0.83*	*0.76*	*0.79*	*0.80*	*0.66*	*0.97*	*404*	*12.3*
	NHS Islington	**232,900**	**1.21**	**1.21**	**1.24**	**1.25**	**1.23**	**1.03**	**1.46**	**554**	**31.8**
	NHS Newham	**341,000**	**0.91**	**1.01**	**1.11**	**1.16**	**1.18**	**1.01**	**1.37**	**504**	**71.0**
	NHS Redbridge	**299,200**	**1.20**	**1.18**	**1.26**	**1.24**	**1.27**	**1.10**	**1.47**	**595**	**57.5**
	NHS Tower Hamlets	304,900	0.79	0.78	0.87	0.87	0.92	0.77	1.10	381	54.8
	NHS Waltham Forest	**275,800**	**1.13**	**1.15**	**1.26**	**1.34**	**1.39**	**1.20**	**1.61**	**649**	**47.8**
	NHS Brent	**328,300**	**1.56**	**1.60**	**1.58**	**1.61**	**1.65**	**1.46**	**1.86**	**786**	**63.7**
	NHS Central London (Westminster)	178,400	0.97	0.95	1.02	1.07	1.10	0.90	1.33	555	36.2
	NHS Ealing	**343,200**	**1.49**	**1.44**	**1.50**	**1.52**	**1.55**	**1.37**	**1.75**	**752**	**51.0**
	NHS Hammersmith and Fulham	179,700	1.04	1.06	1.09	1.08	1.06	0.86	1.30	507	31.9
	NHS Harrow	**248,800**	**1.69**	**1.60**	**1.64**	**1.63**	**1.72**	**1.51**	**1.97**	**856**	**57.8**
	NHS Hillingdon	**302,500**	**1.48**	**1.41**	**1.47**	**1.40**	**1.41**	**1.23**	**1.62**	**671**	**39.4**
	NHS Hounslow	**271,100**	**1.19**	**1.27**	**1.32**	**1.37**	**1.29**	**1.11**	**1.50**	**620**	**48.6**
	NHS West London (Kensington and Chelsea, Queen's Park and Paddington)	226,000	1.07	1.04	1.06	1.01	0.95	0.79	1.15	487	33.4
	NHS Bexley	**244,800**	**1.27**	**1.29**	**1.26**	**1.34**	**1.29**	**1.10**	**1.50**	**641**	**18.1**
	NHS Bromley	326,900	1.13	1.11	1.09	1.10	1.12	0.98	1.30	581	15.7
	NHS Croydon	382,300	0.88	0.94	0.92	0.96	0.97	0.84	1.12	476	44.9
	NHS Greenwich	**279,800**	**1.04**	**1.09**	**1.23**	**1.26**	**1.30**	**1.12**	**1.51**	**604**	**37.5**
	NHS Kingston	176,100	1.02	0.97	0.99	1.00	1.05	0.85	1.29	511	25.5
	NHS Lambeth	327,900	0.98	1.03	1.07	1.12	1.16	1.00	1.34	534	42.9
	NHS Lewisham	301,900	0.86	0.99	1.03	1.11	1.09	0.93	1.28	513	46.5
	NHS Merton	**205,000**	**1.15**	**1.18**	**1.18**	**1.20**	**1.22**	**1.02**	**1.45**	**595**	**35.1**
	NHS Richmond	*195,800*	*0.86*	*0.87*	*0.86*	*0.82*	*0.73*	*0.59*	*0.92*	*383*	*14.0*
	NHS Southwark	**313,200**	**1.38**	**1.40**	**1.45**	**1.43**	**1.43**	**1.25**	**1.64**	**661**	**45.8**
	NHS Sutton	202,200	1.08	1.05	0.99	0.99	1.02	0.84	1.24	519	21.4
	NHS Wandsworth	316,100	0.95	0.96	1.01	1.02	1.03	0.88	1.21	475	28.6

Table 3.4. Continued

UK area	CCG/HB	Total population	O/E 2012	O/E 2013	O/E 2014	O/E 2015	2016 O/E	2016 95% LCL	2016 95% UCL	2016 Crude rate pmp	2016 % non-White
Bath, Gloucestershire, Swindon and Wiltshire	NHS Bath and North East Somerset	187,800	0.70	0.78	0.81	0.81	0.85	0.69	1.06	426	5.4
	NHS Gloucestershire	*623,100*	*0.86*	*0.90*	*0.85*	*0.86*	*0.86*	*0.76*	*0.96*	*467*	*4.6*
	NHS Swindon	223,600	0.98	0.99	1.03	1.11	1.16	0.98	1.38	608	10.0
	NHS Wiltshire	*488,400*	*0.90*	*0.85*	*0.85*	*0.86*	*0.85*	*0.74*	*0.97*	*463*	*3.4*
Bristol, North Somerset, Somerset and South Gloucestershire	**NHS Bristol**	**454,200**	**1.25**	**1.25**	**1.24**	**1.22**	**1.20**	**1.06**	**1.36**	**548**	**16.0**
	NHS North Somerset	211,700	1.11	1.09	1.03	1.02	0.95	0.79	1.15	524	2.7
	NHS Somerset	*549,400*	*0.93*	*0.91*	*0.88*	*0.86*	*0.82*	*0.72*	*0.92*	*455*	*2.0*
	NHS South Gloucestershire	277,600	1.05	1.05	1.01	0.99	0.96	0.81	1.13	504	5.0
Devon, Cornwall and Isles of Scilly	NHS Kernow	556,000	1.17	1.15	1.12	1.11	1.05	0.95	1.17	594	1.8
	NHS North, East, West Devon	898,000	1.05	1.05	1.02	1.01	0.99	0.91	1.08	532	3.0
	NHS South Devon and Torbay	279,900	1.15	1.18	1.16	1.09	1.08	0.93	1.25	618	2.1
Kent and Medway	NHS Ashford	126,200	1.16	1.09	1.13	1.07	1.16	0.93	1.45	610	6.3
	NHS Canterbury and Coastal	210,500	1.20	1.14	1.19	1.10	1.06	0.88	1.27	537	5.9
	NHS Dartford, Gravesham and Swanley	260,600	1.15	1.13	1.17	1.19	1.11	0.95	1.31	572	13.0
	NHS Medway	278,500	0.93	0.96	0.92	0.90	0.91	0.76	1.08	460	10.4
	NHS South Kent Coast	207,600	0.87	0.89	0.94	0.90	0.88	0.73	1.07	491	4.5
	NHS Swale	114,800	1.39	1.43	1.38	1.35	1.25	1.00	1.57	653	3.8
	NHS Thanet	140,700	1.21	1.20	1.17	1.18	1.16	0.94	1.43	619	4.5
	NHS West Kent	481,600	0.86	0.86	0.86	0.84	0.88	0.77	1.00	465	4.9
Surrey and Sussex	NHS Brighton & Hove	289,200	0.87	0.83	0.82	0.88	0.87	0.73	1.04	425	10.9
	NHS Coastal West Sussex	498,900	0.96	0.96	0.94	0.93	0.94	0.83	1.06	521	3.8
	NHS Crawley	*111,400*	*0.78*	*0.71*	*0.70*	*0.65*	*0.62*	*0.44*	*0.87*	*305*	*20.1*
	NHS East Surrey	183,700	0.88	0.87	0.80	0.80	0.82	0.65	1.02	430	8.3
	NHS Eastbourne, Hailsham and Seaford	*189,500*	*0.75*	*0.75*	*0.74*	*0.73*	*0.69*	*0.54*	*0.87*	*375*	*4.4*
	NHS Guildford and Waverley	*207,800*	*0.69*	*0.68*	*0.69*	*0.69*	*0.67*	*0.53*	*0.85*	*342*	*7.2*
	NHS Hastings & Rother	*185,800*	*0.80*	*0.79*	*0.81*	*0.78*	*0.80*	*0.64*	*0.99*	*447*	*4.6*
	NHS High Weald Lewes Havens	*172,600*	*0.83*	*0.78*	*0.78*	*0.73*	*0.74*	*0.59*	*0.93*	*417*	*3.1*
	NHS Horsham and Mid Sussex	*233,500*	*0.70*	*0.72*	*0.77*	*0.79*	*0.74*	*0.60*	*0.90*	*398*	*4.9*
	NHS North West Surrey	344,600	1.03	1.03	1.01	0.98	0.96	0.82	1.11	502	12.5
	NHS Surrey Downs	288,200	0.89	0.90	0.90	0.88	0.87	0.74	1.03	472	9.1
	NHS Surrey Heath	96,700	1.24	1.09	0.95	0.91	0.92	0.69	1.22	496	9.3
Thames Valley	**NHS Aylesbury Vale**	**211,400**	**1.26**	**1.21**	**1.19**	**1.13**	**1.21**	**1.03**	**1.44**	**643**	**9.7**
	NHS Bracknell and Ascot	137,700	1.05	1.03	0.99	0.95	0.98	0.77	1.24	509	9.5
	NHS Chiltern	325,900	1.11	1.10	1.04	1.04	1.05	0.91	1.21	552	15.8
	NHS Newbury and District	107,100	1.31	1.25	1.14	1.05	1.02	0.79	1.32	551	4.4
	NHS North & West Reading	100,300	1.00	0.97	0.90	0.88	0.86	0.64	1.15	458	10.4
	NHS Oxfordshire	668,700	1.08	1.05	1.09	1.09	1.08	0.97	1.19	550	9.3
	NHS Slough	**147,200**	**1.65**	**1.86**	**1.90**	**1.98**	**1.90**	**1.60**	**2.26**	**863**	**54.3**
	NHS South Reading	**112,000**	**1.21**	**1.28**	**1.31**	**1.39**	**1.54**	**1.23**	**1.92**	**678**	**30.5**
	NHS Windsor, Ascot and Maidenhead	**142,900**	**1.23**	**1.26**	**1.30**	**1.27**	**1.23**	**1.00**	**1.51**	**630**	**14.7**
	NHS Wokingham	161,900	1.01	0.97	0.98	0.97	0.95	0.77	1.18	507	11.6
Wessex	*NHS Dorset*	*771,900*	*0.90*	*0.87*	*0.86*	*0.85*	*0.85*	*0.76*	*0.94*	*464*	*4.0*
	NHS Fareham and Gosport	200,800	0.95	1.02	1.03	1.01	0.99	0.82	1.19	538	3.4
	NHS Isle of Wight	*139,800*	*0.76*	*0.66*	*0.65*	*0.68*	*0.68*	*0.52*	*0.89*	*393*	*2.7*
	NHS North East Hampshire and Farnham	210,500	0.86	0.88	0.89	0.92	0.97	0.80	1.17	508	9.7
	NHS North Hampshire	*221,900*	*0.82*	*0.81*	*0.78*	*0.81*	*0.80*	*0.65*	*0.98*	*428*	*6.4*
	NHS Portsmouth	214,800	0.94	0.92	0.85	0.84	0.85	0.69	1.05	400	11.6
	NHS South Eastern Hampshire	212,300	1.08	1.02	1.09	1.07	1.06	0.89	1.27	584	3.1
	NHS Southampton	254,300	1.06	1.08	1.11	1.09	1.09	0.91	1.29	492	14.1
	NHS West Hampshire	*558,300*	*0.93*	*0.91*	*0.88*	*0.85*	*0.87*	*0.77*	*0.98*	*478*	*3.9*

Table 3.4. Continued

UK area	CCG/HB	Total population	O/E 2012	O/E 2013	O/E 2014	O/E 2015	2016 O/E	2016 95% LCL	2016 95% UCL	2016 Crude rate pmp	% non-White
Wales	*Betsi Cadwaladr University*	*695,800*	*0.82*	*0.73*	*0.73*	*0.85*	*0.88*	*0.79*	*0.98*	*483*	*2.5*
	Powys Teaching	*132,200*	*0.80*	*0.77*	*0.75*	*0.73*	*0.66*	*0.51*	*0.87*	*386*	*1.6*
	Hywel Dda	383,700	0.99	1.05	1.00	0.96	0.90	0.78	1.03	495	2.2
	Abertawe Bro Morgannwg University	529,300	1.34	1.30	1.25	1.20	1.12	1.00	1.25	591	3.9
	Cwm Taf	**298,100**	**1.58**	**1.59**	**1.51**	**1.43**	**1.36**	**1.18**	**1.55**	**711**	**2.6**
	Aneurin Bevan	**584,100**	**1.34**	**1.28**	**1.23**	**1.19**	**1.16**	**1.05**	**1.29**	**623**	**3.9**
	Cardiff and Vale University	489,900	1.23	1.18	1.12	1.13	1.12	1.00	1.27	545	12.2
Scotland	Ayrshire and Arran	370,600	0.99	0.98	1.00	0.98	1.01	0.88	1.15	567	1.2
	Borders	114,500	1.09	1.03	0.99	0.93	0.98	0.77	1.25	576	1.3
	Dumfries and Galloway	149,500	0.92	0.85	0.88	0.88	0.86	0.69	1.08	502	1.2
	Fife	*370,300*	*0.88*	*0.88*	*0.86*	*0.85*	*0.81*	*0.70*	*0.95*	*446*	*2.4*
	Forth Valley	304,500	0.88	0.89	0.93	0.94	0.96	0.82	1.12	525	2.2
	Grampian	588,100	0.93	0.94	0.90	0.92	0.93	0.83	1.05	500	4.0
	Greater Glasgow and Clyde	**1,161,400**	**1.14**	**1.14**	**1.15**	**1.13**	**1.14**	**1.05**	**1.22**	**592**	**7.3**
	Highland	321,900	1.08	1.06	1.04	1.05	1.02	0.89	1.18	587	1.3
	Lanarkshire	656,500	1.07	1.05	1.08	1.05	1.04	0.94	1.15	567	2.0
	Lothian	*880,000*	*0.87*	*0.84*	*0.85*	*0.83*	*0.80*	*0.72*	*0.89*	*415*	*5.6*
	Orkney	21,900	0.79	0.74	0.52	0.49	0.47	0.21	1.05	275	0.7
	Shetland	23,200	0.58	0.54	0.51	0.49	0.62	0.31	1.24	345	1.5
	Tayside	415,500	0.98	0.95	0.93	0.92	0.89	0.78	1.03	484	3.2
	Western Isles	26,900	0.64	0.59	0.56	0.53	0.63	0.34	1.18	372	0.9
Northern Ireland	**Belfast**	**354,700**	**1.13**	**1.13**	**1.19**	**1.19**	**1.20**	**1.05**	**1.38**	**584**	**3.2**
	Northern	473,100	0.93	0.95	1.00	1.02	1.03	0.91	1.16	528	1.2
	Southern	**377,200**	**0.96**	**0.97**	**1.03**	**1.13**	**1.20**	**1.05**	**1.37**	**588**	**1.2**
	South Eastern	356,700	0.94	0.93	0.96	1.01	1.06	0.92	1.21	552	1.3
	Western	**300,400**	**0.89**	**1.01**	**1.14**	**1.19**	**1.23**	**1.06**	**1.42**	**619**	**1.0**
	South Eastern	354,700	0.96	0.92	0.92	0.96	1.00	0.87	1.16	505	1.3
	Western	**299,000**	**0.92**	**0.89**	**1.02**	**1.15**	**1.20**	**1.03**	**1.39**	**582**	**1.0**

[a]CCGs where >15% of the prevalent transplant population from 2014 were patients of the Cambridge renal centre. These have not been included in the analysis for 2015 or 2016 but are included for 2011–2014

[b]CCGs where between 5% and 15% of the prevalent transplant population from 2014 were patients of the Cambridge renal centre. In these CCGs the rates/ratios for 2015 and 2016 are likely to be underestimated

transplant recipients, with some areas having higher than the predicted number of prevalent transplant patients per million population and others lower. This interpretation requires caution due to unadjusted underlying population differences and missing data. Variability in the prevalent transplant population may reflect differences in both wait-listing and transplantation rates, as well as differences in the outcomes of transplant recipients. As in previous years, a separate chapter of this report identifies continued significant inter-centre variation in access to transplant wait-listing and access to transplantation [10]. Centre differences in outcomes of transplantation are explored later in this chapter. A large national study (access to Transplant and Transplant Outcome Measures (ATTOM)) is currently investigating differences in access to and outcomes of renal transplantation [11]. The work has already identified significant age, ethnicity, socio-economic and geographic disparities in the utilisation of living kidney donor transplants in the UK [12].

The proportion of prevalent RRT patients with a transplant relative to the number on dialysis has gradually risen over the last decade.

Age and sex

The sex ratio amongst incident and prevalent kidney transplant patients has remained stable for at least the last six years (table 3.6, figure 3.1). The median age of incident transplant recipients increased during the same time period, which reflects changes to the renal replacement therapy population. This was mirrored by an increase in the median age of the prevalent population,

Table 3.5. Distribution of prevalent patients on RRT by centre and modality on 31/12/2016

Centre	*N*	% HD	% PD	% transplant
Transplant centre				
B QEH	2,394	42	6	52
Belfast	829	23	3	74
Bristol	1,470	35	4	62
Camb*	1,551	28	1	71
Cardff	1,630	32	5	64
Covnt	977	39	7	55
Edinb	780	37	5	58
Glasgw	1,754	34	3	63
L Barts	2,372	43	9	48
L Guys	2,098	33	2	65
L Rfree	2,177	33	7	59
L St.G	863	41	5	54
L West	3,417	43	3	54
Leeds	1,552	34	3	63
Leic	2,310	42	4	54
Liv Roy	1,225	30	6	64
M RI	1,994	26	3	71
Newc	1,053	30	5	65
Nottm	1,152	34	7	59
Oxford	1,767	25	5	69
Plymth	513	28	8	64
Ports	1,693	38	4	58
Sheff	1,427	43	4	53
Dialysis centre				
Abrdn	557	41	4	55
Airdrie	440	42	5	53
Antrim	241	51	7	42
B Heart	654	60	13	26
Bangor	180	42	9	49
Basldn	276	59	12	29
Bradfd	635	39	4	57
Brightn	996	46	7	47
Carlis	279	34	13	54
Carsh	1,641	52	7	41
Chelms	278	48	12	40
Clwyd	178	41	8	51
Colchr	124	100		
D & Gall	131	38	8	54
Derby	543	44	14	41
Donc	330	59	8	33
Dorset	687	41	5	54
Dudley	346	59	14	27
Dundee	420	43	5	52
Exeter	1,017	45	8	47
Glouc	470	52	9	39
Hull	858	38	8	53
Inverns	260	36	4	60
Ipswi	411	36	9	56
Kent	1,070	40	5	55
Klmarnk	318	44	10	45
Krkcldy	295	49	6	45
L Kings	1,108	52	8	39
Liv Ain	227	82	11	6

Table 3.5. Continued

Centre	*N*	% HD	% PD	% transplant
Middlbr	891	37	3	60
Newry	237	37	9	54
Norwch	774	43	6	51
Prestn	1,206	47	3	50
Redng	794	38	7	55
Salford	1,022	39	10	50
Shrew	375	55	10	35
Stevng	904	59	2	39
Sthend	237	48	13	39
Stoke	827	42	10	49
Sund	507	50	3	47
Swanse	768	49	9	43
Truro	428	40	4	56
Ulster	166	61	4	35
West NI	307	42	3	55
Wirral	337	59	7	34
Wolve	569	55	12	33
Wrexm	310	40	11	49
York	535	37	6	57
England	**53,361**	**40**	**6**	**54**
N Ireland	**1,780**	**36**	**4**	**60**
Scotland	**4,955**	**38**	**5**	**57**
Wales	**3,066**	**38**	**7**	**55**
UK	**63,162**	**40**	**6**	**54**

*Cambridge was unable to submit any patient level data for 2016 but provided the total number of adult patients on treatment at the end of the year by treatment modality. Those numbers have been added in tables 3.3 and 3.5 only, therefore Cambridge is not included in any of the centre level analyses
Blank cells: no patients on that modality

which reflects the increase in age at which patients were transplanted, the increased access to transplantation for older recipients, as well as improved survival after kidney transplantation over the last ten years.

Primary renal diagnosis

The primary renal diagnosis of patients receiving a kidney transplant in the UK has remained relatively stable over the last five years (table 3.7).

Ethnicity

The ethnicity of those receiving a kidney transplant between 2011 and 2016 is shown in table 3.8. A comparison of the proportion of patients within each ethnic group receiving a transplant to those commencing dialysis from the same group was difficult because data on ethnicity were missing, or there was a high proportion with ethnicity classified as 'missing'. This is a particular issue in Scotland, where ethnicity reporting is not mandatory.

Table 3.6. Median age and sex ratio of incident and prevalent transplant patients 2011–2016

	Incident transplants			Prevalent transplants*		
Year	*N*	Median age	M : F ratio	*N*	Median age	M : F ratio
2011	2,626	49.1	1.7	26,165	51.7	1.6
2012	2,783	50.4	1.6	27,531	52.3	1.5
2013	3,129	50.3	1.6	29,436	52.8	1.6
2014	3,032	50.6	1.5	31,025	53.3	1.5
2015	2,898	50.9	1.5	31,643	53.8	1.5
2016	2,995	51.4	1.6	33,187	54.3	1.5

*As on 31 December for given year

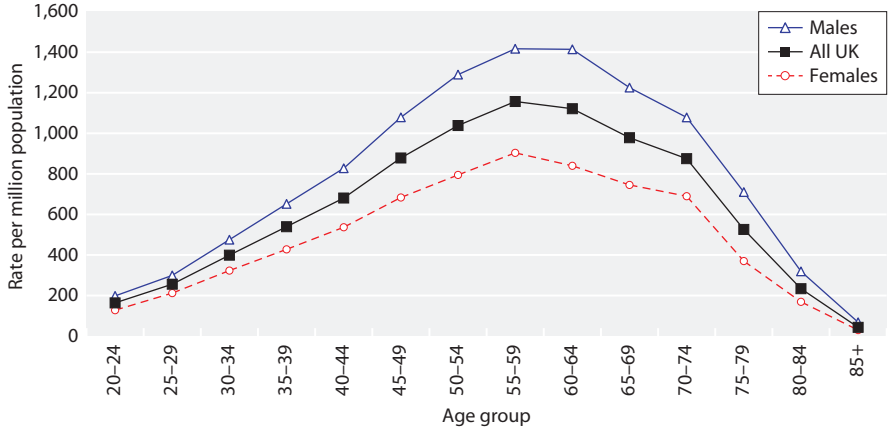

Fig. 3.1. Transplant prevalence rate per million population by age and sex on 31/12/2016

Table 3.7. Primary renal diagnosis in renal transplant recipients 2011–2016

	New transplants by year							Established transplants on 31/12/2016	
Primary renal diagnosis	2011 %	2012 %	2013 %	2014 %	2015 %	2016 %	2016 *N*	%	*N*
Aetiology uncertain	15.1	12.4	13.2	12.5	12.4	13.6	405	14.7	4,866
Diabetes	13.6	15.1	13.9	15.3	15.4	13.2	392	10.7	3,560
Glomerulonephritis	23.4	23.0	22.7	21.8	21.9	23.1	688	23.1	7,662
Polycystic kidney disease	12.6	13.6	13.9	14.0	13.8	13.1	391	13.6	4,508
Pyelonephritis	10.2	10.5	10.2	9.0	9.1	8.0	237	12.4	4,101
Reno-vascular disease	1.1	1.1	1.2	1.2	1.3	1.1	34	1.1	368
Other	17.0	17.1	15.2	17.1	16.0	16.0	477	17.6	5,825
Not available	0.9	1.2	2.6	2.7	3.5	5.2	156	1.7	556

Table 3.8. Ethnicity of patients who received a transplant in the years 2011–2016

Year	% White	% S Asian	% Black	% Other	% Unknown
2011	79.9	10.3	6.4	3.0	0.3
2012	77.6	11.1	7.6	3.2	0.4
2013	75.7	13.1	7.4	3.2	0.6
2014	73.9	13.3	7.0	4.6	1.2
2015	72.8	13.6	8.0	4.2	1.4
2016	70.6	15.6	7.9	3.8	2.1

There has been an increasing trend in the percentage of incident kidney recipients from non-White ethnic groups. This likely reflects the changing population of the UK and the different incidence of CKD in different ethnic groups. It may also reflect improved access to transplantation across these ethnic backgrounds through changes in the wait-listing of patients and changes in the national kidney allocation scheme.

Clinical and laboratory outcomes

Introduction

There continued to be marked variation in the completeness of data (tables 3.9a, 3.9b) reported by each renal centre, particularly for blood pressure and parathyroid hormone, which limits the ability to perform more meaningful comparisons between centres, or determine the causes of inter-centre differences in outcomes.

Table 3.9a. Percentage completeness of ethnicity, eGFR and blood pressure by centre for prevalent transplant patients on 31/12/2016

Centre	*N*	Ethnicity[a]	eGFR	Blood pressure[b]
England				
B Heart	170	100	94	0
B QEH	1,186	99	95	94
Basldn	76	100	95	80
Bradfd	346	100	95	79
Brightn	462	100	98	40
Bristol	883	100	100	81
Carlis	150	100	93	0
Carsh	662	100	91	4
Chelms	112	99	93	91
Covnt	522	100	95	86
Derby	215	100	98	95
Donc	106	100	100	99
Dorset	358	100	90	79
Dudley	84	100	99	44
Exeter	462	100	99	93
Glouc	179	100	97	81
Hull	437	99	95	2
Ipswi	223	98	99	98
Kent	568	100	99	95
L Barts	1,089	100	67	0
L Guys	1,310	99	98	0
L Kings	429	100	99	100
L RFree	1,253	99	96	84
L St.G	450	96	98	0
L West	1,792	100	97	0
Leeds	947	100	97	93
Leic	1,223	98	95	27
Liv Ain	14	100	100	0
Liv Roy	765	99	94	3
M RI	1,322	99	96	4
Middlbr	528	100	97	32
Newc	656	100	98	95
Norwch	389	100	97	4
Nottm	653	100	99	96
Oxford	1,161	95	99	9
Plymth	313	100	97	92
Ports	952	99	96	25
Prestn	592	100	98	0
Redng	417	97	99	98
Salford	505	100	99	0
Sheff	738	100	99	97
Shrew	129	100	95	1
Stevng	332	99	97	0
Sthend	91	100	99	77
Stoke	385	99	99	2
Sund	231	100	100	0
Truro	235	100	98	1
Wirral	101	100	92	0
Wolve	182	99	93	68
York	298	99	99	69
N Ireland				
Antrim	101	100	99	82
Belfast	581	99	99	54
Newry	127	100	97	86
Ulster	58	100	97	93
West NI	164	100	99	91
Scotland				
Abrdn	299	57	99	n/a
Airdrie	222	64	81	n/a
D & Gall	71	34	85	n/a
Dundee	218	59	98	n/a
Edinb	441	32	95	n/a
Glasgw	1,063	28	72	n/a
Inverns	155	79	37	n/a
Klmarnk	138	68	98	n/a
Krkcldy	130	35	95	n/a
Wales				
Bangor	86	100	99	88
Cardff	1,018	100	99	97
Clwyd	88	100	100	84
Swanse	318	100	100	98
Wrexm	146	100	99	92
England	**26,683**	**99**	**96**	**42**
N Ireland	**1,031**	**100**	**98**	**69**
Scotland	**2,737**	**43**	**82**	**n/a**
Wales	**1,656**	**100**	**99**	**96**
UK	**32,107**	**94**	**95**	**42**[c]

n/a – not available
[a]Patients with missing ethnicity were classed as White for eGFR calculation
[b]Scottish centres excluded from blood pressure analysis as data not provided by the Scottish Renal Registry
[c]Excluding Scotland

The 71 renal centres in the UK comprise 52 centres in England, five in Wales, five in Northern Ireland and nine in Scotland. Colchester was reported as having no transplanted patients and was therefore excluded. Cambridge was unable to submit patient level data for 2015 and 2016. After exclusion of these centres, prevalent patient data from 69 renal centres across the UK were analysed.

Table 3.9b. Percentage completeness of haemoglobin, serum cholesterol, serum calcium, serum phosphate and serum PTH by centre for prevalent transplant patients on 31/12/2016

Centre	*N*	Haemoglobin	Total serum cholesterol	Adjusted serum calcium[a]	Serum phosphate	Serum PTH
England						
B Heart	170	94	65	92	92	32
B QEH	1,186	95	95	95	94	0
Basldn	76	93	68	95	93	22
Bradfd	346	94	76	83	52	42
Brightn	462	98	69	96	96	47
Bristol	883	99	95	99	99	99
Carlis	150	93	72	93	83	36
Carsh	662	91	53	89	89	28
Chelms	112	92	86	93	65	38
Covnt	522	95	71	93	52	31
Derby	215	98	93	96	96	93
Donc	106	100	73	100	100	38
Dorset	358	89	68	87	68	32
Dudley	84	99	85	99	99	74
Exeter	462	99	93	99	98	46
Glouc	179	97	68	97	96	25
Hull	437	94	30	90	90	19
Ipswi	223	98	75	98	98	63
Kent	568	98	72	96	96	14
L Barts	1,089	98	100	98	98	98
L Guys	1,310	98	61	95	95	39
L Kings	429	99	79	99	99	68
L RFree	1,253	96	76	93	93	75
L St.G	450	98	90	98	98	87
L West	1,792	97	31	97	97	30
Leeds	947	96	98	94	91	31
Leic	1,223	95	94	94	94	63
Liv Ain	14	100	36	100	100	79
Liv Roy	765	94	41	92	92	54
M RI	1,322	96	66	96	96	55
Middlbr	528	96	40	95	94	11
Newc	656	98	76	98	98	74
Norwch	389	96	97	96	96	27
Nottm	653	99	81	97	97	89
Oxford	1,161	99	65	99	98	42
Plymth	313	96	67	96	96	63
Ports	952	96	55	95	90	32
Prestn	592	98	74	97	96	47
Redng	417	99	77	98	76	57
Salford	505	99	80	99	99	0
Sheff	738	99	57	98	98	0
Shrew	129	95	86	93	93	12
Stevng	332	98	42	93	93	62
Sthend	91	99	34	98	96	8
Stoke	385	99	99	99	99	83
Sund	231	100	83	99	100	94
Truro	235	98	98	98	98	97
Wirral	101	89	37	84	84	51
Wolve	182	91	74	91	77	38
York	298	98	75	96	95	19

Table 3.9b. Continued

Centre	*N*	Haemoglobin	Total serum cholesterol	Adjusted serum calcium[a]	Serum phosphate	Serum PTH
N Ireland						
Antrim	101	98	100	99	99	96
Belfast	581	99	99	98	98	27
Newry	127	97	99	97	97	98
Ulster	58	95	98	93	97	7
West NI	164	96	100	97	98	96
Scotland						
Abrdn	299	99	n/a	97	97	n/a
Airdrie	222	97	n/a	96	95	n/a
D & Gall	71	97	n/a	99	89	n/a
Dundee	218	99	n/a	97	96	n/a
Edinb	441	95	n/a	92	83	n/a
Glasgw	1,063	99	n/a	99	98	n/a
Inverns	155	31	n/a	28	26	n/a
Klmarnk	138	99	n/a	98	97	n/a
Krkcldy	130	93	n/a	93	92	n/a
Wales						
Bangor	86	99	99	99	99	28
Cardff	1,018	98	95	98	98	17
Clwyd	88	99	99	98	98	65
Swanse	318	100	90	99	99	78
Wrexm	146	99	99	99	99	99
England	26,683	97	72	96	93	47
N Ireland	1,031	98	100	98	98	52
Scotland[b]	94	n/a	93	90	n/a	
Wales	1,656	99	95	98	98	39
UK	32,107	97	68[c]	96	93	43[c]

n/a – not available
[a]Serum calcium corrected for serum albumin
[b]Dataset provided by the Scottish Renal Registry for Scottish centres shown did not include data on serum cholesterol or serum PTH
[c]Excluding Scotland

For the one-year post-transplant analyses, in which patients were assigned to the centre that performed their transplant, all 23 transplant centres across the UK were included in the analysis.

Methods

Data for key laboratory variables were reported for all prevalent patients with valid data returns for a given renal centre (both transplanting and non-transplanting centres) and for one year post-transplant results for patients transplanted 2009–2015, with patients attributed to the transplant centre that performed the procedure.

Time since transplantation may have a significant effect on key biochemical and clinical variables and this was likely to be independent of a centre's clinical practices. Therefore, inter-centre comparison of data on prevalent transplant patients was open to bias. To minimise bias relating to fluctuations in biochemical and clinical parameters occurring in the initial post-transplant period, one year post-transplantation outcomes are also reported. It is presumed that patient selection policies and local clinical practices are more likely to be relevant in influencing 12 months post-transplant outcome, therefore comparison of outcomes between centres is more robust. However, even the 12 months post-transplant comparisons could be biased by differences in the repatriation of patients from the transplanting centre. In some centres repatriation of patients occurred at a fixed time post transplantation whilst in others it only occurred if the graft was failing or conversely if the graft function was stable.

Centres with <10 patients or <50% data completeness have been excluded from the figures. Scottish centres were also excluded from blood pressure analyses as data were not provided.

Prevalent patient data

Biochemical and clinical data for patients with a functioning transplant followed in either a transplanting or non-transplanting centre were included in the analyses. The cohort consisted of prevalent patients as on 31 December 2016. Patients were considered as having a functioning transplant if 'transplant' was listed as the last mode of RRT in the last quarter of 2016. Patients were assigned to the renal centre that sent the data to the UKRR but some patients will have received care in more than one centre. If data for the same transplant patient were received from both the transplant centre and non-transplant centre, care was usually allocated to the non-transplant centre (see appendix B). Patients with a functioning transplant of less than three months duration were excluded from analyses. For haemoglobin, estimated glomerular filtration rate (eGFR), corrected calcium, phosphate and blood pressure (BP), the latest value in quarter three or quarter four of 2016 was used.

Estimated glomerular filtration rate (eGFR)

For the purpose of eGFR calculation, the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation formula was used, as advised by NICE recommendations [2]. Previous analyses have used the Modification of Diet in Renal Disease (MDRD) study equation therefore caution is needed in comparing with previous editions of this report. A wide variety of creatinine assays are in use in clinical biochemistry laboratories in the UK and it is not possible to ensure that all measurements of creatinine concentration collected by the UKRR are harmonised. Patients with valid serum creatinine results but no ethnicity data were classed as White for the purpose of the eGFR calculation.

One year post-transplant data

Patients who received a renal transplant between 1 January 2009 and 31 December 2015 were assigned according to the renal centre in which they were transplanted. In a small number of instances, the first documented evidence of transplantation in a patient's record was from a timeline entry of data returned from a non-transplant centre; patients were re-assigned to the nearest transplant centre in this scenario.

As this analysis is stratified by donor type, the donor type used in this analysis was obtained from NHSBT because the donor type reporting to the UKRR was poor from some renal centres.

Patients who died or experienced graft failure within 12 months of transplantation were excluded from the analyses. Patients with more than one transplant between 2009 and 2015 were included as separate episodes, provided that each of the re-transplants functioned for at least a year.

The most recent laboratory or blood pressure result (for the relevant 4th/5th quarter) after renal transplantation was taken to represent one year post-transplant outcome. Patients with valid serum creatinine results but missing ethnicity data were assumed White for the purpose of the eGFR calculation.

Results and Discussion

Post-transplant eGFR in prevalent transplant patients

When interpreting eGFR post-transplantation, it is important to note that the estimated GFR formulae only have a modest predictive performance in the transplant population [13–14]. Median eGFR in each centre and percentage of patients with eGFR <30 ml/min/1.73 m^2 are shown in figures 3.2 and 3.3.

The median eGFR was 52.2 ml/min/1.73 m^2, with 13.1% of prevalent transplant recipients having an eGFR <30 ml/min/1.73 m^2, as summarised by centre in table 3.10. Some of the centre variability can be explained by differences in local repatriation policies for patients from transplanting centres back to referring centres; it is notable that both transplanting and non-transplanting centres feature at both ends of the scale in figure 3.3.

Figure 3.4 shows the percentage of prevalent patients by centre with eGFR <30 ml/min/1.73 m^2 as a funnel

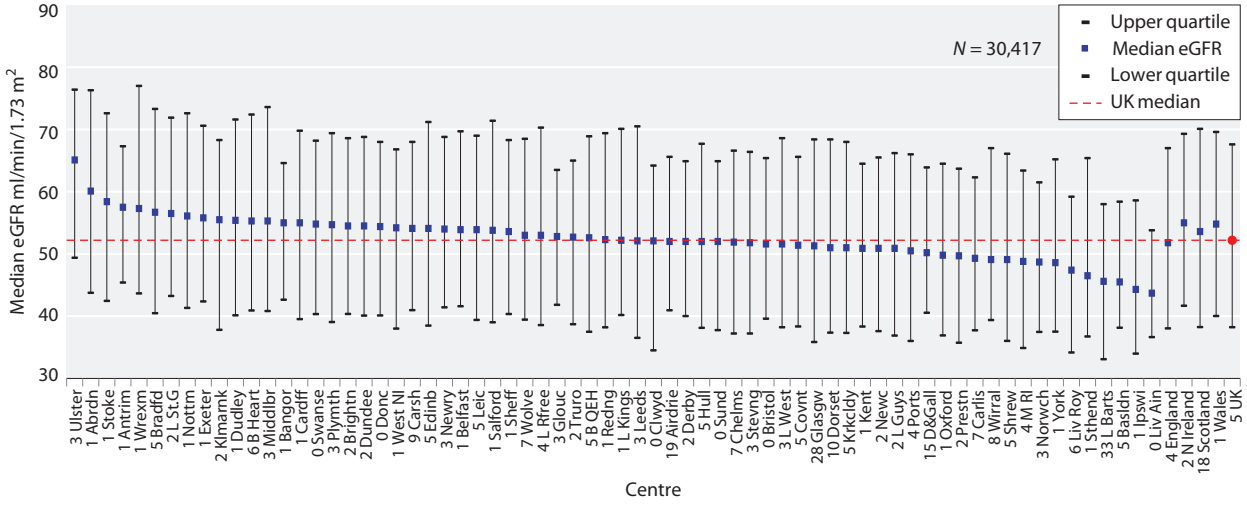

Fig. 3.2. Median eGFR in prevalent transplant patients by centre on 31/12/2016

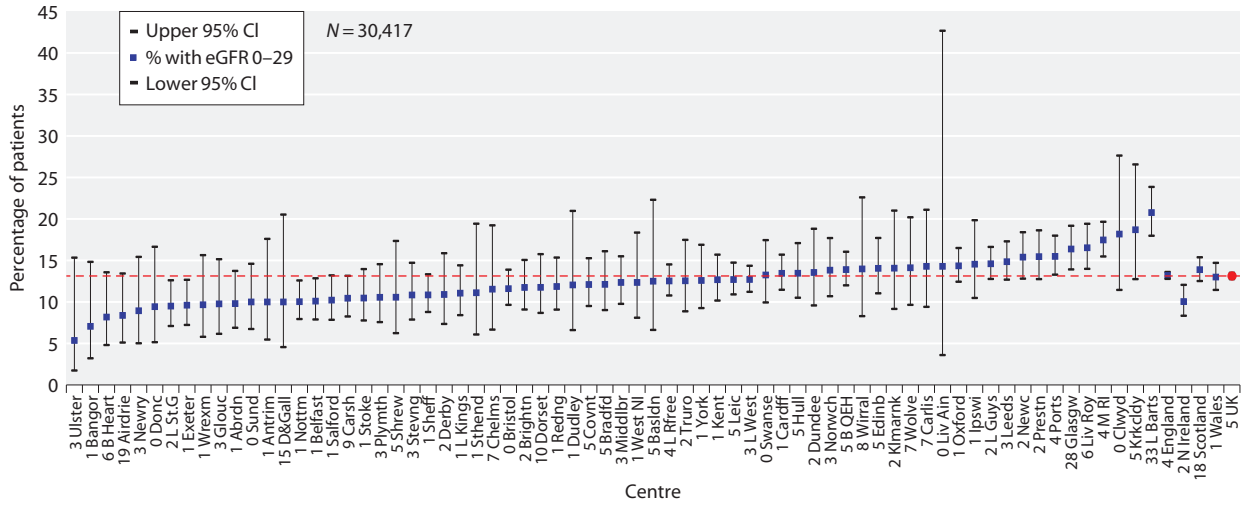

Fig. 3.3. Percentage of prevalent transplant patients by centre on 31/12/2016 with eGFR <30 ml/min/1.73 m^2

plot, enabling a more reliable comparison of outcomes between centres across the UK. The solid red lines show the two standard deviation limits (95%) and the dotted red lines represent the limits for three standard deviations (99.9%). With 69 centres included and a normal distribution, 3–4 centres would be expected to fall between the 95–99.9% CI (1 in 20) and no centres should fall outside the 99.9% limits.

There continued to be marked variation between centres with 15 centres falling above and below the 95% CI. St Bartholomew's hospital and Manchester Royal infirmary both fell outside the upper 99.9% CI, suggesting a higher than expected proportion of patients with eGFR <30 ml/min/1.73 m^2.

eGFR in patients one year after transplantation

Graft function at one year post-transplantation may predict subsequent long-term graft outcome [15]. Figures 3.5a, 3.5b, and 3.5c show the median one-year post-transplant eGFR for patients transplanted between 2009–2015, by transplant centre and donor type. Patients who received kidney transplants from living kidney donors had the highest median eGFR at one year (57.2 ml/min/1.73 m^2), followed by donor after brain-stem death (52.4 ml/min/1.73 m^2) and donor after circulatory death (48.4 ml/min/1.73 m^2).

Figures 3.6a, 3.6b and 3.6c show one-year post-transplant eGFR by donor type and year of transplantation. There was no significant trend in eGFR over the time period for patients who had either DBD, DCD or live kidney donor transplantation.

Haemoglobin in prevalent transplant patients

The Renal Association Anaemia guidelines recommend ***'achieving a population distribution centred on a mean of 11g/dl with a range of 10–12g/dl'*** [16] (equivalent to 110 g/L, range 100–120 g/L). However, many transplant patients with good graft function have haemoglobin concentrations >120 g/L without using erythropoiesis stimulating agents, therefore it is inappropriate to audit performance using the higher limit.

A number of factors, including comorbidity, immunosuppressive medication, graft function, ACE inhibitor use, erythropoietin (EPO) use, intravenous or oral iron use, that affect centre-specific protocols for management of anaemia will affect haemoglobin concentrations in transplant patients. Most of these data are not collected by the UKRR and therefore haemoglobin attainment analyses have to be interpreted with caution.

Figures 3.7a and 3.7b report centre results stratified according to graft function as estimated by eGFR. The percentage of prevalent transplant patients achieving Hb ⩾100 g/L in each centre, stratified by eGFR, is displayed in figures 3.8a and 3.8b.

Figure 3.9 describes the percentage of prevalent patients by centre with haemoglobin <100 g/L as a funnel plot enabling more reliable comparison of outcomes between centres across the UK. With 69 centres included and a normal distribution, 3–4 centres would be expected to fall between the 95%–99.9% CI (1 in 20) and no centres should fall outside the 99.9% CI purely as a chance event.

Table 3.10. Percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 on 31/12/2016

Centre	Patients with eGFR data *N*	eGFR <30%	Centre	Patients with eGFR data *N*	eGFR <30%
Liv Ain	14	14.3	Bradfd	330	12.1
Ulster	56	5.4	Norwch	376	13.8
Inverns	57	12.3	Stoke	382	10.5
D & Gall	60	10.0	Redng	413	11.9
Basldn	72	12.5	Hull	416	13.5
Dudley	83	12.0	Edinb	420	14.0
Bangor	85	7.1	L Kings	425	11.1
Clwyd	88	18.2	L St.G	442	9.5
Sthend	90	11.1	Brightn	451	11.8
Wirral	93	14.0	Exeter	458	9.6
Antrim	100	10.0	Covnt	496	12.1
Chelms	104	11.5	Salford	499	10.2
Donc	106	9.4	Middlbr	510	12.4
Newry	123	8.9	Kent	560	12.7
Shrew	123	10.6	Belfast	574	10.1
Krkcldy	123	18.7	Prestn	582	15.5
Klmarnk	135	14.1	Carsh	603	10.4
Carlis	140	14.3	Newc	643	15.4
Wrexm	145	9.7	Nottm	648	10.0
B Heart	159	8.2	Liv Roy	720	16.5
West NI	162	12.3	Sheff	728	10.9
Wolve	170	14.1	L Barts	732	20.8
Glouc	174	9.8	Glasgw	763	16.4
Airdrie	179	8.4	Bristol	879	11.6
Derby	211	10.9	Ports	910	15.5
Dundee	214	13.6	Leeds	916	14.8
Ipswi	220	14.5	Cardff	1,004	13.4
Sund	230	10.0	B QEH	1,122	13.9
Truro	231	12.6	Oxford	1,150	14.3
York	294	12.6	Leic	1,165	12.7
Abrdn	296	9.8	L Rfree	1,205	12.5
Plymth	303	10.6	M RI	1,265	17.5
Swanse	317	13.2	L Guys	1,288	14.6
Stevng	323	10.8	L West	1,739	12.7
Dorset	323	11.8			

One centre (London St Bartholomew's) fell outside the upper 99.9% CI and two further centres (London Royal Free, London St Mary's Hammersmith) fell outside the upper 95% CI indicating a higher than predicted proportion of transplant patients not achieving the haemoglobin target. Six centres fell outside the lower 99.9% CI, indicating they performed better than expected with fewer than predicted patients having a haemoglobin <100 g/L.

Blood pressure in prevalent transplant patients

The UK Renal Association (RA) guideline for the care of kidney transplant recipients recommends that '***Blood pressure should be <130/80 mmHg (or <125/75 mmHg if proteinuria)***' [7]. This blood pressure (BP) target is

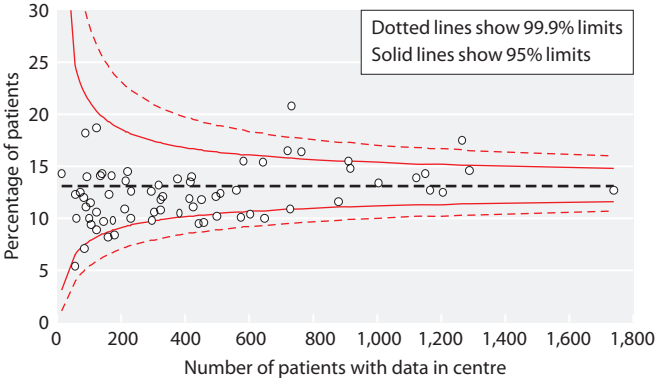

Fig. 3.4. Funnel plot of percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 by centre size on 31/12/2016

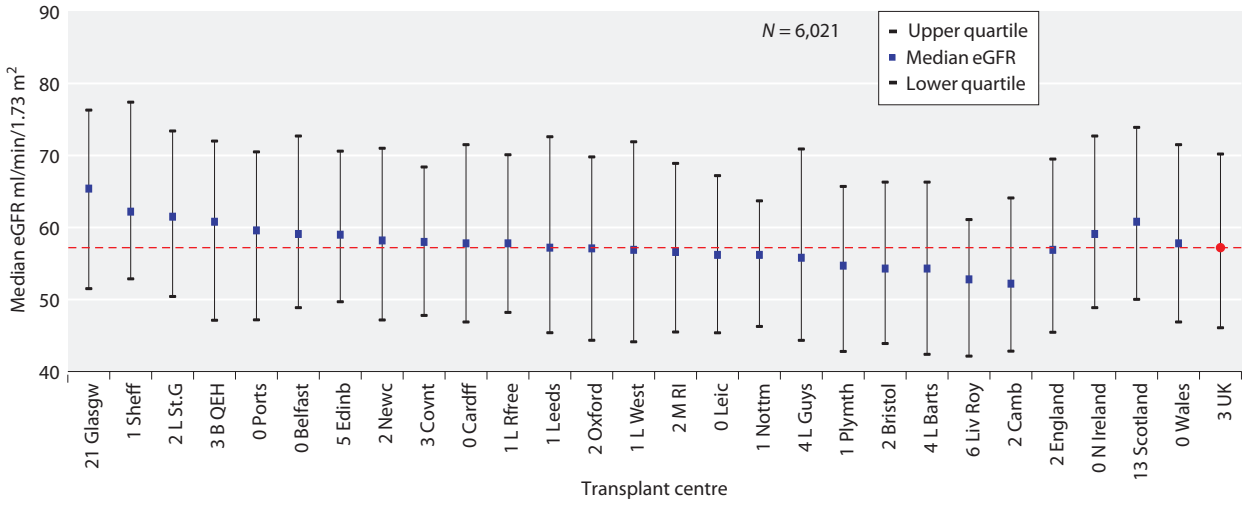

Fig. 3.5a. Median eGFR one year post-live donor transplant by transplant centre 2009–2015

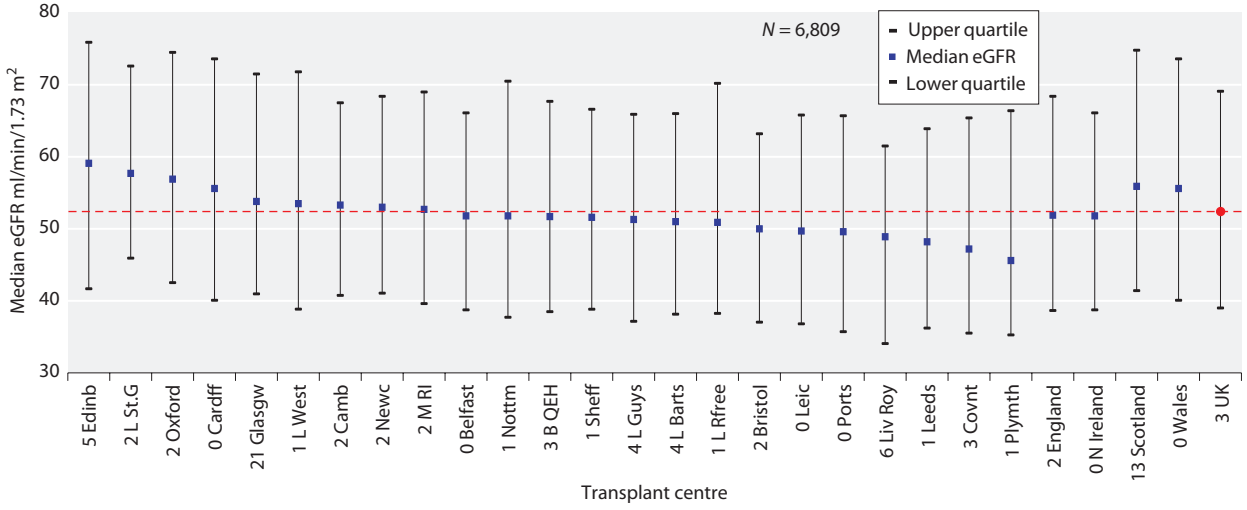

Fig. 3.5b. Median eGFR one year post-brainstem death donor transplant by transplant centre 2009–2015

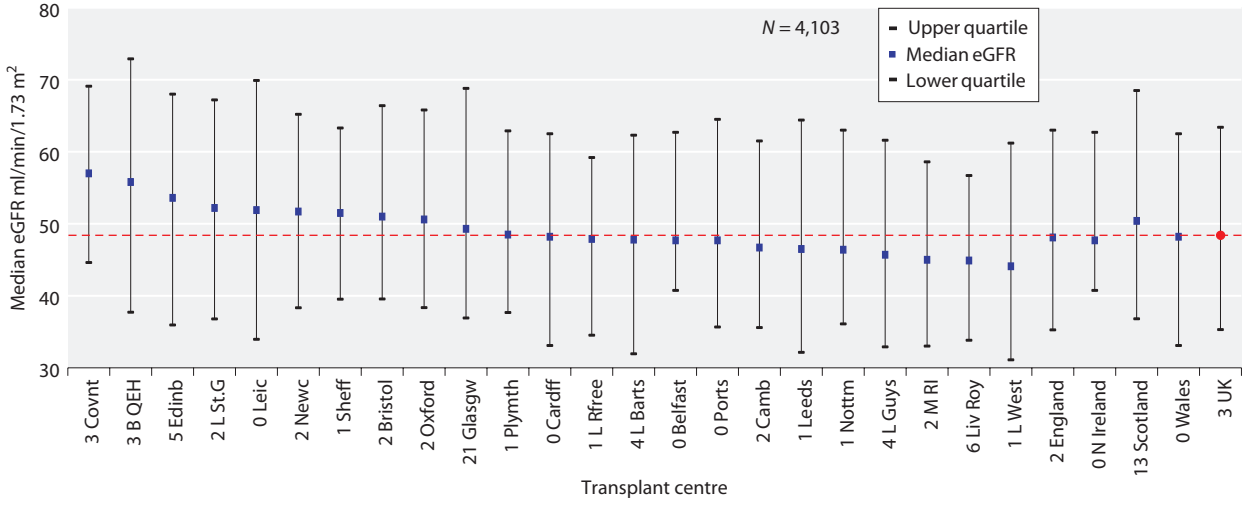

Fig. 3.5c. Median eGFR one year post-circulatory death donor transplant by transplant centre 2009–2015

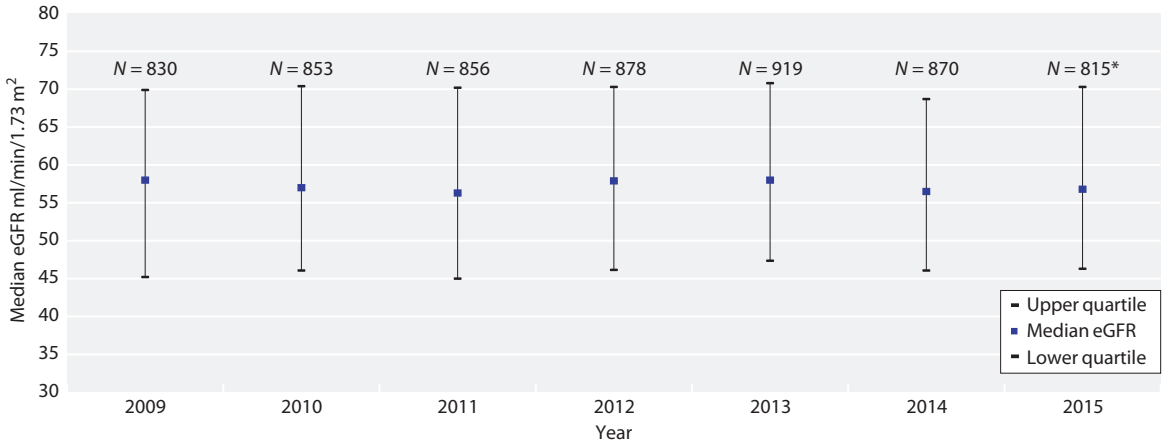

Fig. 3.6a. Median eGFR one year post-live donor transplant by year of transplantation 2009–2015
*This number does not include live-donor transplants performed in 2014 that were followed-up in Cambridge in 2015 and 2016, as Cambridge was unable to submit data for both 2015 and 2016

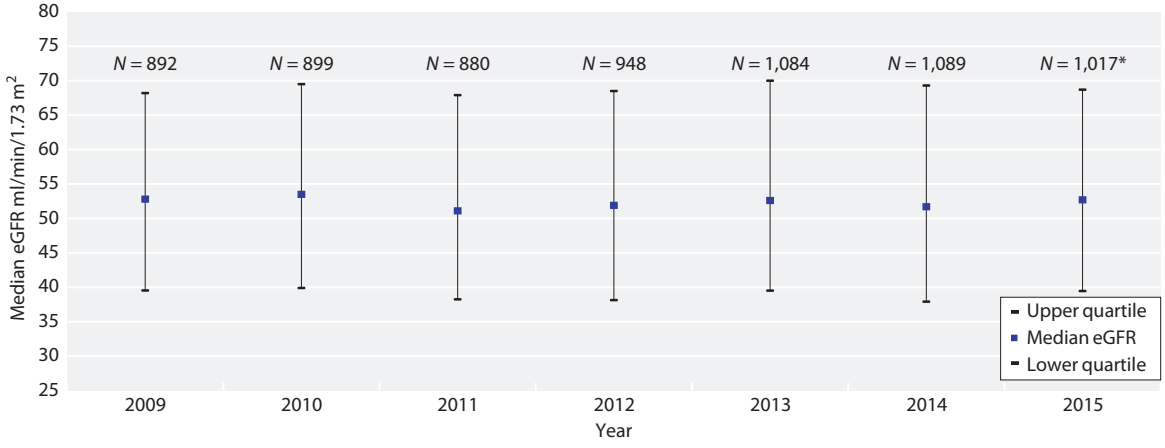

Fig. 3.6b. Median eGFR one year post-brainstem death donor transplant by year of transplantation 2009–2015
*This number does not include post-brainstem death donor transplants performed in 2016 that were followed-up in Cambridge in 2015 and 2016, as Cambridge was unable to submit data for both 2015 and 2016

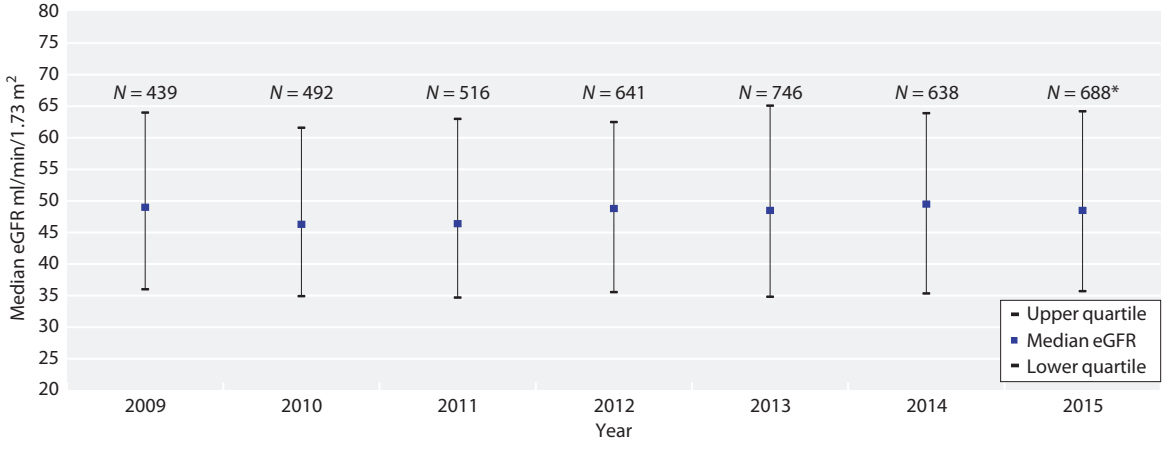

Fig. 3.6c. Median eGFR one year post-circulatory death donor transplant by year of transplantation 2009–2015
*This number does not include post-circulatory death donor transplants performed in 2014 that were followed-up in Cambridge in both 2015 and 2016, as Cambridge was unable to submit data for 2015 and 2016

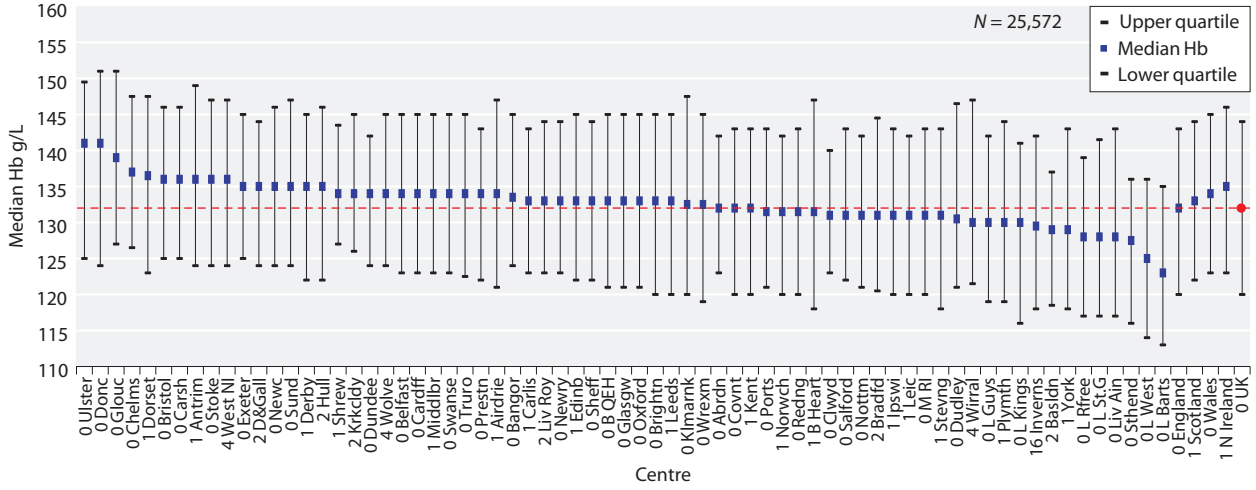

Fig. 3.7a. Median haemoglobin for prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 by centre on 31/12/2016

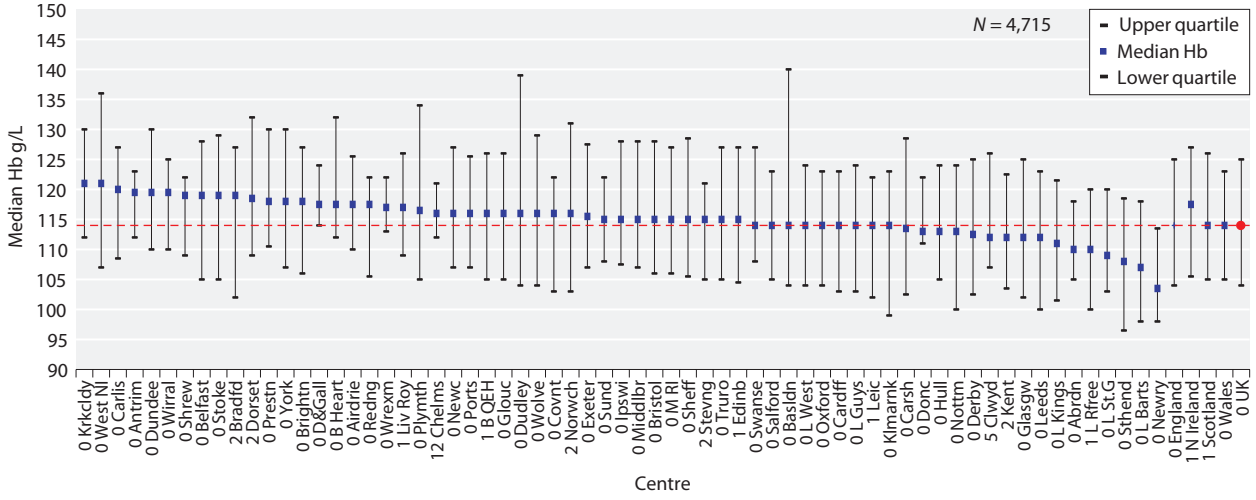

Fig. 3.7b. Median haemoglobin for prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 by centre on 31/12/2016

the same as that used in previous annual reports. The new guideline published by the RA in 2017 advocates higher target blood pressure of <140/90 (or <130/80 mm/Hg if proteinuria) reflecting a lack of strong evidence and will be incorporated into the analysis of 2017 data in the next report. Completeness of blood pressure data continued to be variable with some centres unable to report. Thirty-one centres returned data with >50% completeness and were included in the analysis. Despite restricting the analysis to only include centres with >50% completeness of data, there are other potential biases, especially for those with lower completeness (e.g. centres may be more likely to record blood pressure electronically for patients with poor BP control/other reasons for data to be missing systematically), therefore results should be interpreted with caution.

Figures 3.10a and 3.10b show the percentage of patients with a blood pressure of <130/80 mm Hg, by eGFR. The percentage of patients with BP <130/80 (systolic BP <130 and diastolic BP <80 mmHg) was higher (25.6% vs 19.8%) in those with better renal function (eGFR ⩾30 ml/min/1.73 m^2).

Analysis of prevalent patients by CKD stage

Introduction

Approximately 2.4% of prevalent transplant patients returned to dialysis in 2016, a similar percentage to that seen over the last few years. Amongst patients with native chronic kidney disease, late presentation is associated with

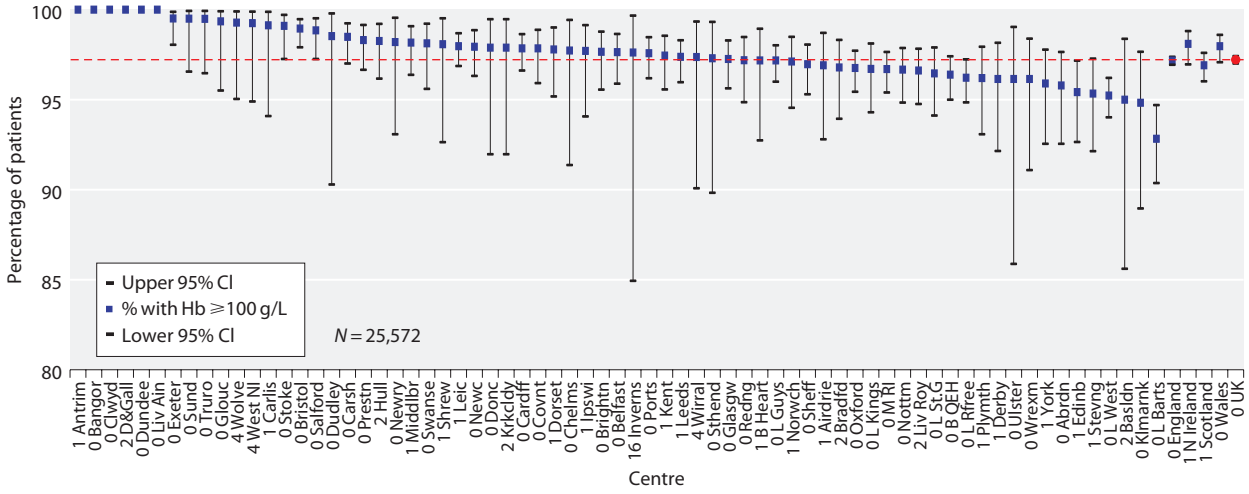

Fig. 3.8a. Percentage of prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 achieving haemoglobin ⩾100 g/L by centre on 31/12/2016

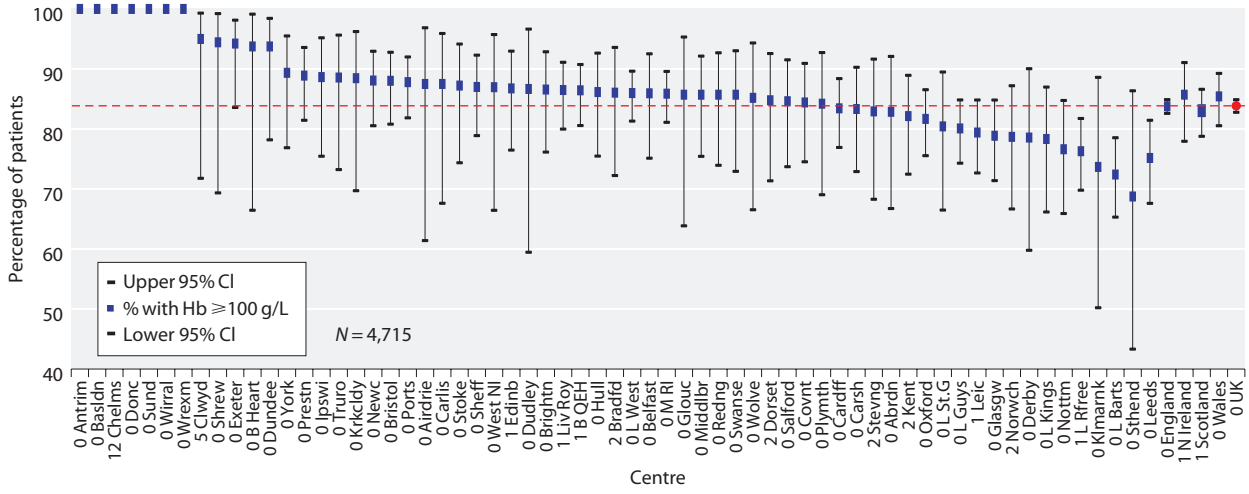

Fig. 3.8b. Percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 achieving haemoglobin ⩾100 g/L by centre on 31/12/2016

poor outcomes, largely attributable to lack of specialist management of anaemia, acidosis, hyperphosphataemia and to inadequate advance preparation for dialysis. Transplant recipients on the other hand, are almost always followed up regularly in specialist transplant or renal clinics and it would be reasonable to expect patients with failing grafts to receive appropriate care and therefore have many of their modifiable risk factors addressed before complete graft failure and return to dialysis.

Methods

The transplant cohort consisted of prevalent transplant recipients as on 31 December 2016 and patients were classified according to the KDIGO staging criteria with the suffix of 'T' to represent

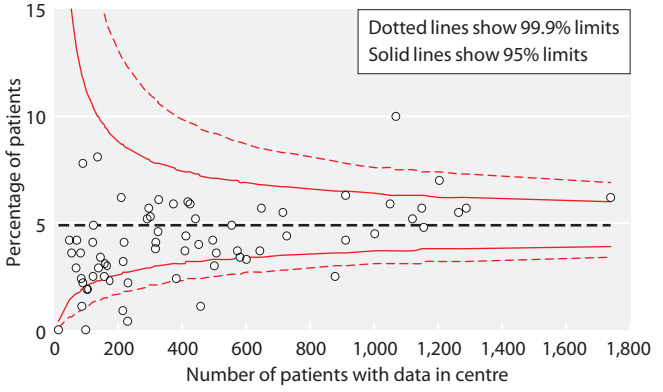

Fig. 3.9. Funnel plot of percentage of prevalent transplant patients with haemoglobin <100 g/L by centre size on 31/12/2016

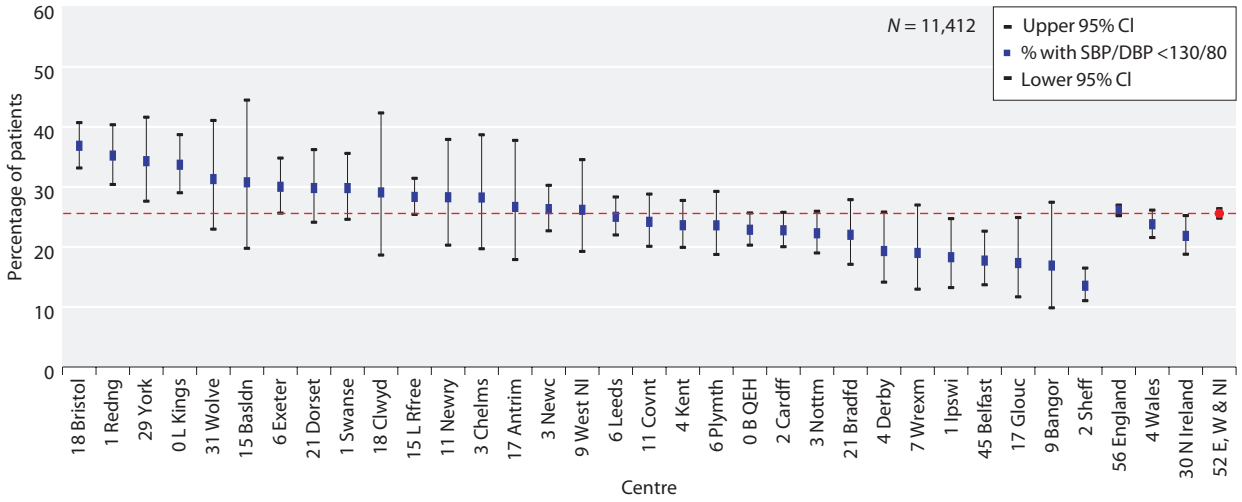

Fig. 3.10a. Percentage of prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 achieving blood pressure of <130/80 mmHg by centre on 31/12/2016

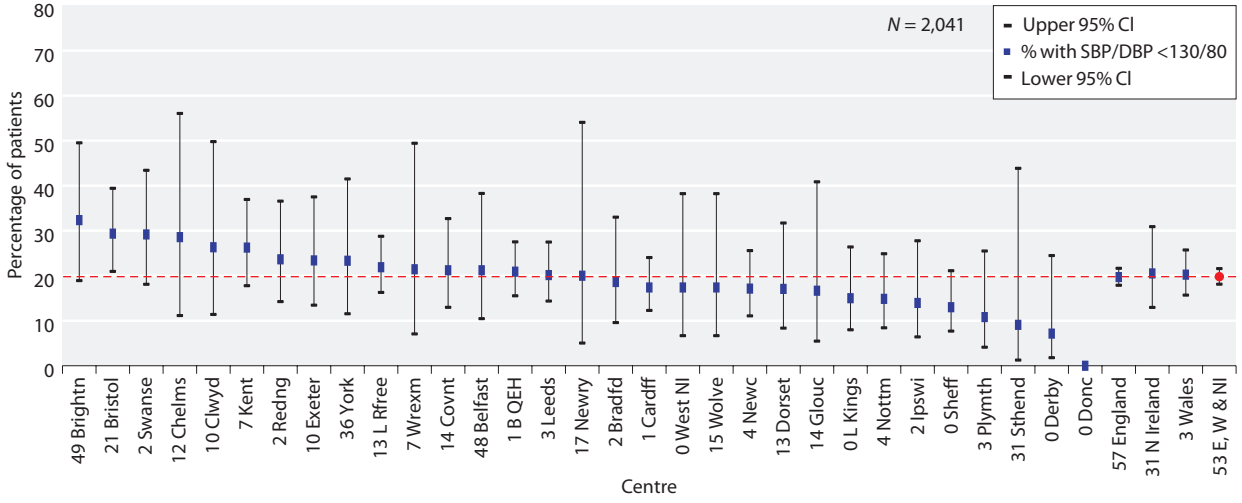

Fig. 3.10b. Percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 achieving blood pressure of <130/80 mmHg by centre on 31/12/2016

their transplant status. Patients with missing ethnicity information were classified as White for the purpose of calculating eGFR. Prevalent dialysis patients, except those who commenced dialysis in 2016, comprised the comparison dialysis cohort ($N = 21,716$) including 2,090 peritoneal dialysis patients. Only patients on peritoneal dialysis were considered when examining differences in serum phosphate between transplant recipients and dialysis patients. For both the transplant and dialysis cohorts, the analysis used the most recent available value from the last two quarters of the 2016 laboratory data. Scottish centres were excluded from blood pressure, cholesterol and PTH analyses as corresponding data were not provided.

Results and Discussion

Table 3.11 shows that 15.6% of the prevalent transplant population (4,733 patients), had moderate to advanced renal impairment of eGFR <30 ml/min/1.73 m^2. The table also demonstrates that patients with failing grafts had poorer blood pressure control and achieved UK Renal Association standards for some key biochemical and clinical outcome variables less often than dialysis patients. This substantial group of patients continues to represent a challenge. Improved pre-dialysis

Table 3.11. Analysis by CKD stage for prevalent transplant patients compared with prevalent dialysis patients on 31/12/2016

CKD stage (eGFR)	Transplant				Prevalent dialysis
	Stage 1–2T (⩾60)	Stage 3T (30–59)	Stage 4T (15–29)	Stage 5T (<15)	Stage 5D
Number of patients	10,309	15,387	4,070	663	21,716
% of patients	33.9	50.6	13.4	2.2	
eGFR ml/min/1.73 m^2[a]					
Mean ± SD	76.9 ± 13.4	45.3 ± 8.4	23.9 ± 4.1	11.9 ± 2.3	
Median	73.7	45.4	24.5	12.4	
Systolic BP mmHg					
Mean ± SD	133.8 ± 16.0	137.0 ± 17.4	140.5 ± 18.7	144.4 ± 19.2	133.4 ± 24.9
% ⩾130	59.7	66.4	72.4	79.3	53.2
Diastolic BP mmHg					
Mean ± SD	79.2 ± 10.3	78.9 ± 10.9	78.7 ± 11.4	81.1 ± 12.6	68.7 ± 14.8
% ⩾80	49.7	49.1	47.2	56.1	21.9
Cholesterol mmol/L					
Mean ± SD	4.5 ± 1.0	4.6 ± 1.1	4.7 ± 1.2	4.7 ± 1.3	3.9 ± 1.1
% ⩾4	70.0	71.3	71.0	71.4	43.8
Haemoglobin g/L					
Mean ± SD	136.8 ± 16.0	128.7 ± 16.7	116.2 ± 16.1	106.6 ± 15.4	110.4 ± 13.7
% <100.0	1.5	3.6	13.7	31.3	19.4
Phosphate mmol/L[b]					
Mean ± SD	0.9 ± 0.2	1.0 ± 0.2	1.1 ± 0.3	1.5 ± 0.3	1.6 ± 0.4
% >1.7	0.1	0.3	1.7	20.4	36.8
Corrected calcium mmol/L					
Mean ± SD	2.4 ± 0.1	2.4 ± 0.1	2.4 ± 0.1	2.4 ± 0.2	2.3 ± 0.2
% >2.5	25.9	26.0	20.1	15.2	15.6
% <2.2	3.1	3.7	7.5	17.7	17.3
PTH pmol/L					
Median	8.4	10.0	16.0	29.5	33.3
% >72	0.2	0.6	3.2	14.6	18.8

[a]Prevalent transplant patients with no ethnicity data were classed as White
[b]Only PD patients included in stage 5D, $N = 2{,}090$

management should allow for timely re-listing for transplantation if appropriate and a smooth transition to another renal replacement modality.

eGFR slope analysis

Introduction

The gradient of deterioration in eGFR (slope) may predict patients likely to have early graft failure. The eGFR slope and its relationship to specific patient characteristics are presented here.

Methods

All UK patients aged ⩾18 years receiving their first renal transplant between 1 January 2005 and 31 December 2014 were considered for inclusion. A minimum duration of 18 months graft function was required and three or more creatinine measurements from the second year of graft function onwards were used to plot eGFR slope. If a transplant failed but there were at least three creatinine measurements between one year post-transplant and graft failure, the patient was included but no creatinine

Table 3.12. Differences in median eGFR slope between subgroups of prevalent transplant patients

Patients characteristics		*N*	Median slope	Lower quartile	Upper quartile	p-value
Age at transplant	<40	4,696	–1.28	–4.51	0.84	<0.0001
	40–55	6,084	–0.52	–2.78	1.40	
	>55	6,573	–0.53	–2.97	1.30	
Ethnicity	Asian	1,896	–1.16	–4.30	0.95	<0.0001
	Black	1,146	–1.26	–4.16	1.00	
	Other	559	–0.86	–3.58	1.53	
	White	12,910	–0.60	–2.97	1.25	
Sex	Male	10,649	–0.47	–2.81	1.40	<0.0001
	Female	6,704	–1.23	–3.94	0.89	
Diabetes	No-diabetes	14,550	–0.59	–3.03	1.27	<0.0001
	Diabetes	2,612	–1.44	–4.31	0.84	
Donor	Deceased	11,088	–0.73	–3.29	1.25	0.76
	Live	6,265	–0.68	–3.15	1.18	
Year of transplant	2006	1,447	–0.69	–2.50	0.49	0.49
	2007	1,585	–0.76	–2.46	0.62	
	2008	1,812	–0.57	–2.46	0.71	
	2009	1,902	–0.80	–2.77	0.77	
	2010	1,991	–0.66	–2.82	0.94	
	2011	1,962	–0.52	–3.07	1.41	
	2012	2,171	–0.80	–3.57	1.63	
	2013	2,327	–0.91	–4.49	2.13	
	2014	2,156	–0.68	–5.96	4.22	
Status of transplant at end of follow-up	Died	1,231	–0.87	–4.09	1.64	<0.0001
	Failed	1,333	–6.37	–12.48	–3.13	
	Re-transplanted	66	–3.40	–7.33	–1.62	
	Functioning	14,789	–0.45	–2.59	1.37	
All		**17,353**	**–0.70**	**–3.24**	**1.22**	

measurements after the quarter preceding the recorded date of transplant failure were analysed.

Slopes were calculated using linear regression, assuming linearity, and the effect of age, ethnicity, sex, diabetes, donor type, year of transplant and current transplant status were analysed. *P* values were calculated using the Kruskal-Wallis test. eGFR was calculated using the CKD-EPI equation and results expressed as ml/min/1.73 m^2/year.

Results and Discussion

The study cohort consisted of 17,353 patients. The median GFR slope was −0.7 ml/min/1.73 m^2/year (table 3.12). The gradient was steeper for Black recipients (−1.26 ml/min/1.73 m^2/year), in keeping with previously published data suggesting poorer outcomes for this group [17].

There was no statistically significant difference in eGFR slope in recipients of deceased donor kidneys (−0.73 ml/min/1.73 m^2/year) compared to patients who received organs from live donors (−0.68 ml/min/1.73 m^2/year). Female patients had a steeper slope (−1.23 ml/min/1.73 m^2/year) than males (−0.47 ml/min/1.73 m^2/year), as did patients with diabetes (−1.44 ml/min/1.73 m^2/year) compared to patients without (−0.59 ml/min/1.73 m^2/year). The slope was steeper in younger recipients, possibly reflecting differences in causes of graft failure including a higher risk of non-adherence as a contributory factor. An analysis of the causes of graft failure using UKRR data is currently awaiting publication and reflects the challenges of accurately coding the causes of graft failure. As might be expected, the steepest slope was in patients where the transplant subsequently failed. This analysis has assumed linearity of progression of fall in GFR and further work is ongoing to characterise the patterns of graft failure as well as the outcomes of patients with graft failure who transition on to dialysis.

Table 3.13. Cause of death by modality in prevalent RRT patients on 1/1/2016, who died in 2016

	All modalities		Dialysis		Transplant	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	807	24	698	24	109	19
Cerebrovascular disease	159	5	129	5	30	5
Infection	696	20	570	20	126	22
Malignancy	351	10	218	8	133	23
Treatment withdrawal	565	17	544	19	21	4
Other	659	19	548	19	111	20
Uncertain	181	5	145	5	36	6
Total	**3,418**		**2,852**		**566**	
No cause of death data	1,775	34	1,464	34	311	35

Cause of death in transplant recipients

Introduction

Differences in cause of death between dialysis and transplant patients may be expected due to selection for transplantation and use of immunosuppression. Chapter 5 includes a more detailed discussion on cause of death in dialysis patients.

Methods

The cause of death is sent by renal centres as an ERA-EDTA registry code. These have been grouped into the following categories: cardiac disease, cerebrovascular disease, infection, malignancy, treatment withdrawal, other and uncertain.

Some centres had high data returns to the UKRR regarding cause of death, whilst others returned no information. Provision of this information is not mandatory. Analysis of prevalent patients included all those aged over 18 years and receiving RRT on 1 January 2016.

Results and Discussion

Table 3.13 and figure 3.11 show the differences in the cause of death between prevalent dialysis and transplant patients. Table 3.14 shows the cause of death for prevalent transplant patients by age.

Death due to cardiovascular disease was less common in transplanted patients than in dialysis patients, perhaps reflecting the lower age of the transplanted patients. Cardiovascular screening undertaken during transplant work-up means transplant recipients are a pre-selected lower risk group of patients and over time, with good renal function, transplant recipients develop less vascular calcification. The leading cause of death amongst transplant patients was malignancy (23%) overtaking infection (22%) compared to last year. There has been a reduction over time in the proportion of deaths in transplant patients attributed to cardiovascular or cerebrovascular

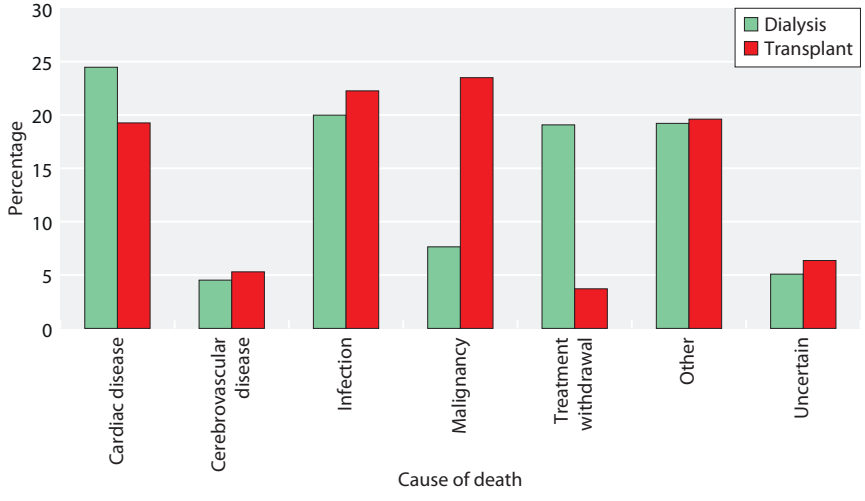

Fig. 3.11. Cause of death by modality for prevalent patients on 1/1/2016, who died in 2016

Table 3.14. Cause of death in prevalent transplant patients on 1/1/2016 by age, who died in 2016

	All age groups		<65 years		⩾65 years	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	109	19	59	23	50	16
Cerebrovascular disease	30	5	15	6	15	5
Infection	126	22	43	17	83	27
Malignancy	133	23	61	24	72	23
Treatment withdrawal	21	4	7	3	14	5
Other	111	20	54	21	57	18
Uncertain	36	6	17	7	19	6
Total	**566**		**256**		**310**	
No cause of death data	311	35	140	35	171	36

disease (43% in 2003 compared to 24% in 2016) with an increase in the proportion ascribed to infection or malignancy (30% in 2003 compared to 45% in 2016). The increased death rate secondary to malignancy and infection may reflect the increasing age of transplant recipients and the increased intensity and duration of immunosuppressive regimens, particularly the use of lymphocyte depleting induction regimes. Forthcoming data linkages with the Hospital Episode Statistics and Office of National Statistics databases will allow better understanding of the causes of death in both transplant and dialysis patients including better understanding those patients opting for treatment withdrawal.

Conflicts of interest: Dr E Sharples has received travel honoraria from Alexion pharmaceuticals.

References

1 Ansell D, Tomson CRV: UK Renal Registry 11th Annual Report (December 2008) Chapter 15 The UK Renal Registry, UKRR database, validation and methodology. Nephron Clin Pract 2009;111(suppl 1): c277-c285
2 NICE. (2014). Chronic kidney disease in adults: Assessment and management. Retrieved from www.nice.org.uk/guidance/cg182.
3 White CA, Akbari A, Doucette S, Fergusson D, Knoll GA: Estimating Glomerular Filtration Rate in Kidney Transplantation: Is the New Chronic Kidney Disease Epidemiology Collaboration Equation Any Better? Clin Chem 2010;56:3:474–477
4 Murata KI, Baumann NA, Saenger AK, Larson TS, Rule AD, Lieske JC: Relative performance of the MDRD and CKD-EPI equations for estimating glomerular filtration rate among patients with varied clinical presentations. Clin J Am Soc Nephrol. 2011 Aug;6(8):1963–72. doi: 10.2215/CJN.02300311. Epub 2011 Jul 7.
5 Masson I, Flamant M, Maillard N, Rule AD, Vrtovsnik F, Peraldi MN, et al. MDRD versus CKD-EPI equation to estimate glomerular filtration rate in kidney transplant recipients. Transplantation 2013; 95:1211–1217
6 Shaffi, K, et al. Performance of Creatinine-Based GFR Estimating Equations in Solid-Organ Transplant Recipients. American Journal of Kidney Diseases 63(6):1007–1018.
7 Baker R, Jardine A, Andrews P, Renal Association Clinical Practice Guideline on Post-operative Care of the Kidney Transplant Recipient. Nephron Clin Pract 2011;118(suppl 1):c311–c347
8 Baker RJ; Mark PB; Patel RK; Stevens KK; Palmer N: Renal association clinical practice guideline in post-operative care in the kidney transplant recipient. BMC Nephrol. 2017;18(1):174 https://renal.org/wp-content/uploads/2017/06/FINAL-Post-Operative-Care-Guideline.pdf
9 Annual Report on Kidney Transplantation – Report for 2016/2017, NHSBT https://nhsbtdbe.blob.core.windows.net/umbraco-assets-corp/4607/kidney-annual-report-2016-17.pdf
10 Taylor D, Robb M, Casula A, Caskey F. UK Renal Registry 19th Annual Report: Chapter 11 Centre Variation in Access to Kidney Transplantation (2010–2015). Nephron 2017;137(suppl 1):259–268. DOI: 10.1159/000481373
11 Oniscu GC, Ravanan R, et al. Access to Transplantation and Transplant Outcome Measures (ATTOM); study protocol of a UK wide, in-depth, prospective cohort analysis. BMJ Open 2016; 6: e010377.doi:10.1136/bmjopen-2015-010377
12 Wu DA, Robb ML, Watson CJ, Forsythe JL, Tomson CR, Cairns J, Roderick P, et al. Barriers to living donor kidney transplantation in the United Kingdom: a national observational study. Neph Dial Trans 2017;32(5):890–900
13 Bosma RJ, Doorenbos CRC, Stegeman CA, Homan van der Heide JJ, Navis G: Predictive Performance of Renal Function Equations in Renal Transplant Recipients: An analysis of Patient Factors in Bias. Am J Transplant 2005;5:2183–2203
14 White CA, Knoll GA, Poggio ED. Measuring vs. estimating glomerular filtration rate in kidney transplantation. Transplant Rev (Orlando) 2010;24(1):18–27
15 Hariharan, S, McBride MA, Cherikh WS, Tolleris CB, Bresnahan BA, Johnson CP: Post-transplant renal function in the first year predicts long-term kidney transplant survival. Kidney Int 2002;62:1:311–318
16 Mikhail A, Shrivastava R, Richardson D, Renal Association Clinical Practice Guideline on Anaemia of Chronic Kidney Disease. Nephron Clin Pract 2011;118(suppl 1):c101–c124 https://renal.org/wp-content/uploads/2017/06/anaemia-in-ckd-5th-edition-1.pdf
17 Ng FL, Holt DW, Chang RWS, MacPhee IAM: Black renal transplant recipients have poorer long-term graft survival than CYP3A5 expressers from other ethnic groups. Nephrol Dial Transplant 2010;25:628–634

Appendix 1: Reporting status of audit measures

Table 3.15. The reporting status of the recommended Renal Association audit measures for the Post-operative Care of Kidney Transplant Recipients (KTR) in the 20th Annual Report

RA audit measure	Included in UKRR annual report?	Reason for non-inclusion
1. Proportion of blood results available for review, and reviewed, within 24 hours	No	UKRR does not currently collect these data
2. Proportion of renal centres with a written follow-up schedule available to all staff and patients	No	UKRR does not currently collect these data
3. Percentage of patients accessing their results through PatientView	No	Requires linkage with PatientView
4. Percentage of total patients assessed in an annual review clinic	No	UKRR does not currently collect these data
5. Percentage of total patients receiving induction with ILRAs and TDAs	No	Poor data completeness
6. Percentage of de novo KTRs receiving tacrolimus	No	Poor data completeness
7. Percentage of de novo KTRs receiving MPA based immunosuppression	No	Poor data completeness
8. Percentage of de novo KTRs receiving corticosteroid maintenance therapy	No	Poor data completeness
9. Use of generic agents	No	UKRR does not currently collect these data
10. Severity of biopsy proven acute rejection (BPAR) recorded by Banff criteria.	No	UKRR does not currently collect these data
11. Percentage of KTRs with BPAR in first 3 months and first 12 months.	No	UKRR does not currently collect these data
12. Percentage of KTRs requiring TDAs to treat rejection in first year	No	UKRR does not currently collect these data
13. Complication rates after renal transplant biopsy	No	UKRR does not currently collect these data
14. Proportion of patients receiving a target blood pressure of 130/80 mmHg or 125/75 mmHg in the presence of proteinuria (PCR >100 or ACR >70)	No	Poor data completeness on proteinuria
15. Proportion of patients receiving an ACE inhibitor or angiotensin receptor blocker	No	Poor data completeness
16. Proportion of patients with proteinuria assessed by dipstick and, if present, quantified at each clinic visit	No	UKRR does not currently collect these data
17. Proportion of renal transplant recipients with an annual fasting lipid profile	No	UKRR does not currently collect these data
18. Proportion of KTR taking statins (including the type of statin) for primary and secondary prevention of premature cardiovascular disease	No	UKRR does not currently collect these data
19. Proportion of patients on other lipid lowering agents	No	Poor data completeness
20. Proportion of patients achieving dyslipidaemia targets	No	Poor data completeness
21. Incidence of new onset diabetes after transplantation (NODAT) at three months and at annual intervals thereafter	No	UKRR does not currently collect these data
22. Proportion of patients who require insulin, and in whom remedial action is undertaken – minimisation of steroids and switching of CNIs	No	UKRR does not currently collect these data
23. Proportion of patients with ischaemic heart disease	No	Poor data completeness
24. Proportion of patients suffering myocardial infarction	No	Poor data completeness
25. Proportion of patients undergoing primary revascularisation	No	Poor data completeness

Table 3.15. Continued

RA audit measure	Included in UKRR annual report?	Reason for non-inclusion
26. Proportion of patients receiving secondary prevention with a statin, anti-platelet agents and RAS blockers	No	UKRR does not currently collect these data
27. Proportion of patients who are obese	No	Poor data completeness
28. Proportion of patients having screening procedures for neoplasia at the annual review clinic	No	UKRR does not currently collect these data
29. Incidence of CMV disease	No	Poor data completeness
30. Rate of EBV infection and PTLD	No	UKRR does not currently collect these data
31. Completeness of records for EBV donor and recipient serology	No	UKRR does not currently collect these data
32. Rates of primary VZV and shingles infection	No	UKRR does not currently collect these data
33. Completeness of records for VZV recipient serology	No	UKRR does not currently collect these data
34. Rates and outcomes of HSV infection	No	UKRR does not currently collect these data
35. Rates of BK viral infection in screening tests	No	UKRR does not currently collect these data
36. Rates and outcomes of BK nephropathy	No	UKRR does not currently collect these data
37. Frequency of bisphosphonate use	No	UKRR does not currently collect these data
38. Incidence of fractures	No	UKRR does not currently collect these data
39. Incidence of hyperparathyroidism	Partly	Reported but not at centre level, due to poor data completeness
40. Incidence of parathyroidectomy	No	UKRR does not currently collect these data
41. Use of cinacalcet	No	Poor data completeness
42. Frequency of hyperuricaemia and gout	No	UKRR does not currently collect these data
43. Prevalence of anaemia	Yes	
44. Prevalence of polycythaemia	No	Poor data completeness
45. Pregnancy rates and outcomes	No	UKRR does not currently collect these data
46. Prevalence of sexual dysfunction	No	UKRR does not currently collect these data

ACE – angiotensin converting enzyme (inhibitor); ACR – albumin:creatinine ratio; BKN – BK virus nephropathy; CMV – cytomegalovirus; CNI – calcineurin inhibitor; EBV – Epstein Barr Virus; HSV – herpes simplex virus; IL2-RA – interleukin-2 receptor antagonists; MPA – mycophenolic acid; NODAT – new onset of diabetes after transplantation; PCR – protein:creatinine ratio; PTLD – post transplant lymphoproliferative disorder; RAS – renin angiotensin system; TDA – T-cell (lymphocyte) depleting antibodies; VZV – varicella zoster virus