# Chapter 13
# Centre Variation in Access to Renal Transplantation in the UK (2004–2006)

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**Key Words**
Centre variation · Comorbidity · Donor after brain stem death · Donor after cardiac death · Equity of access · Living kidney donor · Outcomes · Patient factors · Quality improvement · Renal transplantation · Transplant waiting-list

**Summary**

- A patient starting dialysis in a non-transplanting renal centre was less likely to be registered for transplantation [OR (odds ratio) 0.90, 95% CI 0.82–0.99] compared with a patient treated in a transplanting renal centre.
- A patient starting dialysis in a non-transplanting renal centre was less likely to receive a transplant from a donor after cardiac death or a living kidney donor (OR 0.69, 95% CI 0.60–0.79) compared with a patient treated in a transplanting renal centre.
- Once registered for kidney transplantation, patients in both transplanting and non-transplanting renal centres had an equal chance of receiving a transplant from a donor after brain stem death (OR 0.92, 95% CI 0.78–1.08).
- After adjustment for case mix, this analysis identified significant centre differences for the probability of being activated on the kidney transplant waiting-list ($p < 0.0001$) and the probabilities of receiving a renal transplant from a donor after brain stem death ($p = 0.0002$) or a donor after cardiac death/living kidney donor ($p < 0.0001$).

## Introduction

For suitable patients with established renal failure (ERF), renal transplantation is accepted as the optimal modality of renal replacement therapy. However, deciding which patients are 'suitable' for renal transplantation requires an individualised assessment of the risks of transplantation as well as the likely benefit. The probability of receiving a transplant from a donor after brain stem death, once a patient is on the waiting-list, is predominantly under the influence of national organ allocation algorithms. Conversely, the probability of receiving a transplant from a living kidney donor is predominantly influenced by individual centres' policies and patterns of practice (transplant and non-transplanting centres are listed in chapter 3). The latter is also true for the probability of receiving a kidney from a donor after cardiac death, as during the time of this study the retrieving centre had the major influence on the distribution of such organs.

Many patient specific factors including age, gender, ethnicity and comorbidity have been reported to influence access to kidney transplantation. Time on dialysis is recognised as an important prognostic factor which adversely influences graft and patient survival following transplantation; patients who have been longer on dialysis have poorer outcomes. The time taken to register a suitable patient on the transplant waiting-list is mainly influenced by a centre's practice patterns; that is, the efficiency of the pathway from diagnosis of ERF to activation of the patient on the transplant list. Furthermore, the current organ allocation algorithm considers time spent on the national transplant waiting-list as an important factor when prioritising the allocation of deceased donor kidneys in the UK. Therefore, patients who are activated on the list at an early stage accrue more waiting time credit than do patients listed later in their dialysis treatment. Consequently, centres that achieve earlier listing for transplantation provide an advantage for their patients compared with centres that take longer.

This analysis aims to evaluate whether equity of access to the renal transplant list exists for patients with ERF across the UK, whether centres differ in the time taken to activate suitable patients on the waiting-list and whether equity exists in the receipt of a renal transplant once the patient is on the transplant list (that is, the conversion efficiency from being on the waiting-list to receiving a transplant). Patient specific and independent variables that influenced access to the waiting-list or transplantation were analysed.

## Methods

*Study population*

All patients starting renal replacement therapy (n = 17,597) between 1st January 2004 and 31st December 2006 in renal centres returning data to the UK Renal Registry (n = 65) were considered for inclusion. For the analysis of the proportion of a centre's patients included on the waiting-list, patients aged 65 years or above (n = 8,944), patients with inappropriate activation and early suspension as described below (n = 125) and patients listed for multi-organ transplants other than pancreas (n = 26) were excluded, resulting in a final cohort of 8,502 patients. These patients were followed to 31st December 2008 or until they were put on the waiting-list for kidney transplant alone, kidney plus pancreas transplant, or death, whichever was earliest. For the analysis of the proportion transplanted, all patients from the incident cohort who were activated on the waiting-list before 31st December 2007 (n = 4,446) were followed until 31st December 2009, to estimate the proportion transplanted with a kidney alone or kidney plus pancreas within two years of inclusion on the waiting-list.

*Centre exclusions*

Only centres contributing data to the UKRR were considered for inclusion (65 centres) because there was no reliable mechanism for identifying or recording the patient level data needed for patients starting renal replacement therapy in centres (Colchester, Derry, Doncaster, Kent, London St George's, Manchester Royal Infirmary, Stoke) who at that time were not linked to the registry.

Patients who were suspended for more than 30 days within 90 days of first activation were excluded. This avoided any potential bias from centres that may activate patients on the transplant list and then immediately suspend them before more permanent activation at a later date after more formal medical assessment of the patient's fitness.

*Data analysed*

Information on start date of renal replacement therapy and relevant patient level data including age (grouped as 18–29, 30–39, 40–49, 50–59 and 60–64), gender, ethnicity (white, non-White and missing) and PRD (primary renal diagnosis, classified as patient with diabetes, patient without diabetes and missing) came from the UKRR. The date of activation on the kidney transplant waiting-list, date of transplantation, or both came from the UK Transplant Registry held by the Organ Donation and Transplantation Directorate of NHS Blood and Transplant.

*Statistical methods*

A logistic regression model was developed to identify the influence of patient specific variables including age, gender, ethnicity and primary renal diagnosis, on the probability of access to the transplant list and receipt of a transplant once on the waiting-list. After adjusting for patient specific variables, the percentage of patients activated on the transplant list and the percentage of patients on the waiting-list who achieved a transplant in each centre were determined. The overall affect of the centre associated with each analysis was assessed by including renal centre as a random effect in the risk-adjusted logistic regression model. The extent of variation between centres was determined by

using a log likelihood ratio test that provided the change in the value of −2Log L on inclusion of the random centre effect. SASv9.1 was used for analyses; a p value of less than 5% was considered significant.

To analyse access to the transplant list, the proportion of incident patients with ERF in each centre who were subsequently activated on the waiting-list within two years of starting renal replacement therapy was identified. All patients who achieved live donor transplantation without prior activation on the national transplant waiting-list were assumed to been activated for the purposes of this analysis. Time to activation on the waiting-list was defined as the interval between the start of RRT and the date of activation on the waiting-list. Patients achieving pre-emptive deceased donor transplantation were considered to have been activated on the same day as starting RRT i.e. a time to activation of 0 days. Patients achieving pre-emptive live donor transplantation without prior activation on the national transplant list were considered to have been 'active' on the list for an arbitrary time of 6 months. This was to take into account an average of 6 months required by most centres to complete live donor fitness evaluation and hence the likelihood that the intended recipient was considered fit for transplantation (and by inference suitable to be active on the waiting-list) for that duration. This was done to account for different centre practices with regard to listing patients on the deceased donor list prior to receiving a living donor transplant.

The median time to activation was estimated from the Kaplan-Meier plot for patients at each renal centre, with the event as the date of activation and censoring at death or on 31st December 2008, whichever was earlier. Data from patients who did not achieve activation were included in the calculation of median times using this method, thus providing a meaningful estimate of the true time to activation. Including only those patients activated would produce a biased estimate. The overall centre effect associated with time to activation was calculated by including renal centre as a variable in a risk-adjusted Cox regression model.

To analyse the differences between centres in achieving a renal transplant, the percentage of patients activated on the waiting-list who received a renal transplant within two years of being activated was estimated (conversion efficiency). The conversion efficiency for receiving a transplant from a donor after brain stem death or a donor after cardiac death/living kidney donor were analysed separately. Receipt of a kidney from a donor after brain stem death is predominantly influenced by national allocation policy, whereas receipt from a donor after cardiac death/live donor kidney is much more dependent on local transplant centre practices. For the cohort under consideration, donor after cardiac death transplantation was predominantly a locally managed service.

Funnel plots are used to present the results for each outcome of interest, providing a visual comparison of each centre's performance compared with its peers. Where relevant, the funnel plots are adjusted for patient specific variables influencing that outcome. The solid black straight line in each funnel plot shows the overall average together with the 95% and 99.8% confidence intervals, which correspond to two and three standard deviations from the mean. Each point on the plot represents one renal centre. With 65 centres included, for each outcome of interest, two or three centres would be predicted to fall between the 95% and 99.8% confidence intervals (one above and one below) and no centre should fall outside the 99.8% confidence interval. Centres with fewer than 10 patients starting dialysis (n = 1) or fewer than 10 patients activated on the waiting-list (n = 4) are not included in the funnel plots.

The analysis methodology described above is identical to a recent independent peer reviewed publication [1].

## Results

The results of the logistic regression model analysis of patient characteristics influencing access to the waiting-list are presented in table 13.1. Ethnicity data were missing for 20.7% of patients and PRD for 4.1% of patients.

Tables 13.2 and 13.3 show the results of the logistic regression analysis of factors influencing the likelihood

**Table 13.1.** Factors influencing activation on the national kidney transplant waiting-list within two years of RRT start

| Factor | Category (at baseline) | Patients N | Odds ratio | 95% CI | P value |
|---|---|---|---|---|---|
| Age | (18–29) | 779 | 1.00 | ref | n/a |
| | 30–39 | 1,283 | 0.66 | 0.54–0.82 | 0.0002 |
| | 40–49 | 2,035 | 0.45 | 0.37–0.54 | <0.0001 |
| | 50–59 | 2,647 | 0.23 | 0.19–0.28 | <0.0001 |
| | 60–64 | 1,758 | 0.12 | 0.10–0.15 | <0.0001 |
| Ethnicity | (White) | 5,242 | 1.00 | ref | n/a |
| | Non-White | 1,497 | 0.90 | 0.80–1.03 | 0.12 |
| | Missing | 1,763 | 0.68 | 0.61–0.76 | <0.0001 |
| Gender | (Male) | 5,159 | 1.00 | ref | n/a |
| | Female | 3,343 | 1.00 | 0.91–1.10 | 0.97 |
| PRD | (Non-diabetic) | 6,168 | 1.00 | ref | n/a |
| | Diabetic | 1,989 | 0.43 | 0.38–0.48 | <0.0001 |
| | Missing | 345 | 0.43 | 0.34–0.54 | <0.0001 |

ref = reference category, n/a = not applicable

**Table 13.2.** Factors affecting the probability of receiving a transplant from a donor after brain stem death within two years of registration on the national kidney transplant waiting-list

| Factor | Category (at baseline) | Patients N | Odds ratio | 95% CI | P value |
|---|---|---|---|---|---|
| Age | (18–29) | 626 | 1.00 | ref | n/a |
| | 30–39 | 898 | 1.24 | 0.96–1.58 | 0.1 |
| | 40–49 | 1,229 | 0.88 | 0.69–1.12 | 0.3 |
| | 50–59 | 1,174 | 0.50 | 0.38–0.64 | <0.0001 |
| | 60–64 | 519 | 0.27 | 0.19–0.39 | <0.0001 |
| Ethnicity | (White) | 2,859 | 1.00 | ref | n/a |
| | Non-White | 818 | 0.45 | 0.36–0.57 | <0.0001 |
| | Missing | 769 | 0.84 | 0.69–1.04 | 0.11 |
| Gender | (Male) | 2,683 | 1.00 | ref | n/a |
| | Female | 1,763 | 0.82 | 0.70–0.96 | 0.01 |
| PRD | (Non-diabetic) | 3,593 | 1.00 | ref | n/a |
| | Diabetic | 730 | 3.36 | 2.80–4.03 | <0.0001 |
| | Missing | 123 | 0.95 | 0.57–1.59 | 0.85 |

ref = reference category, n/a = not applicable

of receiving a transplant from a donor after brain stem death and the analysis of factors influencing receipt of a transplant from a donor after cardiac death or a living kidney donor. Ethnicity data were missing for 17.3% of patients and PRD for 2.8% of patients.

A patient starting dialysis in a non-transplanting renal centre was less likely to be registered for transplantation [OR (odds ratio) 0.90, 95% CI 0.82–0.99] or receive a transplant from a donor after cardiac death or a living kidney donor (OR 0.69, 95% CI 0.60–0.79) compared with patients managed in transplanting renal centres. Once registered for kidney transplantation, patients in both transplanting and non-transplanting renal centres had an equal chance of receiving a transplant from a donor after brain stem death (OR 0.92, 95% CI 0.78 to 1.08).

After adjusting for patient specific variables that were shown to influence outcome (age, ethnicity, gender and PRD), significant centre effects were identified for the probability of being activated on the waiting-list (figure 13.1 and table 13.4) [change in $-2\text{Log L} = 157.2$, df (degrees of freedom) $= 1$, $p < 0.0001$].

After adjustment for patient variables, significant centre differences were seen in the probability of receiving a renal transplant from a donor after brain stem death (figure 13.2 and table 13.5) (change in $-2\text{Log L} = 14.1$, $df = 1$, $p = 0.0002$) or a donor after cardiac death/living kidney donor (figure 13.3 and table

**Table 13.3.** Factors affecting the probability of receiving a transplant from a donor after cardiac death or living kidney donor within two years of registration on the national kidney transplant waiting-list

| Factor | Category (at baseline) | Patients N | Odds ratio | 95% CI | P value |
|---|---|---|---|---|---|
| Age | (18–29) | 626 | 1.00 | ref | n/a |
| | 30–39 | 898 | 0.57 | 0.46–0.71 | <0.0001 |
| | 40–49 | 1,229 | 0.53 | 0.43–0.65 | <0.0001 |
| | 50–59 | 1,174 | 0.35 | 0.28–0.43 | <0.0001 |
| | 60–64 | 519 | 0.36 | 0.27–0.47 | <0.0001 |
| Ethnicity | (White) | 2,859 | 1.00 | ref | n/a |
| | Non-White | 818 | 0.55 | 0.45–0.67 | <0.0001 |
| | Missing | 769 | 0.81 | 0.67–0.97 | 0.02 |
| Gender | (Male) | 2,683 | 1.00 | ref | n/a |
| | Female | 1,763 | 0.90 | 0.79–1.04 | 0.15 |
| PRD | (Non-diabetic) | 3,593 | 1.00 | ref | n/a |
| | Diabetic | 730 | 0.36 | 0.29–0.46 | <0.0001 |
| | Missing | 123 | 0.76 | 0.50–1.16 | 0.2 |

ref = reference category, n/a = not applicable

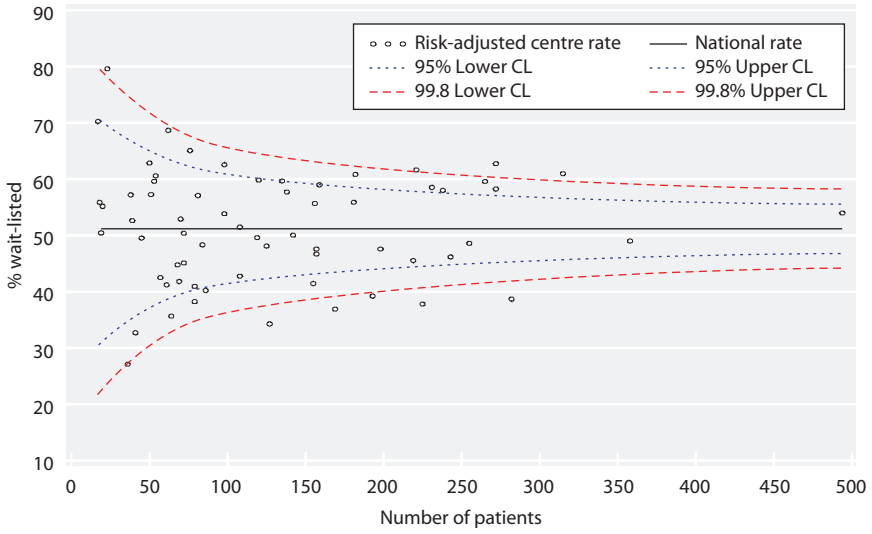



**Fig. 13.1.** The percentage of patients wait-listed for a kidney transplant by renal centre, prior to or within two years of starting dialysis (centres with <10 patients excluded)

**Table 13.4.** The percentage of patients wait-listed for a kidney transplant by renal centre, prior to or within two years of starting dialysis

| Centre | RRT N | Registrations N | % wait-listed Unadjusted | % wait-listed Risk-adjusted | Centre | RRT N | Registrations N | % wait-listed Unadjusted | % wait-listed Risk-adjusted |
|---|---|---|---|---|---|---|---|---|---|
| Abrdn | 81 | 42 | 51.9 | 57.1 | L Guys | 219 | 105 | 47.9 | 45.5 |
| Airdrie | 86 | 36 | 41.9 | 40.2 | L Kings | 198 | 103 | 52.0 | 47.6 |
| Antrim | 23 | 17 | 73.9 | 79.6 | L Rfree | 182 | 107 | 58.8 | 60.8 |
| B Heart | 142 | 66 | 46.5 | 50.1 | L West | 494 | 262 | 53.0 | 54.0 |
| B QEH | 282 | 115 | 40.8 | 38.7 | Leeds | 238 | 133 | 55.9 | 58.0 |
| Bangor | 41 | 14 | 34.1 | 32.7 | Leic | 315 | 197 | 62.5 | 61.0 |
| Basldn | 57 | 24 | 42.1 | 42.5 | Liv Ain | 36 | 10 | 27.8 | 27.1 |
| Belfast | 119 | 62 | 52.1 | 49.6 | Liv RI | 225 | 91 | 40.4 | 37.8 |
| Bradfd | 84 | 41 | 48.8 | 48.3 | M Hope | 181 | 113 | 62.4 | 55.9 |
| Brightn | 135 | 76 | 56.3 | 59.7 | Middlbr | 138 | 84 | 60.9 | 57.7 |
| Bristol | 231 | 136 | 58.9 | 58.5 | Newc | 157 | 82 | 52.2 | 47.6 |
| Camb | 193 | 82 | 42.5 | 39.2 | Newry | 17 | 12 | 70.6 | 70.3 |
| Cardff | 265 | 151 | 57.0 | 59.6 | Norwch | 108 | 44 | 40.7 | 42.8 |
| Carlis | 38 | 23 | 60.5 | 57.2 | Nottm | 169 | 63 | 37.3 | 36.9 |
| Carsh | 255 | 122 | 47.8 | 48.6 | Oxford | 272 | 169 | 62.1 | 62.7 |
| Chelms | 45 | 19 | 42.2 | 49.6 | Plymth | 76 | 47 | 61.8 | 65.1 |
| Clwyd | 18 | 9 | 50.0 | 55.9 | Ports | 221 | 141 | 63.8 | 61.6 |
| Covnt | 125 | 67 | 53.6 | 48.1 | Prestn | 157 | 76 | 48.4 | 46.7 |
| D & Gall | 20 | 8 | 40.0 | 55.2 | Redng | 98 | 66 | 67.3 | 62.6 |
| Derby | 98 | 48 | 49.0 | 53.9 | Sheff | 243 | 114 | 46.9 | 46.2 |
| Dorset | 70 | 36 | 51.4 | 52.9 | Shrew | 72 | 36 | 50.0 | 45.1 |
| Dudley | 64 | 23 | 35.9 | 35.7 | Stevng | 155 | 67 | 43.2 | 41.5 |
| Dundee | 68 | 29 | 42.6 | 44.8 | Sthend | 50 | 28 | 56.0 | 62.8 |
| Dunfn | 51 | 27 | 52.9 | 57.3 | Sund | 79 | 32 | 40.5 | 41.0 |
| Edinb | 159 | 88 | 55.3 | 59.0 | Swanse | 108 | 52 | 48.1 | 51.5 |
| Exeter | 120 | 66 | 55.0 | 59.8 | Truro | 62 | 38 | 61.3 | 68.7 |
| Glasgw | 272 | 139 | 51.1 | 58.2 | Tyrone | 19 | 10 | 52.6 | 50.5 |
| Glouc | 72 | 35 | 48.6 | 50.4 | Ulster | 3 | 2 | 66.7 | 68.2 |
| Hull | 156 | 77 | 49.4 | 55.7 | Wirral | 79 | 31 | 39.2 | 38.3 |
| Inverns | 53 | 31 | 58.5 | 59.6 | Wolve | 127 | 44 | 34.6 | 34.3 |
| Ipswi | 69 | 29 | 42.0 | 41.8 | Wrexm | 39 | 19 | 48.7 | 52.6 |
| Klmarnk | 61 | 21 | 34.4 | 41.2 | York | 54 | 34 | 63.0 | 60.6 |
| L Barts | 358 | 180 | 50.3 | 49.0 | | | | | |

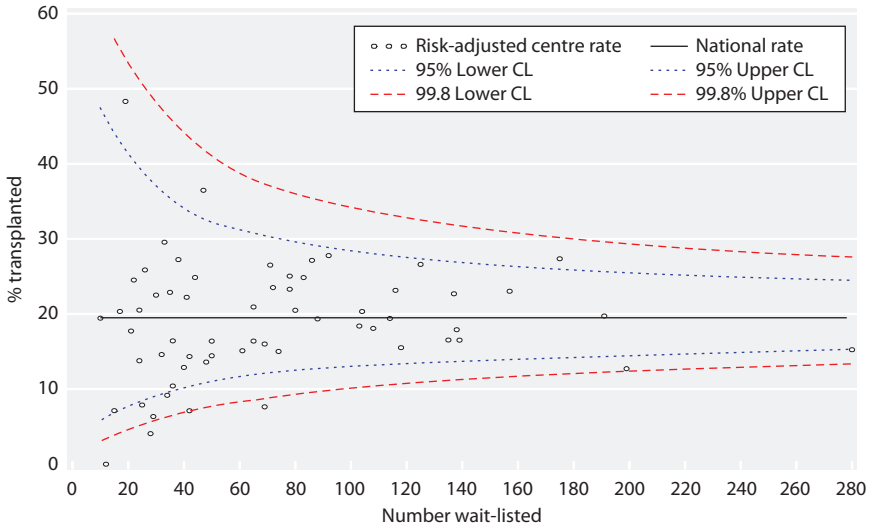



**Fig. 13.2.** The percentage of patients receiving a transplant from a donor after brain stem death by renal centre, within two years of transplant waiting-list registration (centres with <10 patients excluded)

**Table 13.5.** The percentage of patients receiving a transplant, by donor type and renal centre, within two years of transplant waiting-list registration

| | | Organ from donor after brain stem death | | | Organ from living kidney donor/donor after cardiac death | | |
|---|---|---|---|---|---|---|---|
| | | | Transplant rate (%) | | | Transplant rate (%) | |
| Centre | Listed N | Transplanted N | Unadjusted | Risk-adjusted | Transplanted N | Unadjusted | Risk-adjusted |
| Abrdn | 42 | 6 | 14.3 | 14.3 | 8 | 19.0 | 18.6 |
| Airdrie | 40 | 7 | 17.5 | 12.9 | 6 | 15.0 | 13.3 |
| Antrim | 15 | 1 | 6.7 | 7.1 | 1 | 6.7 | 6.1 |
| B Heart | 69 | 5 | 7.2 | 7.6 | 17 | 24.6 | 26.0 |
| B QEH | 116 | 24 | 20.7 | 23.2 | 35 | 30.2 | 28.8 |
| Bangor | 17 | 4 | 23.5 | 20.3 | 1 | 5.9 | 4.7 |
| Basldn | 25 | 2 | 8.0 | 7.9 | 10 | 40.0 | 36.1 |
| Belfast | 61 | 10 | 16.4 | 15.1 | 5 | 8.2 | 7.1 |
| Bradfd | 41 | 8 | 19.5 | 22.2 | 8 | 19.5 | 20.0 |
| Brightn | 78 | 18 | 23.1 | 23.3 | 20 | 25.6 | 24.2 |
| Bristol | 138 | 24 | 17.4 | 17.9 | 44 | 31.9 | 32.9 |
| Camb | 83 | 23 | 27.7 | 24.9 | 24 | 28.9 | 27.6 |
| Cardff | 157 | 38 | 24.2 | 23.0 | 47 | 29.9 | 30.3 |
| Carlis | 24 | 6 | 25.0 | 20.5 | 8 | 33.3 | 33.8 |
| Carsh | 125 | 32 | 25.6 | 26.6 | 36 | 28.8 | 29.6 |
| Chelms | 21 | 4 | 19.0 | 17.7 | 4 | 19.0 | 17.8 |
| Clwyd | 9 | 4 | 44.4 | 33.8 | 1 | 11.1 | 9.9 |
| Covnt | 69 | 11 | 15.9 | 16.0 | 29 | 42.0 | 39.2 |
| D & Gall | 7 | 1 | 14.3 | 18.7 | 2 | 28.6 | 27.9 |
| Derby | 48 | 7 | 14.6 | 13.6 | 5 | 10.4 | 11.7 |
| Dorset | 38 | 10 | 26.3 | 27.3 | 7 | 18.4 | 17.1 |
| Dudley | 24 | 4 | 16.7 | 13.8 | 8 | 33.3 | 30.0 |
| Dundee | 29 | 2 | 6.9 | 6.3 | 6 | 20.7 | 21.4 |
| Dunfn | 28 | 1 | 3.6 | 4.1 | 3 | 10.7 | 10.8 |
| Edinb | 88 | 16 | 18.2 | 19.3 | 21 | 23.9 | 23.9 |
| Exeter | 71 | 19 | 26.8 | 26.5 | 27 | 38.0 | 34.9 |
| Glasgw | 139 | 24 | 17.3 | 16.5 | 35 | 25.2 | 26.7 |
| Glouc | 36 | 7 | 19.4 | 16.4 | 12 | 33.3 | 34.9 |
| Hull | 78 | 21 | 26.9 | 25.1 | 18 | 23.1 | 23.6 |
| Inverns | 34 | 4 | 11.8 | 9.2 | 5 | 14.7 | 15.7 |

**Table 13.5.** Continued

| | | Organ from donor after brain stem death | | | Organ from living kidney donor/donor after cardiac death | | |
|---|---|---|---|---|---|---|---|
| | | | Transplant rate (%) | | | Transplant rate (%) | |
| Centre | Listed N | Transplanted N | Unadjusted | Risk-adjusted | Transplanted N | Unadjusted | Risk-adjusted |
| Ipswi | 32 | 5 | 15.6 | 14.6 | 13 | 40.6 | 39.7 |
| Klmarnk | 22 | 6 | 27.3 | 24.5 | 1 | 4.5 | 5.1 |
| L Barts | 191 | 32 | 16.8 | 19.7 | 46 | 24.1 | 26.8 |
| L Guys | 104 | 21 | 20.2 | 20.3 | 39 | 37.5 | 38.9 |
| L Kings | 103 | 16 | 15.5 | 18.4 | 30 | 29.1 | 31.0 |
| L Rfree | 108 | 15 | 13.9 | 18.1 | 25 | 23.1 | 27.7 |
| L West | 280 | 37 | 13.2 | 15.2 | 100 | 35.7 | 43.2 |
| Leeds | 135 | 20 | 14.8 | 16.5 | 50 | 37.0 | 35.8 |
| Leic | 199 | 24 | 12.1 | 12.7 | 62 | 31.2 | 32.2 |
| Liv Ain | 10 | 2 | 20.0 | 19.4 | 0 | 0.0 | 0.0 |
| Liv RI | 92 | 28 | 30.4 | 27.8 | 29 | 31.5 | 27.2 |
| M Hope | 114 | 19 | 16.7 | 19.4 | 17 | 14.9 | 13.9 |
| Middlbr | 80 | 18 | 22.5 | 20.5 | 23 | 28.8 | 27.0 |
| Newc | 86 | 26 | 30.2 | 27.2 | 35 | 40.7 | 36.9 |
| Newry | 12 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 |
| Norwch | 44 | 11 | 25.0 | 24.9 | 8 | 18.2 | 17.0 |
| Nottm | 65 | 12 | 18.5 | 16.4 | 14 | 21.5 | 19.9 |
| Oxford | 175 | 55 | 31.4 | 27.4 | 54 | 30.9 | 31.8 |
| Plymth | 47 | 17 | 36.2 | 36.5 | 20 | 42.6 | 40.8 |
| Ports | 137 | 34 | 24.8 | 22.7 | 34 | 24.8 | 23.6 |
| Prestn | 72 | 17 | 23.6 | 23.5 | 16 | 22.2 | 21.5 |
| Redng | 65 | 14 | 21.5 | 20.9 | 14 | 21.5 | 22.0 |
| Sheff | 118 | 19 | 16.1 | 15.5 | 29 | 24.6 | 23.4 |
| Shrew | 36 | 4 | 11.1 | 10.4 | 11 | 30.6 | 25.4 |
| Stevng | 74 | 12 | 16.2 | 15.0 | 27 | 36.5 | 36.7 |
| Sthend | 26 | 6 | 23.1 | 25.9 | 5 | 19.2 | 20.1 |
| Sund | 35 | 8 | 22.9 | 22.9 | 12 | 34.3 | 32.0 |
| Swanse | 50 | 8 | 16.0 | 16.4 | 13 | 26.0 | 26.4 |
| Truro | 42 | 3 | 7.1 | 7.1 | 20 | 47.6 | 49.5 |
| Tyrone | 8 | 0 | 0.0 | 0.0 | 1 | 12.5 | 12.4 |
| Ulster | 2 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 |
| Wirral | 30 | 7 | 23.3 | 22.5 | 7 | 23.3 | 20.2 |
| Wolve | 50 | 8 | 16.0 | 14.4 | 10 | 20.0 | 19.5 |
| Wrexm | 19 | 9 | 47.4 | 48.3 | 1 | 5.3 | 5.4 |
| York | 33 | 11 | 33.3 | 29.6 | 7 | 21.2 | 18.5 |

13.5) (change in $-2\text{Log L} = 60.9$, $df = 1$, $p < 0.0001$). As shown, several centres fall outside the 95% and 99.8% confidence intervals.

Figure 13.4 and table 13.6 show the unadjusted median time taken to activate patients on the transplant list for each renal centre.

The funnel plot is based on the assumption of an exponential distribution for time to activation. Although this assumption is broadly consistent with the data, the model based estimate of the national median was greater than that observed. This leads to an unusually large number of centres falling outside the lower 99.8% confidence limit for this national rate and perhaps too few occurring outside the upper limit. However, the plot highlights those centres that have significantly longer time to activation but small numbers of patients on the waiting-list. The Cox model giving a risk-adjusted analysis of time to activation identified a significant effect of centre (change in $-2\text{Log L} = 323.5$, $df = 64$, $p < 0.0001$). In general, centres with the longest unadjusted waiting times also had the longest risk-adjusted waiting times. The four centres lying outside the upper 99.8% confidence limit all had hazard ratios that indicated a significant delay in the chance of

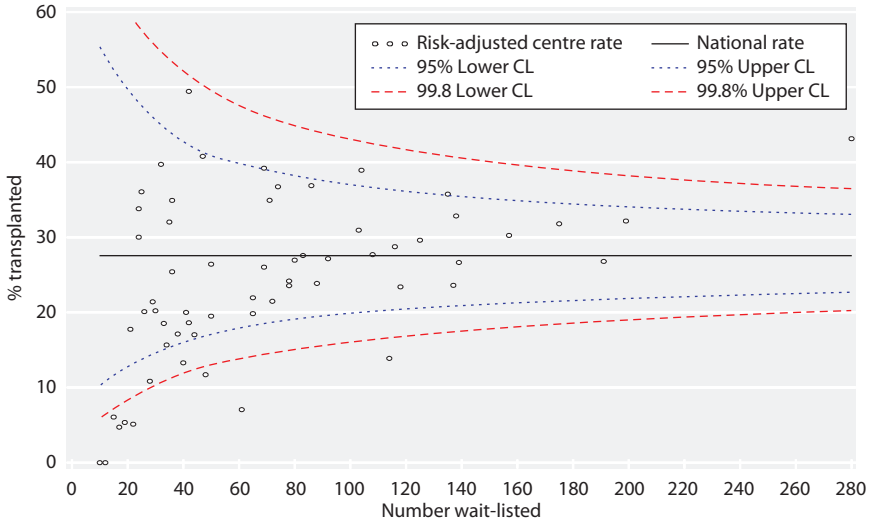


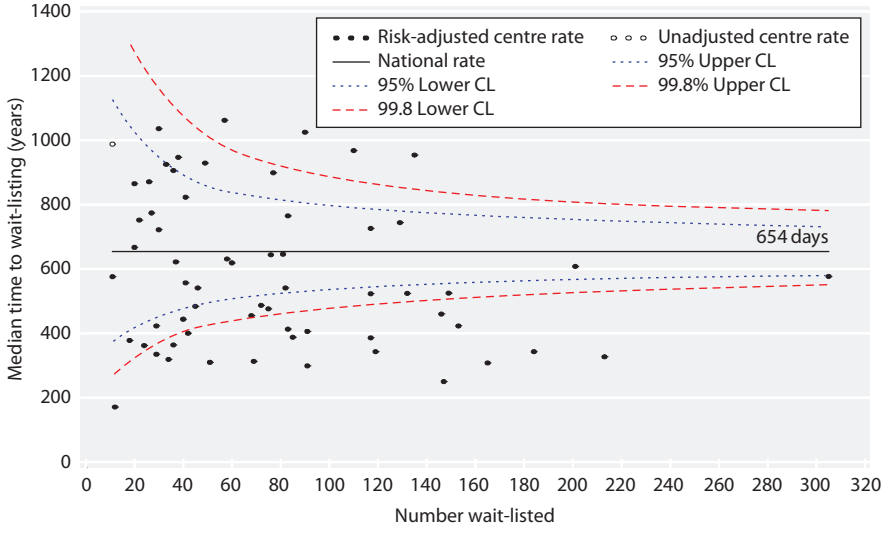

**Fig. 13.3.** The percentage of patients receiving a transplant from a living kidney donor/donor after cardiac death by renal centre, within two years of transplant waiting-list registration (centres with <10 patients excluded)

wait-listing compared with a baseline centre that had a median time comparable to the national median.

## Discussion

The analyses indicate that there was a centre effect in relation to patients' access to the national renal transplant waiting-list in both the time taken to activate patients on the waiting-list and in the receipt of transplantation once activated on the waiting-list. Variations between renal centres persisted in the analyses adjusted for patient characteristics (case-mix), suggesting other factors were important. Inter-centre differences were more pronounced for both access to transplants from donors after cardiac death/living kidney donors and the time taken to activate patients on the transplant list. These are outcomes that are often predominantly influenced by individual centres' practices and policies.

Lack of comprehensive comorbidity data on all patients is a potential weakness of this study as it precluded definitive adjustment for case-mix and hence these results need to be interpreted with caution, as patient related factors other than those analysed as part of the study may be important in influencing access to renal transplantation. Some centres may take on 'sicker' patients with more comorbidity, explaining




The centre represented by an unfilled symbol has its final event time as the plotting position as the median time could not be estimated

**Fig. 13.4.** Median time to wait-listing for a kidney transplant, by renal centre (centres with <10 patients excluded)

**Table 13.6.** Median time to wait-listing for a kidney transplant, by renal centre (censoring at the earliest of death or 31st December 2008)

| Centre | RRT N | Registrations N | Median (days) | Centre | RRT N | Registrations N | Median (days) |
|---|---|---|---|---|---|---|---|
| Abrdn | 81 | 46 | 541 | L Guys | 219 | 117 | 726 |
| Airdrie | 86 | 41 | 823 | L Kings | 198 | 117 | 523 |
| Antrim | 23 | 18 | 378 | L Rfree | 182 | 117 | 386 |
| B Heart | 142 | 76 | 644 | L West | 494 | 305 | 577 |
| B QEH | 282 | 135 | 954 | Leeds | 238 | 146 | 460 |
| Bangor | 41 | 20 | 865 | Leic | 315 | 213 | 327 |
| Basldn | 57 | 27 | 774 | Liv Ain | 36 | 11 | ***988*** |
| Belfast | 119 | 68 | 455 | Liv RI | 225 | 110 | 968 |
| Bradfd | 84 | 45 | 484 | M Hope | 181 | 119 | 343 |
| Brightn | 135 | 83 | 413 | Middlbr | 138 | 85 | 388 |
| Bristol | 231 | 153 | 423 | Newc | 157 | 91 | 406 |
| Camb | 193 | 90 | 1,025 | Newry | 17 | 12 | 171 |
| Cardff | 265 | 165 | 308 | Norwch | 108 | 49 | 929 |
| Carlis | 38 | 24 | 362 | Nottm | 169 | 77 | 899 |
| Carsh | 255 | 132 | 524 | Oxford | 272 | 184 | 343 |
| Chelms | 45 | 22 | 752 | Plymth | 76 | 51 | 310 |
| Clwyd | 18 | 9 | 377 | Ports | 221 | 147 | 250 |
| Covnt | 125 | 72 | 487 | Prestn | 157 | 81 | 646 |
| D & Gall | 20 | 8 | ***422*** | Redng | 98 | 69 | 313 |
| Derby | 98 | 58 | 631 | Sheff | 243 | 129 | 744 |
| Dorset | 70 | 41 | 557 | Shrew | 72 | 40 | 444 |
| Dudley | 64 | 30 | 1,036 | Stevng | 155 | 83 | 765 |
| Dundee | 68 | 30 | 722 | Sthend | 50 | 29 | 423 |
| Dunfn | 51 | 29 | 335 | Sund | 79 | 38 | 947 |
| Edinb | 159 | 91 | 299 | Swanse | 108 | 60 | 619 |
| Exeter | 120 | 75 | 476 | Truro | 62 | 42 | 400 |
| Glasgw | 272 | 149 | 525 | Tyrone | 19 | 11 | 576 |
| Glouc | 72 | 37 | 622 | Ulster | 3 | 2 | 316 |
| Hull | 156 | 82 | 541 | Wirral | 79 | 36 | 906 |
| Inverns | 53 | 36 | 364 | Wolve | 127 | 57 | 1,062 |
| Ipswi | 69 | 33 | 925 | Wrexm | 39 | 20 | 667 |
| Klmarnk | 61 | 26 | 871 | York | 54 | 34 | 319 |
| L Barts | 358 | 201 | 608 | | | | |

Results in ***bold italics*** are final event times as median times could not be estimated

some of the observed inter-centre variability. It would be expected that centres in which many patients have comorbidity will have fewer patients fit for transplantation, resulting in a smaller percentage of patients being wait-listed. Additionally, it may take longer to activate patients in these centres due to the need for more intensive investigation and medical optimisation prior to transplantation.

When interpreting the analyses in this chapter it is important to consider the potential impact of missing data on the results. Missing data occurs as a result of either a renal centre failing to complete relevant fields on their renal IT system or a failure to extract this data. Missing data may not be at random; sicker patients may die more quickly, allowing inadequate time for their physician to enter relevant comorbidity data. The very process of working up and listing a patient makes it less likely that data will be missing. It is therefore perhaps not surprising that patients activated on the national kidney transplant waiting-list are more likely to have ethnicity and PRD data reported ($p < 0.0001$) (table 13.1).

The finding that certain patient related variables such as increasing age have a negative association with access to transplantation is understandable, as the risk-benefit ratio of receiving a renal transplant alters with age. However, the effect of factors such as gender and ethnicity on access to transplantation is more difficult to understand. The importance given to HLA matching in the national allocation protocol at the time of this study may have favoured a predominantly white donor pool being matched with white recipients, which may explain the

effect of ethnicity on this outcome. This study has not analysed the interplay between factors such as social deprivation and ethnicity and whether the observed differences based on ethnicity are likely to persist after adjustment for social deprivation and varying co-morbidity burden in different ethnic groups. One possible explanation for the observed disparity between the sexes in receipt of a transplant from a donor after brain stem death could be pregnancy related HLA sensitisation in women, which in turn will limit offers of organs. The higher proportion of patients with diabetes receiving a transplant corresponds to an increase in the number of simultaneous kidney-pancreas transplants during the study period, as the allocation algorithm prioritised dual organ recipients.

This study highlights the presence of significant centre variation in access to transplantation with respect to the proportion of patients listed and the time taken to activate suitable patients, even after correction for available relevant patient related variables. To conclude that centres with a lower proportion of patients on the waiting-list are in some way performing less well would be simplistic. Such centres could be choosing patients more carefully to ensure that the scarce resource of donated organs is appropriately targeted to patients who are likely to benefit the most. Centres with the highest proportion of patients on the waiting-list could be including patients who have a higher risk of peri-operative morbidity or mortality. They may as a consequence have inferior post-transplant outcomes resulting in suboptimal use of the scarce resource of donated organs although there are no significant centre differences in post-transplant survival of patients and grafts to support this explanation. For these reasons it is not possible to offer a guideline on the minimum percentage of patients who should be activated on the renal transplant waiting-list in each centre. However significant inter-centre differences in the time taken to activate suitable patients for transplantation should not exist.

The UKRR is collaborating with other researchers in the National Institute for Health research (NIHR) funded Access to Transplant and Transplant Outcome Measures (ATTOM) research project to study access to kidney transplantation in greater detail. This will allow those practices identified in the better performing centres to be disseminated to other centres, thereby facilitating equity of access to transplantation across the UK.

Conflicts of interest: none

## Reference

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