

NHS BLOOD AND TRANSPLANT

RETRIEVAL ADVISORY GROUP

DCD KIDNEYS RETRIEVED WITH OR WITHOUT NRP – ACTIVITY AND OUTCOMES

INTRODUCTION

- 1 Abdominal Normothermic Regional Perfusion (A-NRP) in DCD donors does not form part of the commissioned NORS service but has been in use in the UK since 2010. This has primarily been performed by Edinburgh and Cambridge teams on donors where they have accepted the liver but has recently expanded to include a wider range of donors. Since 2018/19, limited funding support has been provided by Scotland, Wales and Northern Ireland Health Departments, along with NHSBT and some local funding to sustain the restricted use of A-NRP. An implementation group was set up in November 2020 provide oversight and governance for A-NRP and to support new teams wishing to utilise the technology.
- 2 This paper presents kidney utilisation and post-transplant outcomes from DCD donors between 1 April 2016 and 31 March 2021 by whether NRP was performed, and by centre where appropriate. Kidney utilisation rates are presented for all proceeding UK DCD kidney donors, with graft survival and 1 year eGFR considered for first adult kidney only transplants from DCD donors.

METHODS

- 3 Kidney utilisation rates were calculated on an organ basis for all donors proceeding to donate at least one kidney for the purposes of transplantation and is the percent of kidneys transplanted of those retrieved. Utilisation rates were compared by NRP use using the Chi-square test. Thoraco-abdominal NRP (TA-NRP) and A-NRP are both considered.
- 4 One year graft survival rates were considered for first adult kidney only transplants from DCD donors between 1 April 2016 and 31 March 2021, where survival information was available. Graft survival is defined as time from transplant to graft failure, censoring for death with a functioning graft and grafts still functioning at time of last report. Unadjusted survival estimates were obtained using the Kaplan-Meier method, and compared using the log-rank test. Cox Proportional Hazard models were then used to model graft survival, adjusting for known risk factors. Any missing values for the risk factors were imputed using the mean value for the cohort. NRP use was then added to the model to assess if it significantly impacted 1 year graft survival using the likelihood ratio test.
- 5 eGFR at 1 year post-transplant was calculated using the MDRD formula for the cohort considered in the graft survival analysis. A General Linear Model was used to model eGFR at one-year post-transplant, adjusting for known risk factors. Any missing values for the risk factors were imputed using the mean value for the cohort. NRP use was then added to the model to assess if it significantly impacted 1 year eGFR. If the graft failed within one year, the eGFR value was set to the average value for a person on dialysis as quoted in the UK Renal Registry annual report (8.5 ml/min/1.73m²). If the patient died with a functioning graft within 12 months of transplant, eGFR was set to the mean value for the overall cohort.

RESULTS

- 6 Between 1 April 2016 and 31 March 2021, there were 2,811 UK DCD donors who donated at least one kidney for the purposes of transplantation. 198 (7%) of these donors underwent NRP. **Table 1** shows the number of kidneys retrieved and transplanted from these donors, along with the utilisation rates. The NRP cohort had a higher rate of transplantation of 88% of those retrieved compared to standard DCD with 85%, but this was not statistically significant (Chi-square p-value: 0.16). **Table A1** in the Appendix shows demographics for the two donor cohorts.

Table 1 Number of kidneys retrieved and transplanted, by NRP status, 1 April 2016 – 31 March 2021

Method	Number of kidney donors	Number of kidneys retrieved	Number of kidneys transplanted	% transplanted (of retrieved)
Standard DCD	2613	5176	4390	85%
NRP	198	394	345	88%
Total	2811	5570	4735	85%

- 7 **Table 2** shows the number of DCD kidney transplants in the period by centre and NRP status. In the five year period, 22 centres have performed at least one transplant using an NRP kidney and 7% of all DCD kidney transplants involved NRP. Edinburgh, Cambridge, and Glasgow have done the highest proportions of NRP transplants, making up 28%, 18%, and 18% of their DCD kidney activity respectively.

Table 2 DCD kidney transplants, by recipient centre and NRP status, 1 April 2016 – 31 March 2021

Recipient centre	Number of transplants	Standard DCD		NRP	
		N	% at centre	N	% at centre
Belfast	132	128	97	4	3
Birmingham	203	181	89	22	11
Bristol	172	170	99	2	1
Cambridge	478	391	82	87	18
Cardiff	144	144	100	0	-
Coventry	65	60	92	5	8
Edinburgh	135	97	72	38	28
Glasgow	212	174	82	38	18
Great Ormond Street	1	1	100	0	-
Guy's	298	281	94	17	6
Leeds	295	282	96	13	4
Leicester	183	162	89	21	11
Liverpool	156	149	96	7	4
Manchester	456	431	95	25	5
Newcastle	162	158	98	4	2
Nottingham	152	143	94	9	6
Oxford	391	372	95	19	5
Plymouth	88	85	97	3	3
Portsmouth	119	118	99	1	1
Sheffield	98	87	89	11	11
St George's	138	135	98	3	2
The Royal Free	133	131	99	2	2
The Royal London	160	156	98	4	3
WLRTC	232	226	97	6	3
Total	4603*	4262	93	341	7

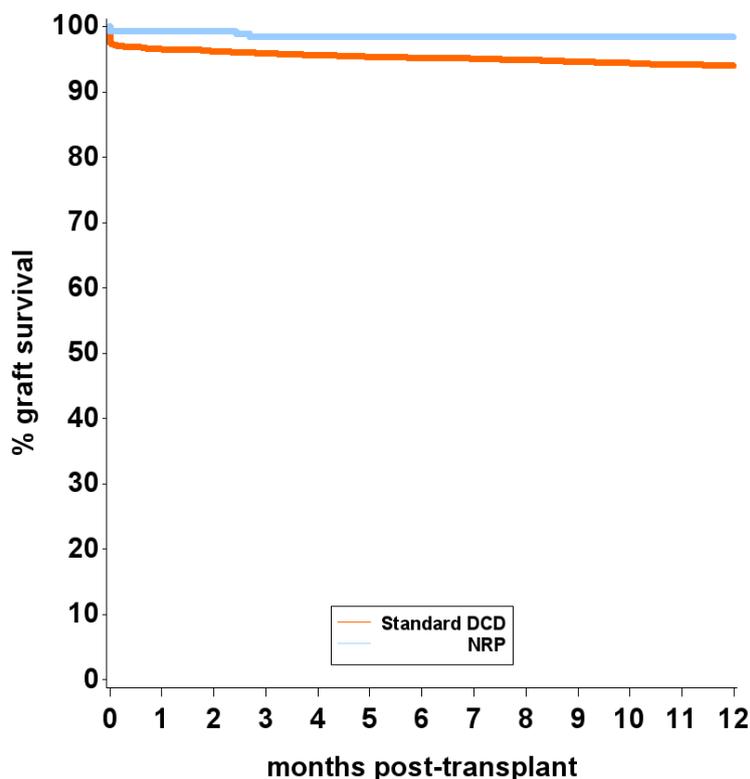
* Includes 133 dual kidney transplants

- 8 Of the 4,603 DCD transplants, 3,727 were first adult kidney only transplants with graft survival information available. **Table 3** shows the one year unadjusted survival rates by NRP status for these recipients and **Figure 1** shows the Kaplan-Meier survival curve for graft survival up to 1 year. The one year graft survival rate for the NRP cohort was 98.4% (95% CI: 95.8-99.4) and for the standard DCD cohort was 94.0% (95% CI: 93.1-94.8), and was significantly different (log-rank p-value: 0.006).

Table 3 One year graft survival rates following DCD first kidney only transplant, by NRP status, 1 April 2016 – 31 March 2021

Method	Number of transplants	1 year survival (95% CI)
Standard DCD	3471	94.0 (93.1-94.8)
NRP	256	98.4 (95.8-99.4)
Log-rank p-value		0.0059
Total	3727	94.3 (93.5-95.0)

Figure 1 Kaplan-Meier graft survival function for DCD first kidney only transplant recipients by NRP status, 1 April 2016 – 31 March 2021



- 9 One year graft survival was then adjusted using Cox Proportional Hazard modelling for the following risk factors: donor age, donor cause of death, recipient age, recipient waiting time, recipient diabetic status, recipient ethnicity, ischaemia time, and HLA mismatch group. **Table A2** in the Appendix shows demographics for these factors for the cohort. NRP use was then added to the model and found to be significantly associated with graft survival (likelihood ratio test p-value: 0.002), with recipients in the standard DCD group having 3.5 times higher chance of suffering graft failure within 1 year (hazard ratio for standard DCD compared to NRP: 3.51, 95% CI: 1.30-9.44).
- 10 There were 3,125 first kidney only transplants performed in the period where eGFR at 1 year was known, or could be estimated. **Table 4** shows the mean eGFR at 12 months in the abdominal NRP group was 55.3 compared with 46.2 in the standard DCD group. One year eGFR was then adjusted using a general linear model for the following risk factors: recipient sex, recipient ethnicity, recipient age, recipient waiting time, donor history of hypertension, donor history of diabetes, donor height, donor age, and cold ischaemia time. NRP use was then added to the model and there appeared to be a statistically significant difference between transplants from NRP donors and standard DCD donors (F-test p-value: <0.0001) in terms of 12 month eGFR, with the expected value of eGFR increasing by 7.6 ml/min/1.73m² if NRP was used.

Table 4 Mean eGFR at 12 months following DCD first kidney only transplant, by NRP status, 1 April 2016 – 31 March 2021

Method	Number of transplants	Mean eGFR
Standard DCD	2929	46.2
NRP	196	55.3
Total	3125	46.8

SUMMARY

- 11 Between 1 April 2016 and 31 March 2021, 198 (7%) of the 2,811 DCD kidney donors in the UK underwent NRP, with most centres performing at least one transplant using an NRP kidney. When looking at first adult kidney only transplants in the period, the NRP cohort had significantly higher unadjusted graft survival compared to standard DCD retrieval (98.4% compared to 94.0%). After adjusting for known risk factors, use of NRP was significantly associated with graft survival with the standard DCD group having 3.5 times higher chance of suffering graft failure within 1 year. The NRP cohort had a higher eGFR at 1 year, and after adjustment, the expected value of eGFR at 1 year increased by 7.6 ml/min/1.73m² if NRP was used.

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APPENDIX

Variable	Level	Standard DCD	NRP	p-value*	Overall
Number of donors		2613 (100)	198 (100)		2811 (100)
Age (years)	Median (IQR) Missing	56 (45-65) 0	52.5 (41-60) 0	<0.0001	56 (44-65) 0
Cause of death	Intracranial Trauma Other	1040 (40) 86 (3) 1487 (57)	86 (43) 8 (4) 104 (53)	0.4630	1126 (40) 94 (3) 1591 (57)
History of diabetes	No Yes Missing	2358 (91) 234 (9) 21	189 (96) 7 (4) 2	0.0128	2547 (91) 241 (9) 23
History of hypertension	No Yes Missing	1749 (68) 829 (32) 35	146 (76) 46 (24) 6	0.0228	1895 (68) 875 (32) 41
BMI (kg/m ²)	Median (IQR) Missing	26.5 (23.4-30.5) 0	26.0 (22.5-29.6) 0	0.0840	26.5 (23.4-30.4) 0
eGFR at retrieval (ml/min/1.73m ²)	Median (IQR) Missing	57.8 (44.6-77.7) 131	57.8 (44.6-80.1) 13	0.8491	57.8 (44.6-78.0) 144
* Chi-square test for categorical variables, Wilcoxon rank-sum test for continuous variables					

Table A2 Demographics of DCD kidney transplants considered in the graft survival analysis, by NRP status, 1 April 2016 – 31 March 2021

Variable	Level	Standard DCD	NRP	p-value*	Overall
Number of transplants		3471 (100)	256 (100)		3727 (100)
Donor age (years)	Median (IQR)	56 (45-64)	55 (43-60.5)	0.0091	56 (45-64)
	Missing	0	0		0
Donor cause of death	Intracranial	1387 (40)	100 (39)	0.6617	1487 (40)
	Trauma	113 (3)	11 (4)		124 (3)
	Other	1971 (57)	145 (57)		2116 (57)
Recipient age (years)	Median (IQR)	57 (48-65)	55.5 (46-63)	0.0203	57 (48-65)
	Missing	0	0		0
Recipient waiting time (days)	Median (IQR)	482 (202-904)	451.5 (161.5-900)	0.2955	480 (199-904)
	Missing	0	0		0
Recipient diabetic status	No	2985 (86)	217 (85)	0.6498	3202 (86)
	Yes	486 (14)	39 (15)		525 (14)
Recipient ethnicity	White	2420 (71)	190 (75)	0.4374	2610 (71)
	Asian	580 (17)	34 (13)		614 (17)
	Black	292 (9)	19 (8)		311 (8)
	Other	131 (4)	9 (4)		140 (4)
	Missing	48	4		52
Ischaemia time (hours)	Median (IQR)	12 (10-16)	12.5 (9-16)	0.4287	12 (10-16)
	Missing	1	4		5
HLA mismatch group	1 (best match)	97 (3)	11 (4)	0.2212	108 (3)
	2	730 (21)	63 (25)		793 (21)
	3	1925 (55)	136 (53)		2061 (55)
	4	719 (21)	46 (18)		765 (21)

* Chi-square test for categorical variables, Wilcoxon rank-sum test for continuous variables