

NHS BLOOD AND TRANSPLANT

LIVER ADVISORY GROUP

BLOOD GROUP: WAITING TIMES AND DEATHS ON THE TRANSPLANT LIST

SUMMARY

BACKGROUND

- 1 Restrictions in the allocation of livers were imposed in 2006 as a measure to reverse the prolonged waiting time to transplant in blood group O patients. These restrictions regulate the allocation of livers depending on the blood groups of donor and recipient. This paper reports the median waiting time to elective liver-only transplant and the proportion of patients dying on the transplant list for different blood groups.

DATA AND METHODS

- 2 Data were obtained from the UK Transplant Registry (UKTR) including all new active Group 1 elective liver only registrations between 1 April 2010 and 31 March 2013 and excluding multi-organ transplants and registrations ending in living donor liver transplant. Median waiting time to transplant and post-registration outcomes were compared over patient blood group, financial year of registration and transplant centre.

RESULTS

- 3 The median waiting time to transplant in 2012/2013 for blood group O adult patients was significantly greater than that for blood group B patients (234 and 145 days, respectively). No evidence of differences was found on this same comparison for adult patients with UKELD score > 62.
- 4 The median waiting times to transplant for adult patients with blood group O, A or B significantly varied between transplant centres (log-rank test, $p < 0.0001$, $p < 0.0001$ and $p = 0.006$, respectively).
- 5 The percentage of blood group O adult patients transplanted within 6-months post-registration in 2012/2013 was significantly lower than that of blood group B adult patients (37% and 52%, respectively). This difference was not significant at 12-months post-registration. There was no evidence of differences in the percentage of adult patients that died on the transplant list neither at 6 nor at 12 months post registration when comparing blood groups.

ACTION

- 6 Members are asked if annual monitoring is still required or if the contents of this paper should be reviewed and produced again in two years time.

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INTRODUCTION

- 1 In an attempt to reverse the prolonged waiting time to transplant primarily for blood group O patients, blood group restrictions were imposed on 1 June 2006 (Ref: **LAG(06)10**). These restrictions were that for elective patients, blood group O donor livers could no longer be given to blood group B patients unless first offered to all blood group O patients in the UK. Additionally, blood group B donor livers could no longer be given to blood group AB patients unless first offered to blood group B patients in the UK. A summary of this paper is presented in **Appendix 1**. (There was a subsequent change to this endorsed at the Liver Advisory Group (LAG) meeting on 15 November 2006 which was that blood group B patients could be considered for liver left lateral segments from blood group O donors.)
- 2 Further papers monitoring the impact of this change were presented to the LAG on 17 November 2010 (Ref: **LAG(10)37**), 11 May 2011 (Ref: **LAG(11)16**), 9 November 2011 (Ref: **LAG(11)45**) and 14 November 2012 (Ref: **LAG(12)34**). Following the LAG in November 2011, it was requested that this paper be presented annually to continue to monitor waiting times and deaths on the transplant list by blood group.
- 3 This paper therefore reports on changes in the median waiting time to elective liver-only transplant for patients with different blood groups registered between 1 April 2010 and 31 March 2013, and also changes in the proportion of patients with different blood groups dying on the transplant list over the same time period. The data were analysed in three cohorts; 2010/2011, 2011/2012 and 2012/2013.

DATA AND METHODS

- 4 Data on all new active Group 1 elective liver only registrations onto the UK liver transplant list between 1 April 2010 and 31 March 2013 were obtained from the UKTR. Registrations for a multi-organ transplant, including intestinal transplants, were excluded from all analyses, as were registrations known to have ended in living donor liver transplant. Median waiting time to transplant and 6 and 12 month post-registration outcomes were compared over patient blood group, financial year of registration and transplant centre for all adult registrations in the first part of the results section, for adult registrations for patients with a UKELD score > 62 at time of registration in the second part of the results section, and finally for paediatric registrations in the third part of the results section.
- 5 The donor to recipient ABO match distribution was examined for transplants using livers from donors after brain death (DBD) and donor after circulatory death (DCD), using data on all Group 1 elective liver only transplants in the UK between 1 April 2010 and 31 March 2013, obtained from the UKTR as recorded on 11 October 2013. These data are presented separately for adult transplants, adult transplants for patients with a UKELD score > 62 at time of transplantation and finally for paediatric transplants.

RESULTS

Adult registrations

Waiting time to transplant

- 6 The median waiting time to transplant for new adult Group 1 elective liver only registrations between 1 April 2010 and 31 March 2013 is presented in **Table 1** by blood group and financial year and in **Table 2** by blood group and transplant centre. In **Table 1** the outcome for registrations in each financial year was recorded approximately 6-months after the end of each financial year. In **Table 2** all outcomes were recorded as at 11 October 2013.
- 7 **Table 1** shows that the median waiting time to transplant for all patients, regardless of blood group, reached a lowest level in 2012/2013 relative to previous financial years. This decreasing trend was also observed in the median waiting time to transplant for blood group B patients but not for blood group O patients, for which the median waiting time to transplant remained reasonably stable over the years. In fact, in 2012/2013 there was strong evidence of the median waiting time to transplant for blood group O patients being greater than the median waiting time for blood group B patients (log-rank test, $p=0.03$).
- 8 In **Table 2** it can be seen that the overall median waiting time to transplant for blood group O patients and blood group B patients registered between 1 April 2010 and 31 March 2013 was 232 days and 245 days, respectively. For blood group O patients, the median waiting time was longest at Leeds (453 days) and shortest at Cambridge (130 days). For blood group B patients the median waiting time was longest at The Royal Free (378 days) and shortest at Cambridge (149 days). There is evidence of differences in median waiting times between centres for blood groups O, A and B.

Table 1 Median waiting time to deceased donor liver only transplant for new adult Group 1 elective registrations between 1 April 2010 and 31 March 2013, by blood group and financial year

Blood group	2010/2011 ¹			2011/2012 ²			2012/2013 ³		
	No. registrations	Median waiting time (days)	(95% CI)	No. registrations	Median waiting time (days)	(95% CI)	No. registrations	Median waiting time (days)	(95% CI)
O	375	252	(188 - 316)	375	222	(161 - 283)	353	234	(185 - 283)
A	307	85	(70 - 100)	312	109	(86 - 132)	292	71	(58 - 84)
B	112	329	(205 - 453)	101	246	(144 - 348)	83	145	(76 - 214)
AB	36	52	(16 - 88)	36	61	(34 - 88)	31	72	(38 - 106)
Total	830	150	(134 - 166)	824	172	(152 - 192)	759	127	(110 - 144)

¹ Outcome as at 13 October 2011

² Outcome as at 15 October 2012

³ Outcome as at 11 October 2013

Table 2 Median waiting time to deceased donor liver only transplant for new adult Group 1 elective registrations between 1 April 2010 and 31 March 2013, by blood group and transplant centre					
Blood Group	Transplant centre	No. registrations	Median waiting time (days) 95% CI		log-rank test p-value
O	Birmingham	252	173	(131-215)	<0.0001
	Cambridge	122	130	(82-178)	
	Edinburgh	138	145	(104-186)	
	King's College	233	377	(317-437)	
	Leeds	168	453	(287-619)	
	Newcastle	79	419	(203-635)	
	Royal Free	112	235	(86-384)	
	OVERALL	1104	232	(202-262)	
A	Birmingham	213	78	(65-91)	<0.0001
	Cambridge	127	166	(126-206)	
	Edinburgh	100	63	(48-78)	
	King's College	176	70	(59-81)	
	Leeds	145	96	(62-130)	
	Newcastle	52	59	(33-85)	
	Royal Free	97	138	(102-174)	
	OVERALL	910	86	(76-96)	
B	Birmingham	53	175	(127-223)	0.006
	Cambridge	24	149	(0-369)	
	Edinburgh	36	181	(112-250)	
	King's College	70	245	(100-390)	
	Leeds	53	270	(144-396)	
	Newcastle	16	312	(0-634)	
	Royal Free	44	378	(309-447)	
	OVERALL	296	245	(195-295)	
AB	Birmingham	24	61	(35-87)	0.617
	Cambridge	15	38	(23-53)	
	Edinburgh	12	52	(40-64)	
	King's College	25	58	(2-114)	
	Leeds	19	91	(39-143)	
	Newcastle	2	107	-	
	Royal Free	6	108	(0-287)	
	OVERALL	103	60	(38-82)	

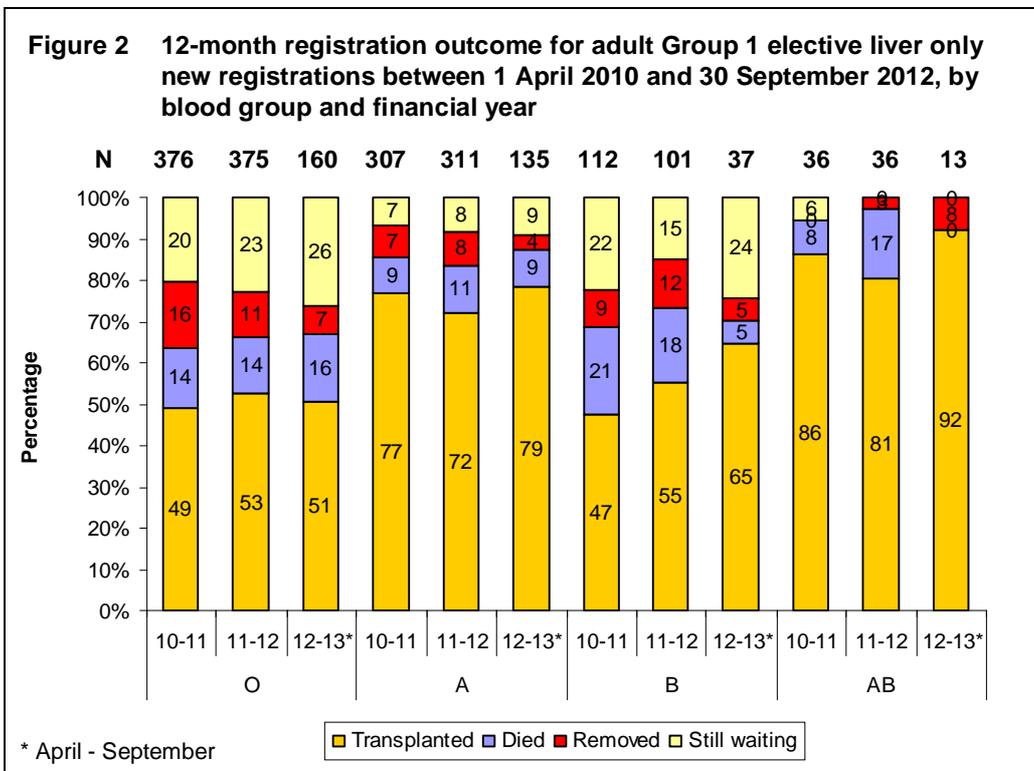
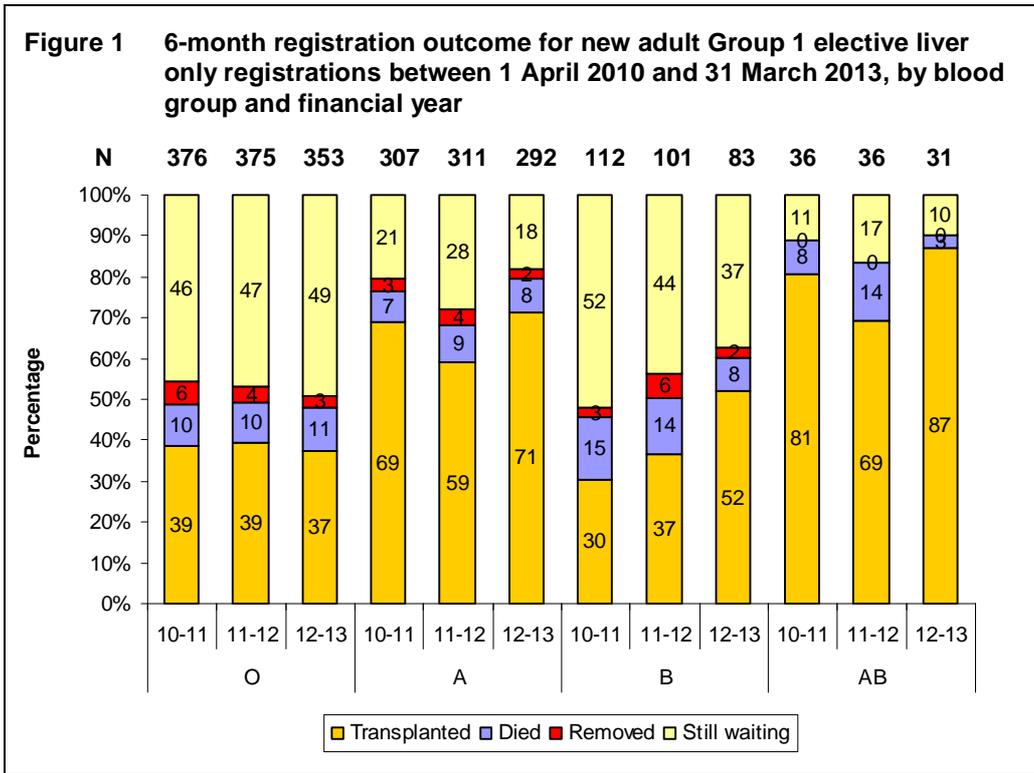
Outcome as at 11 October 2013

Registration outcome

- 9 Registration outcomes (death, transplant, removal, still waiting) at 6-months post-registration are shown by patient blood group and financial year, for new adult Group 1 elective liver only registrations between 1 April 2010 and 31 March 2013, in **Figure 1**. Outcomes at 12-months post-registration are shown in **Figure 2**. Removals due to

condition deteriorated have been included as deaths in both figures. Only half of the latest financial year, 2012/2013, has been included in **Figure 2**, in order to allow enough time to obtain 12-month outcomes.

- 10 **Comparisons within blood group.** For blood group O patients registered in the time period, the proportion of registrations that resulted in a transplant or in a death within 6- and 12-months was virtually the same across the three financial years. The proportion of transplanted blood group B patients increased over the course of the three financial years, both within 6- and 12-months of registration. This blood group saw a reduction, in 2012/2013, in the proportion of patients dying on the list within 6- and 12-months post-registration compared with previous years. For blood group A patients the proportion of patients transplanted within 6-months and 12-months of registration remained reasonably stable, as did the proportion of patients dying on the transplant list. The proportion of registrations resulting in a transplant for blood group AB patients was the highest in 2012/2013 compared with the two previous financial years within 6- and 12-months of registration. Conversely, the proportion of patients dying on the list for this same blood group was at its lowest in 2012/2013 compared with 2010/2011 and 2011/2012.
- 11 **Comparisons between blood groups.** In 2012/2013, there was a statistically significant difference observed between blood groups in the proportion of patients transplanted within 6-months and 12-months of registration (chi-squared test $p < 0.0001$ in both cases). However, in that same financial year there was no statistically significant difference observed between blood groups in the proportion of patients that died on the transplant list within both 6-months and 12-months of registration (chi-squared test $p = 0.4$ and $p = 0.06$, respectively). When comparing the proportion of patients transplanted in 2012/2013 for blood group O patients and blood group B patients, there were statistically significant differences observed within 6-months of registration but not within 12-months (chi-squared test $p = 0.02$ and $p = 0.1$, respectively).



Donor to recipient ABO match distribution

- 12 **Table 3** shows the donor to recipient ABO blood group match for Group 1 adult elective liver only transplants using livers from deceased donors split by DBD and DCD donors. Four (2%) of blood group O DCD donor livers were transplanted into blood group B patients; the remaining 98% were transplanted into blood group O patients.

Donor type	Donor blood group	O		Recipient blood group				AB		Total
		N	%	N	%	N	%	N	%	
DBD	O	507	100	0	0	0	0	0	0	507
	A	0	0	586	97	0	0	16	3	602
	B	0	0	0	0	156	100	0	0	156
	AB	0	0	1	1	0	0	67	99	68
	Total	507	38	587	44	156	12	83	6	1333
DCD	O	157	98	0	0	4	2	0	0	161
	A	0	0	141	95	0	0	8	5	149
	B	0	0	0	0	37	100	0	0	37
	AB	0	0	0	0	0	0	7	100	7
	Total	157	44	141	40	41	12	15	4	354

Adult registrations for patients with a UKELD score > 62

Waiting time to transplant

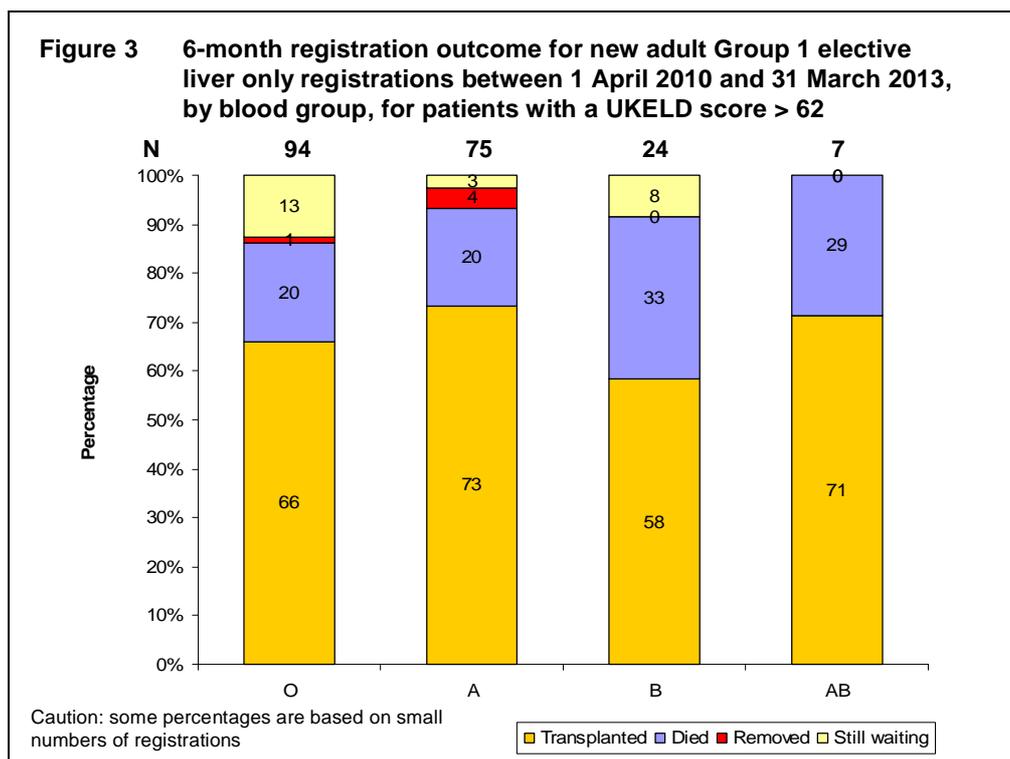
- 13 The median waiting time to transplant for new adult Group 1 elective liver only registrations between 1 April 2010 and 31 March 2013 for patients with a UKELD score > 62 at time of registration, by blood group and financial year is presented in **Table 4**. Note that median waiting times and 95% confidence intervals (CIs) could not be calculated in some cases due to small numbers of registrations in this cohort of patients, in particular for blood group AB patients. As in **Table 1**, the outcome for registrations in each financial year was recorded approximately 6-months after the end of each financial year. For the overall column, outcomes were recorded as at 11 October 2013. For blood group O patients the median waiting time decreased from 56 days for patients registered in 2011/2012 to 29 days for those registered in 2012/2013. In 2012/2013 there was no evidence of differences in median waiting time to transplant for blood group O patients compared with blood group B patients (log-rank test, p=0.98).

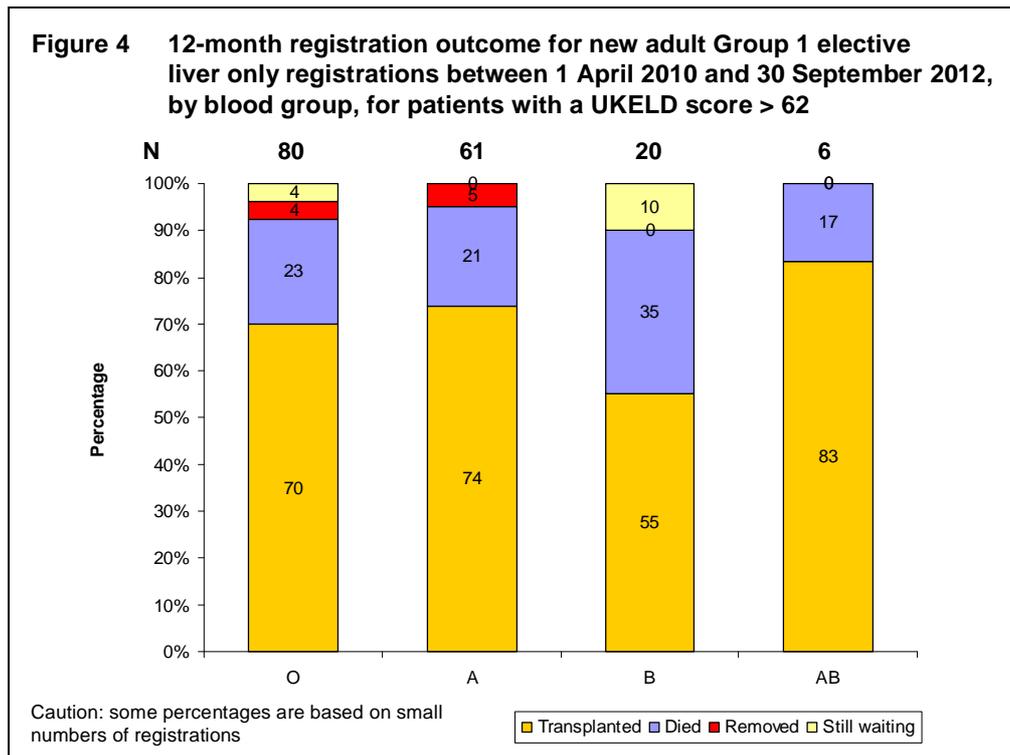
Blood group	2010/2011 ²			2011/2012 ³			2012/2013 ⁴			OVERALL ⁴		
	No. registered	Median waiting time (days) (95% CI)		No. registered	Median waiting time (days) (95% CI)		No. registered	Median waiting time (days) (95% CI)		No. registered	Median waiting time (days) (95% CI)	
O	29	48 (8 - 88)		37	56 (37 - 75)		28	29 (0 - 92)		94	54 (28 - 80)	
A	27	20 (7 - 33)		20	31 (16 - 46)		28	37 (17 - 57)		75	28 (15 - 41)	
B	8	157 (38 - 276)		9	19 (0 - 39)		7	16 (12 - 20)		24	37 (22 - 52)	
AB	1	-		4	45 (25 - 65)		2	37	-	7	45 (38 - 52)	
Total	65	48 (19 - 77)		70	45 (19 - 71)		65	33 (14 - 52)		200	37 (25 - 49)	

¹ UKELD score calculated at time of registration
² Outcome as at 13 October 2011
³ Outcome as at 15 October 2012
⁴ Outcome as at 11 October 2013

Registration outcome

- 14 Registration outcomes (death, transplant, removal, still waiting) at 6-months post-registration are shown by patient blood group, for new adult Group 1 elective liver only registrations between 1 April 2010 and 31 March 2013 for patients with a UKELD score > 62 at time of registration, in **Figure 3**. Outcomes at 12-months post-registration are shown in **Figure 4**. Removals due to condition deteriorated have been included as deaths in both figures. Only half of the latest financial year, 2012/2013, has been included in **Figure 4**, in order to allow enough time to obtain 12-month outcomes. Caution should be taken when interpreting some of the percentages as they are based on small numbers of registrations, in particular for blood group AB.
- 15 In the cohort of registrations for patients with a UKELD score > 62 and blood group O, A or B, the proportion of registrations resulting in transplant within 6-months and 12-months of registration was highest for blood group A patients and lowest for blood group B patients. The proportions of deaths on the transplant list were reasonably similar for O and A blood groups within 6- and 12-months post transplant. The cohort of blood group B patients experienced the highest proportion of deaths on the waiting list after 6-months and 12-months of registration compared with blood group O and A patients.





Donor to recipient ABO match distribution

- 16 **Table 5** shows the donor to recipient ABO blood group match for Group 1 adult elective liver only transplants using livers from deceased donors split by DBD donors and DCD donors, for patients with a UKELD score > 62 at time of transplantation. One (8%) blood group O DCD donor liver was transplanted into a blood group B patient with a UKELD score > 62.

Table 5 ABO blood group match for Group 1 adult elective liver only transplants using livers from deceased donors, 1 April 2010 - 31 March 2013, by donor type, for patients with a UKELD score > 62¹

Donor type	Donor blood group	Recipient blood group								Total
		O		A		B		AB		
		N	%	N	%	N	%	N	%	
DBD	O	66	100	0	0	0	0	0	0	66
	A	0	0	62	97	0	0	2	3	64
	B	0	0	0	0	19	100	0	0	19
	AB	0	0	0	0	0	0	2	100	2
	Total	66	44	62	41	19	12	4	3	151
DCD	O	11	92	0	0	1	8	0	0	12
	A	0	0	4	100	0	0	0	0	4
	B	0	0	0	0	2	100	0	0	2
	AB	0	-	0	-	0	-	0	-	0
	Total	11	61	4	22	3	17	0	0	18

¹ UKELD score calculated at time of transplantation

Paediatric registrations

Waiting time to transplant

- 17 The median waiting time to transplant for new paediatric Group 1 elective liver only registrations between 1 April 2010 and 31 March 2013, by blood group and financial year is presented in **Table 6**. Note that the small numbers of registrations in each blood group means that some caution should be taken when interpreting the median waiting times. Median waiting times were quite varied for blood group O and blood group B paediatric registrations in the three financial years. There was an increase in median waiting time between 2011/2012 and 2012/2013 for blood group O and blood group B paediatric registrations. In 2012/2013 there was borderline evidence of differences in median waiting time to transplant for blood group O patients compared with blood B patients (log-rank test, $p=0.04$).

Table 6 Median waiting time to deceased donor liver only transplant for new paediatric Group 1 elective registrations between 1 April 2010 and 31 March 2013, by blood group and financial year

Blood group	2010/2011 ¹			2011/2012 ²			2012/2013 ³		
	No. registered	Median waiting time (days)	(95% CI)	No. registered	Median waiting time (days)	(95% CI)	No. registered	Median waiting time (days)	(95% CI)
O	28	120	(70 - 170)	28	108	(62 - 154)	31	294	(165 - 423)
A	31	71	(45 - 97)	35	54	(12 - 96)	27	44	(8 - 80)
B	13	174	(0 - 358)	11	76	(1 - 151)	4	187	(41 - 333)
AB	3	37	(0 - 90)	7	13	(12 - 14)	2	146	-
Total	75	88	(47 - 129)	81	76	(36 - 116)	64	75	(0 - 167)

¹ Outcome as at 13 October 2011

² Outcome as at 15 October 2012

³ Outcome as at 11 October 2013

Registration outcome

- 18 Registration outcomes (death, transplant, removal, still waiting) at 6-months post-registration are shown by patient blood group and financial year, for new paediatric Group 1 elective liver only registrations between 1 April 2010 and 31 March 2013, in **Figure 5**. Outcomes at 12-months post-registration are shown in **Figure 6**. Removals due to condition deteriorated have been included as deaths in both figures. Only half of the latest financial year, 2012/2013, has been included in **Figure 6**, in order to allow enough time to obtain 12-month outcomes. Caution should be taken when interpreting some of the percentages as they are based on small numbers of registrations, in particular for blood group AB.

Figure 5 6-month registration outcome for new paediatric Group 1 elective liver only registrations between 1 April 2010 and 31 March 2013, by blood group and financial year

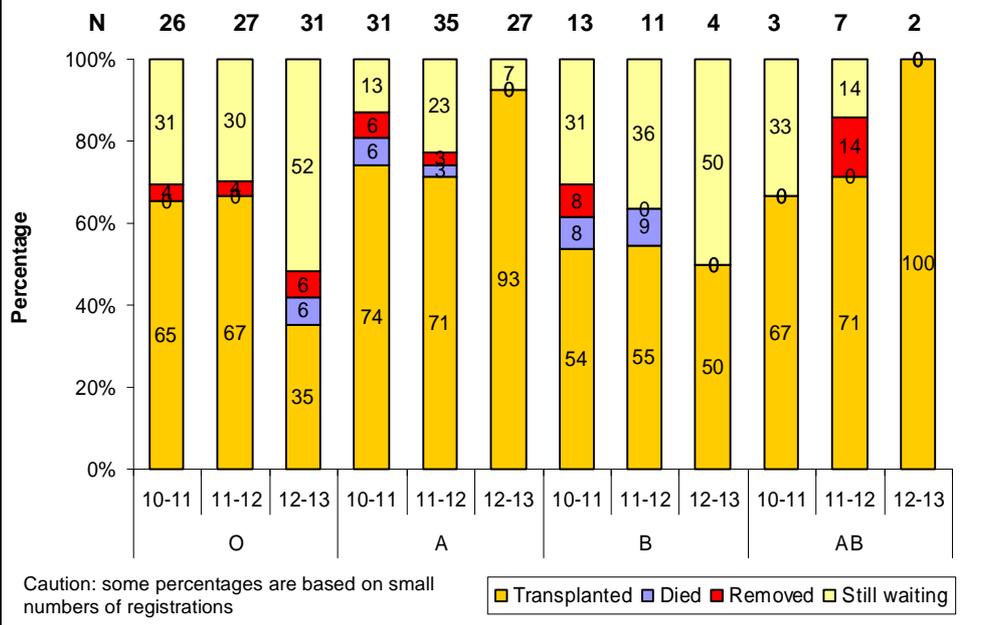
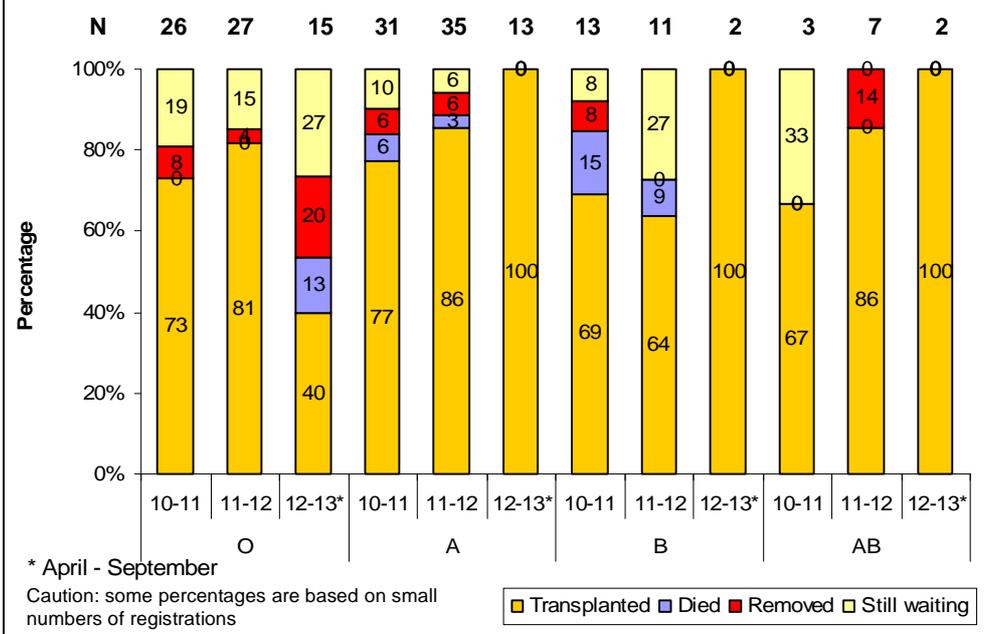


Figure 6 12-month registration outcome for new paediatric Group 1 elective liver only registrations between 1 April 2010 and 30 September 2012, by blood group and financial year



Donor to recipient ABO match distribution

- 19 **Table 7** shows the donor to recipient ABO blood group match for Group 1 paediatric elective liver only transplants using livers from deceased donors split by DBD donors and DCD donors. Four (6%) of blood group O DBD donor livers were transplanted into blood group B paediatric patients.

Donor type	Donor blood group	Recipient blood group								Total
		O		A		B		AB		
		N	%	N	%	N	%	N	%	
DBD	O	57	86	4	6	4	6	1	2	66
	A	0	0	69	93	0	0	5	7	74
	B	0	0	0	0	23	100	0	0	23
	AB	0	0	0	0	0	0	5	100	5
	Total	57	34	73	43	27	16	11	7	168
DCD	O	3	60	1	20	0	0	1	20	5
	A	0	0	4	100	0	-	0	0	4
	B	0	-	0	-	0	0	0	0	0
	AB	0	-	0	-	0	-	0	10	0
	Total	3	33	5	56	0	0	1	11	9

CONCLUSION

- 20 The median waiting time to transplant for adult and adult with UKELD score > 62 patients, regardless of blood group, reached its lowest value in 2012/2013, relative to previous financial years.
- 21 The median waiting time to transplant in 2012/2013 for blood group O adult patients was significantly greater than that for blood group B. No evidence of differences was found when doing the same comparison for adult patients with UKELD score > 62.
- 22 The median waiting times to transplant for adult patients with blood group O, A or B significantly varied between transplant centres.
- 23 The proportion of blood group O adult patients transplanted within 6-months post-registration in 2012/2013 was statistically significantly lower than that of blood group B adult patients. This difference was not significant at 12-months post-registration. No statistically significant differences were found in the proportion of adult patients that died on the transplant list neither at 6 nor at 12 months after registration when comparing patients in different blood groups.
- 24 For paediatric registrations, there was an increase in median waiting time in 2012/2013 for blood groups O and B relative to previous financial years.

APPENDIX 1

Summary of results from the LAG paper entitled “Blood group O patients” (Ref: LAG(06)10) presented to the LAG meeting on 26 April 2006

This paper reported on changes in the median waiting time to first adult elective liver only transplant for patients with different blood groups registered between 1 January 2001 and 31 December 2004. The data were analysed in two cohorts; 2001-2002 and 2003-2004.

Unadjusted median waiting time to first transplant for 868 and 991 new active adult Group 1 elective registrations onto the liver transplant list in 2001-2002 and 2003-2004, respectively, were analysed by blood group. Registration outcomes at 12-months post-registration for 1,026 and 1,169 new active adult Group 1 elective registrations in 2001-2002 and 2003-2004, respectively, were analysed to examine the proportion of deaths and transplants on the liver transplant list. To examine the donor to recipient ABO match distribution, data were obtained on 890 and 860 adult deceased donors after brain death transplants performed in the UK in 2001-2002 and 2003-2004, respectively.

In 2003-2004, blood group O patients waited significantly longer to transplant than blood group A, B and AB patients; 132 days (95% Confidence Interval (CI) 108-156 days) compared with 73 days (95% CI 64-82 days), 41 days (95% CI 32-50 days) and 31 days (95% CI 16-46 days), respectively. These differences in median waiting time were not apparent in the earlier time period where blood group O patients waited 80 days (95% CI 70-90 days) compared with 57 days (95% CI 44-70 days), 82 days (95% CI 65-99 days) and 33 days (95% CI 24-42 days) for blood group, A, B and AB patients, respectively.

In 2003-2004, a smaller proportion of blood group O patients were transplanted and a larger proportion had died after one year of registration compared with patients of other blood groups, as shown below. These differences were not evident in the earlier time period.

	Recipient blood group				Chi-squared p-value
	O	A	B	AB	
Number of registrations	530	466	123	50	
% transplanted at 12 months post-registration	70	82	83	88	<0.0001
% died at 12 months post-registration	13	7	7	8	<0.01

For elective transplants, 4% of blood group O donor livers were used for non-O recipients in 2003-2004 compared with 3% in 2001-2002. A slightly smaller proportion of liver donors were blood group O in 2003-2004, 48% compared with 51% in 2001-2002.