

NHS BLOOD AND TRANSPLANT

CARDIOTHORACIC ADVISORY GROUP – HEART

ADULT LONG-TERM CONDITIONAL SURVIVAL POST-HEART TRANSPLANT

INTRODUCTION

1. NHSBT publishes patient survival rates post-heart transplantation up to a maximum of 10 years on a national basis and 5 years on a centre-specific basis post-transplant. There is interest in presenting longer-term survival rates, beyond 10 years, for the UK adult heart transplant population.
2. There is also interest in examining conditional survival rates, which represent the probability of surviving to a given time point on the condition that the patient has survived beyond the initial post-transplant period. **Appendix A** shows the equivalent analysis from the International Society for Heart and Lung Transplantation.
3. This paper reports on long-term survival post-heart transplant both nationally and on a centre-specific basis. It also presents survival conditional on surviving the first year post-transplant. Transplants performed between April 1996 and March 2016 were included in the analysis.

DATA AND METHODS

4. Adult (age \geq 16) first time heart only transplants performed across the UK between 1 April 1996 and 31 March 2016 were extracted from the UK Transplant Registry. Patient survival was defined as time from transplant to death or last known survival date recorded as of 15 August 2023. Data from two historic transplant centres (Sheffield and London, St George's) were included in the national rates but not in the centre-specific charts.
5. The Kaplan-Meier estimation method was used to calculate survival probabilities at 10 years and beyond, both nationally and on a centre-specific basis. Median survival times were also estimated, by selecting the time when 50% of patients were still alive. Conditional survival was calculated by excluding patients who died within 1 year of transplant.
6. Survival rates were also stratified by transplant era (April 1996 – March 2001, April 2001 – March 2006, April 2006 – March 2011, April 2011 – March 2016) to examine changes in survival rates over time. Differences across eras were examined using the log-rank test.

RESULTS

7. **Figure 1a** shows long-term national survival post-heart transplant and **Figure 1b** shows survival conditional on surviving the first year. **Figures 2a** and **2b** show the same information, stratified by era. **Table 1** presents 10, 15 and 20 year survival rates by era (not conditional on surviving the first year).

Figure 1a Long-term patient survival post-heart transplant, for transplants performed 1 April 1996 - 31 March 2016

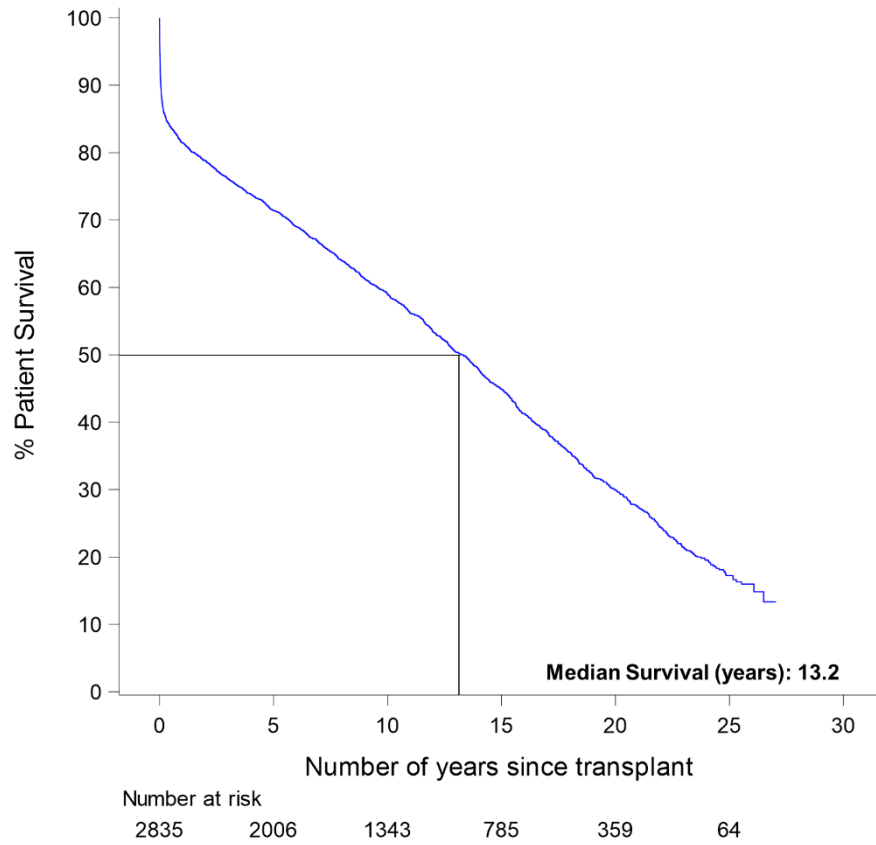


Figure 1b Long-term patient survival post-heart transplant, conditional on surviving the first year, for transplants performed 1 April 1996 - 31 March 2016

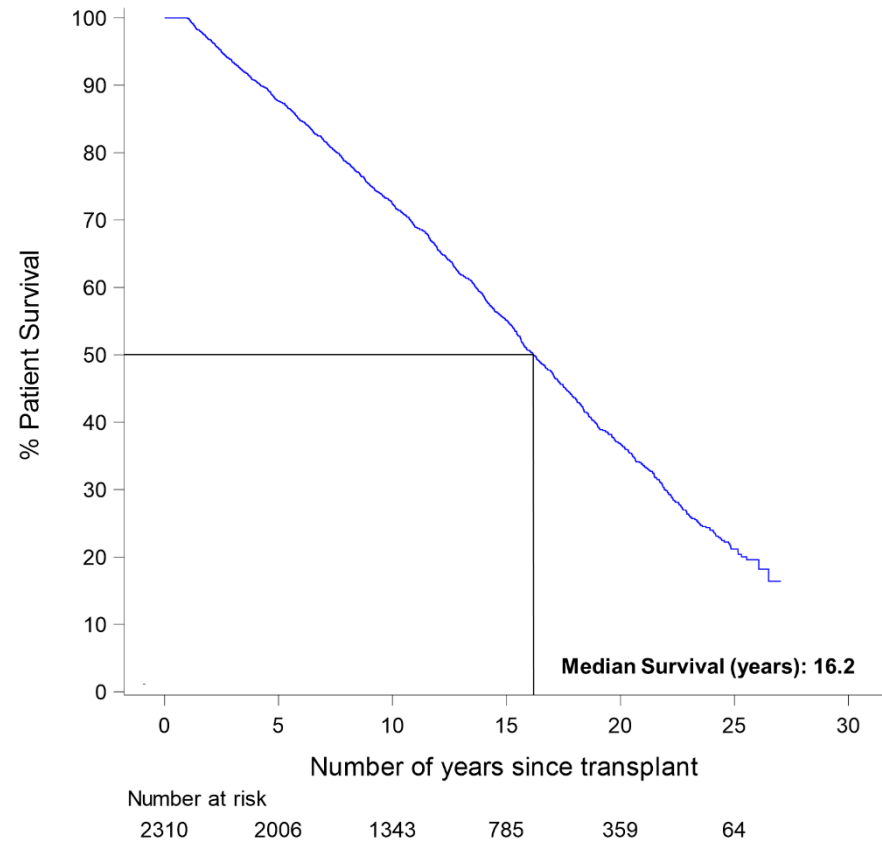
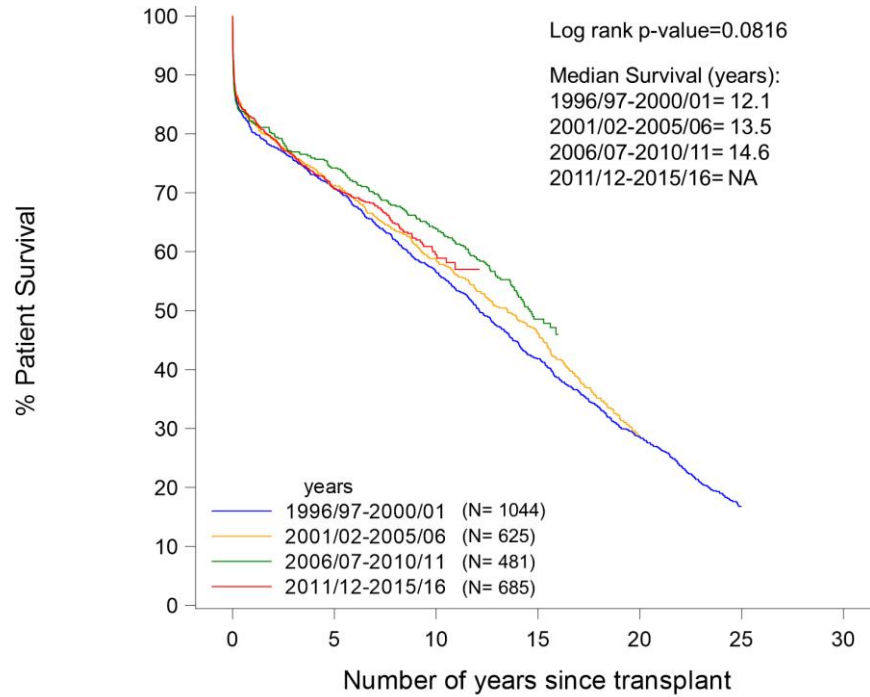
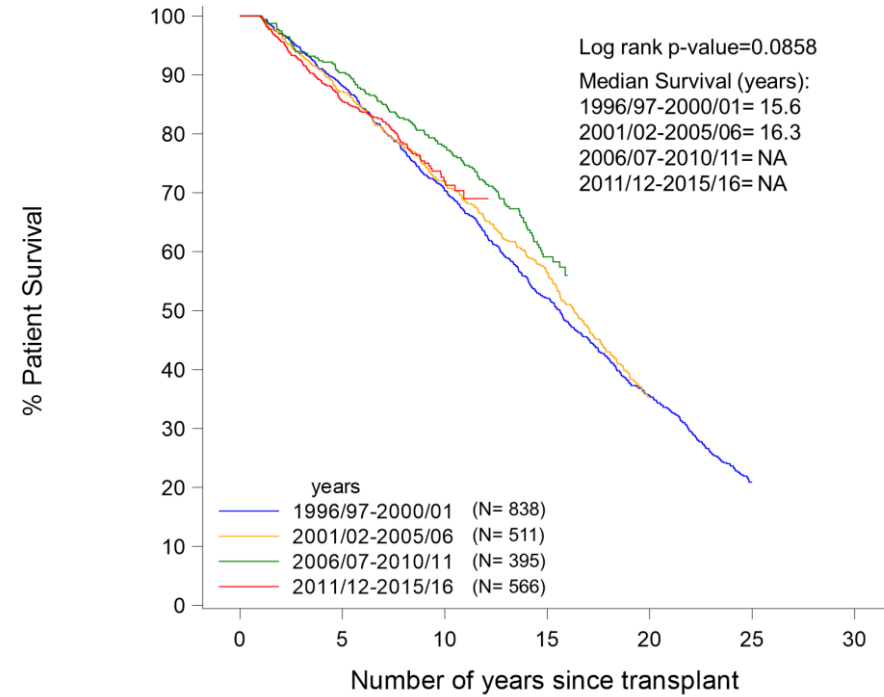


Figure 2a Long-term patient survival post-heart transplant stratified by era, for transplants performed 1 April 1996 - 31 March 2016



	Number at risk				
1996/97-2000/01	1044	737	582	424	288
2001/02-2005/06	625	437	357	280	71
2006/07-2010/11	481	353	298	81	
2011/12-2015/16	685	479	106		

Figure 2b Long-term patient survival post-heart transplant, stratified by era and conditional on surviving the first year, for transplants performed 1 April 1996 - 31 March 2016

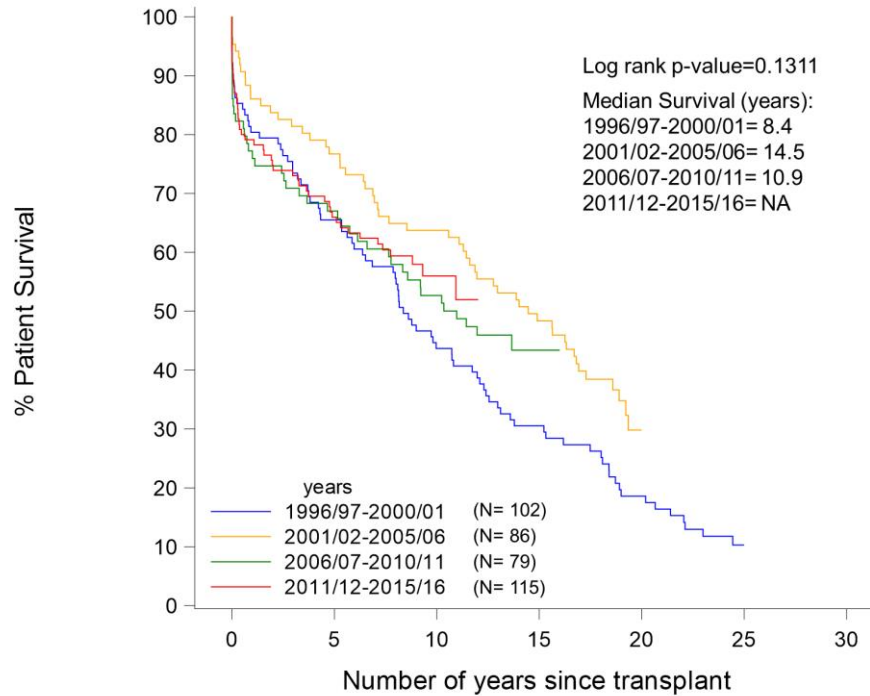


	Number at risk				
1996/97-2000/01	838	737	582	424	288
2001/02-2005/06	511	437	357	280	71
2006/07-2010/11	395	353	298	81	
2011/12-2015/16	566	479	106		

Era of transplant	Number of transplants performed	10 year survival		15 year survival		20 year survival	
		%	95% CI	%	95% CI	%	95% CI
1996/97-2000/01	1044	56	53 - 59	42	39 - 45	29	26 - 31
2001/02-2005/06	625	59	55 - 62	46	42 - 50	29	25 - 33
2006/07-2010/11	481	64	59 - 68	48	44 - 53	-	-
2011/12-2015/16	685	59	55 - 64	-	-	-	-
Total	2835	59	57 - 61	45	43 - 47	30	28 - 32

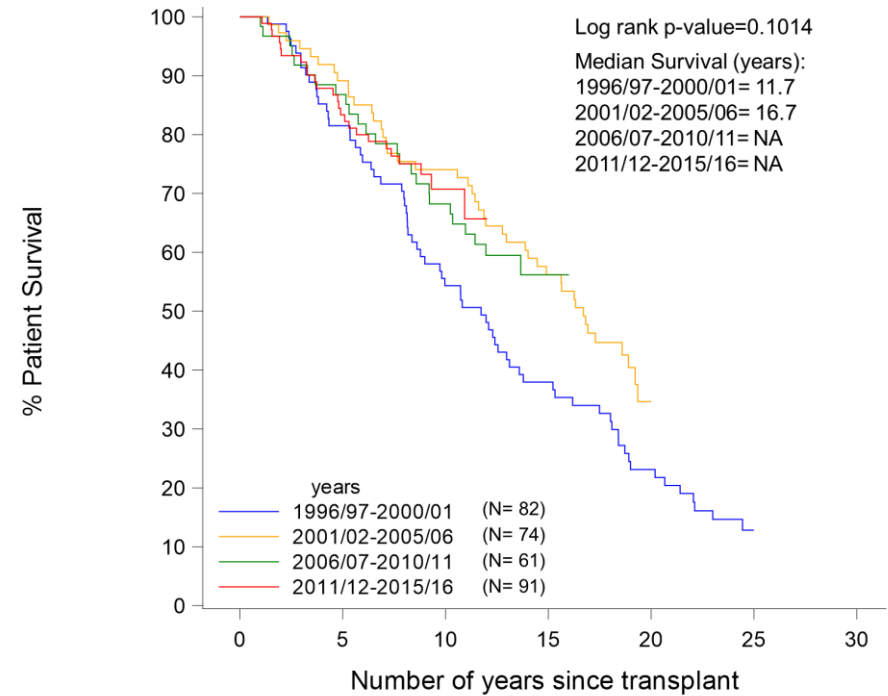
8. **Figures 3a** and **3b** through to **8a** and **8b**, show centre specific survival plots of long-term survival and conditional survival, by era.

Figure 3a Birmingham long-term patient survival post-heart transplant stratified by era, for transplants performed 1 April 1996 - 31 March 2016



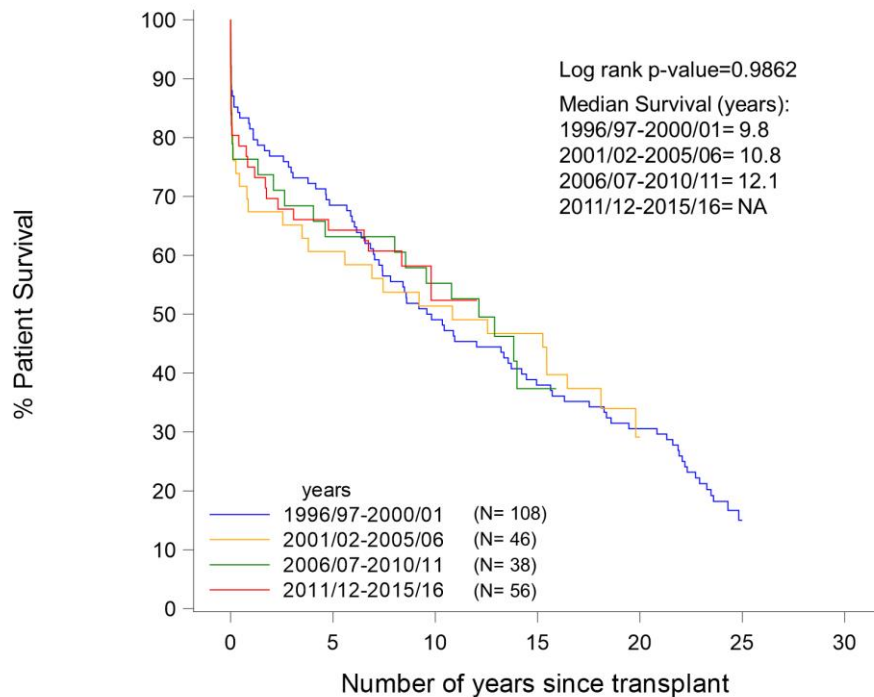
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	102	66	44	30	17
2001/02-2005/06	86	65	54	40	10
2006/07-2010/11	79	52	40	11	
2011/12-2015/16	115	74	20		

Figure 3b Birmingham long-term patient survival post-heart transplant, stratified by era and conditional on surviving the first year, for transplants performed 1 April 1996 - 31 March 2016



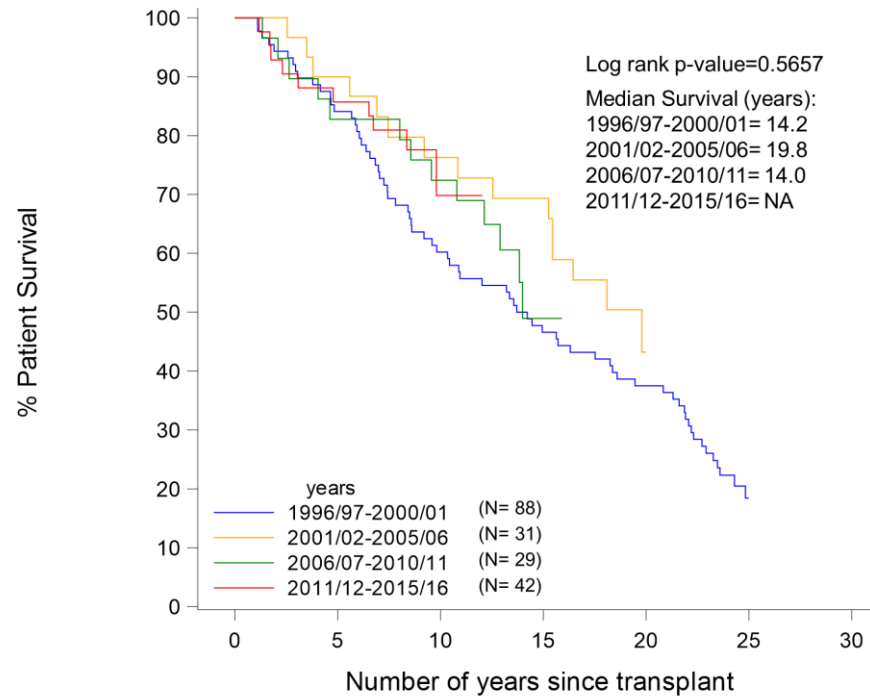
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	82	66	44	30	17
2001/02-2005/06	74	65	54	40	10
2006/07-2010/11	61	52	40	11	
2011/12-2015/16	91	74	20		

Figure 4a Glasgow long-term patient survival post-heart transplant stratified by era, for transplants performed 1 April 1996 - 31 March 2016



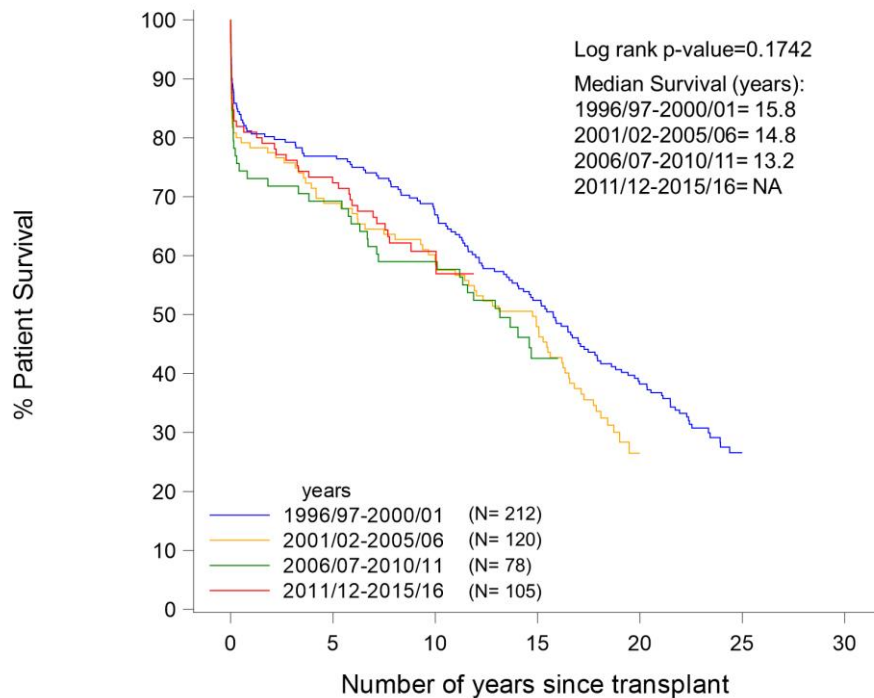
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	108	74	53	41	33
2001/02-2005/06	46	27	22	20	4
2006/07-2010/11	38	24	21	4	
2011/12-2015/16	56	36	7		

Figure 4b Glasgow long-term patient survival post-heart transplant, stratified by era and conditional on surviving the first year, for transplants performed 1 April 1996 - 31 March 2016



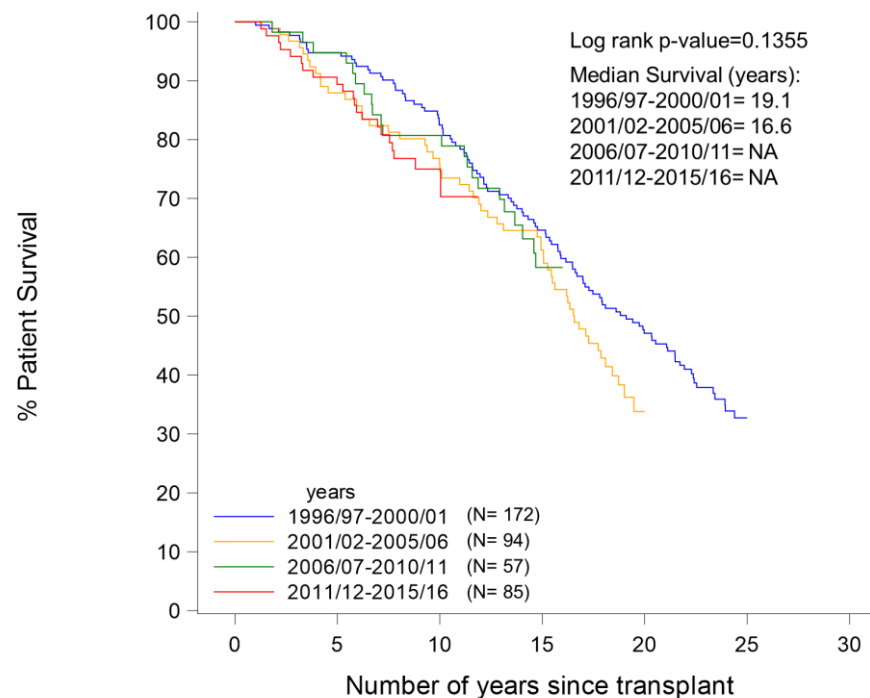
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	88	74	53	41	33
2001/02-2005/06	31	27	22	20	4
2006/07-2010/11	29	24	21	4	
2011/12-2015/16	42	36	7		

Figure 5a Harefield long-term patient survival post-heart transplant stratified by era, for transplants performed 1 April 1996 - 31 March 2016



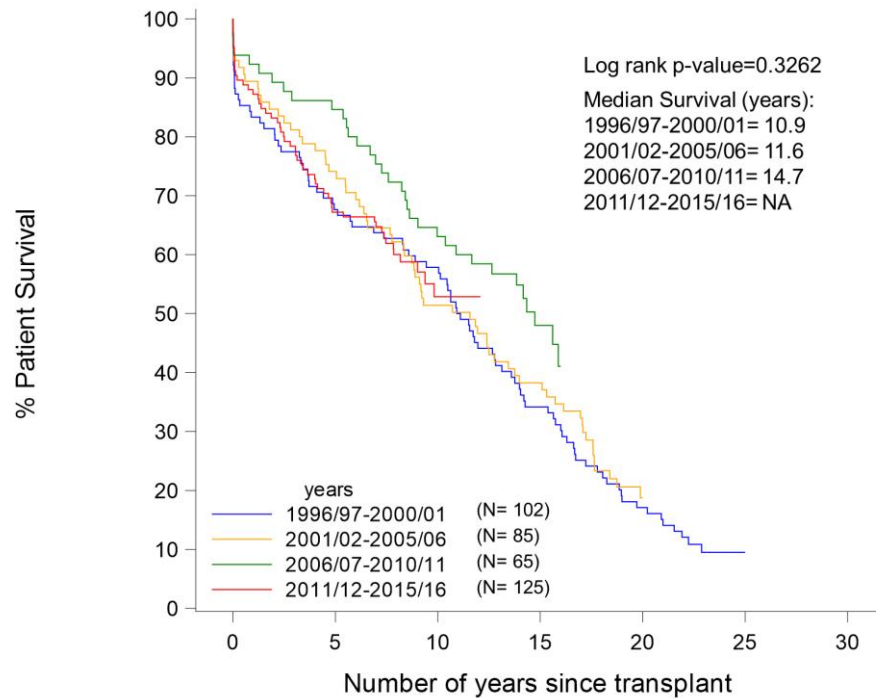
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	212	163	140	107	78
2001/02-2005/06	120	79	68	55	14
2006/07-2010/11	78	54	45	17	
2011/12-2015/16	105	75	18		

Figure 5b Harefield long-term patient survival post-heart transplant, stratified by era and conditional on surviving the first year, for transplants performed 1 April 1996 - 31 March 2016



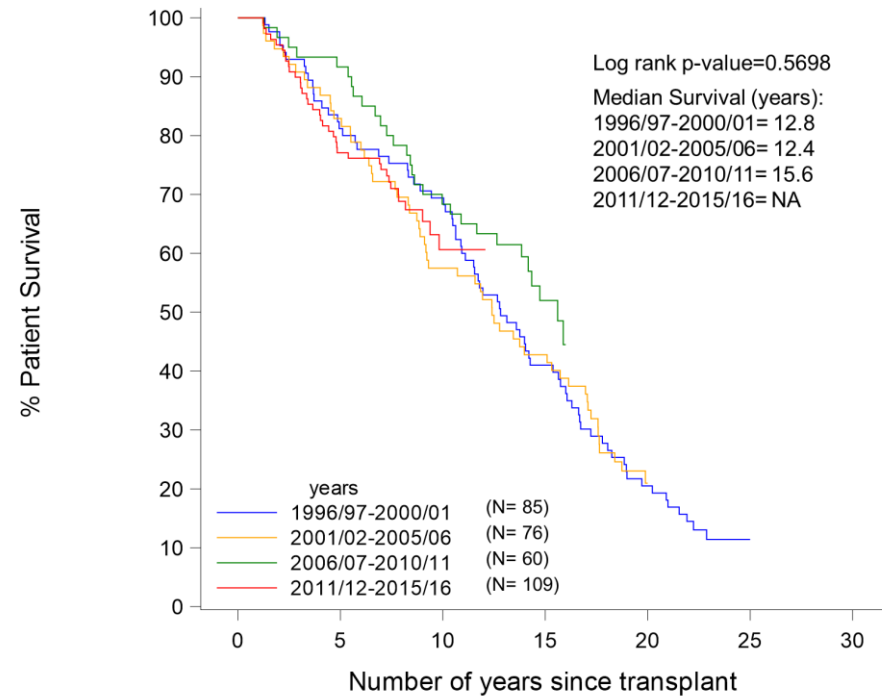
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	172	163	140	107	78
2001/02-2005/06	94	79	68	55	14
2006/07-2010/11	57	54	45	17	
2011/12-2015/16	85	75	18		

Figure 6a Manchester long-term patient survival post-heart transplant stratified by era, for transplants performed 1 April 1996 - 31 March 2016



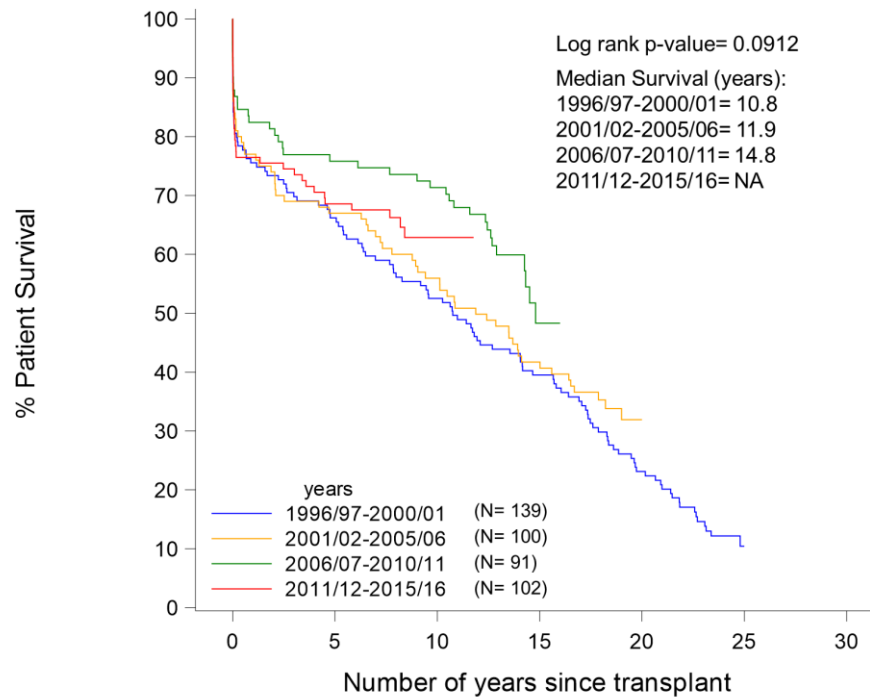
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	102	69	59	34	17
2001/02-2005/06	85	62	43	32	10
2006/07-2010/11	65	55	41	16	
2011/12-2015/16	125	84	18		

Figure 6b Manchester long-term patient survival post-heart transplant, stratified by era and conditional on surviving the first year, for transplants performed 1 April 1996 - 31 March 2016



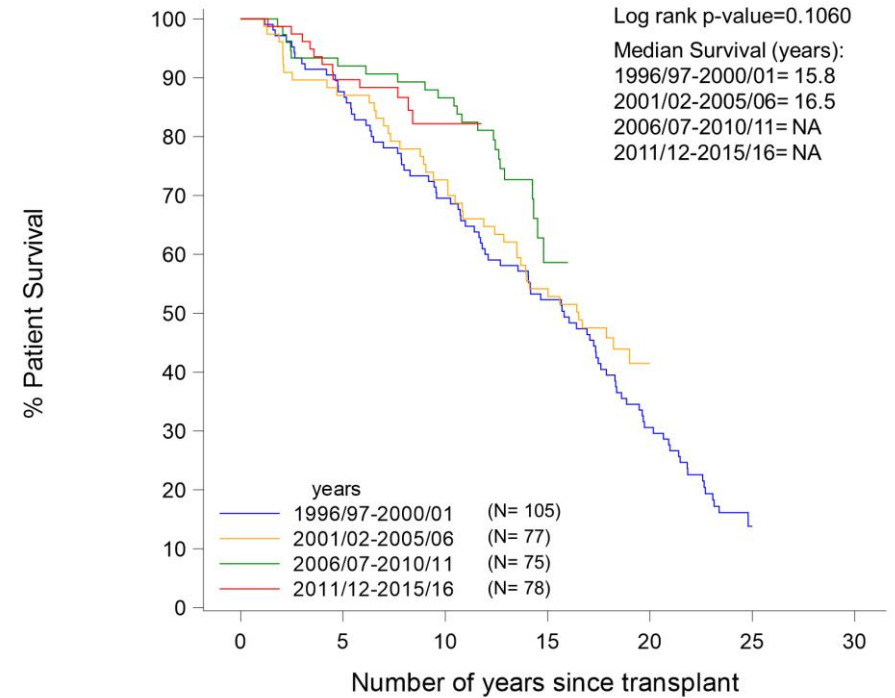
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	85	69	59	34	17
2001/02-2005/06	76	62	43	32	10
2006/07-2010/11	60	55	41	16	
2011/12-2015/16	109	84	18		

Figure 7a Newcastle long-term patient survival post-heart transplant stratified by era, for transplants performed 1 April 1996 - 31 March 2016



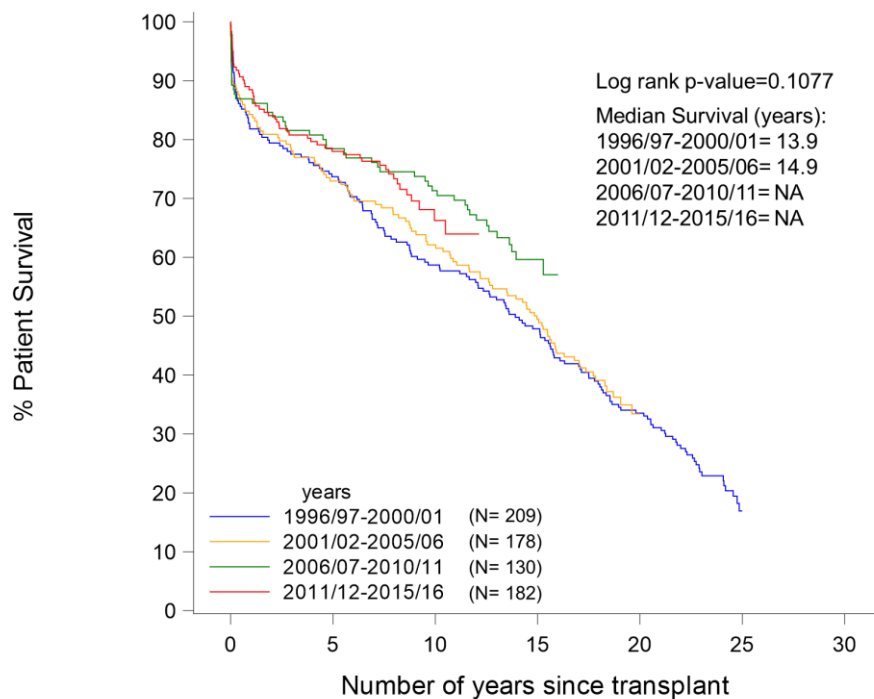
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	139	92	73	53	31
2001/02-2005/06	100	67	55	41	11
2006/07-2010/11	91	68	63	7	
2011/12-2015/16	102	69	7		

Figure 7b Newcastle long-term patient survival post-heart transplant, stratified by era and conditional on surviving the first year, for transplants performed 1 April 1996 - 31 March 2016



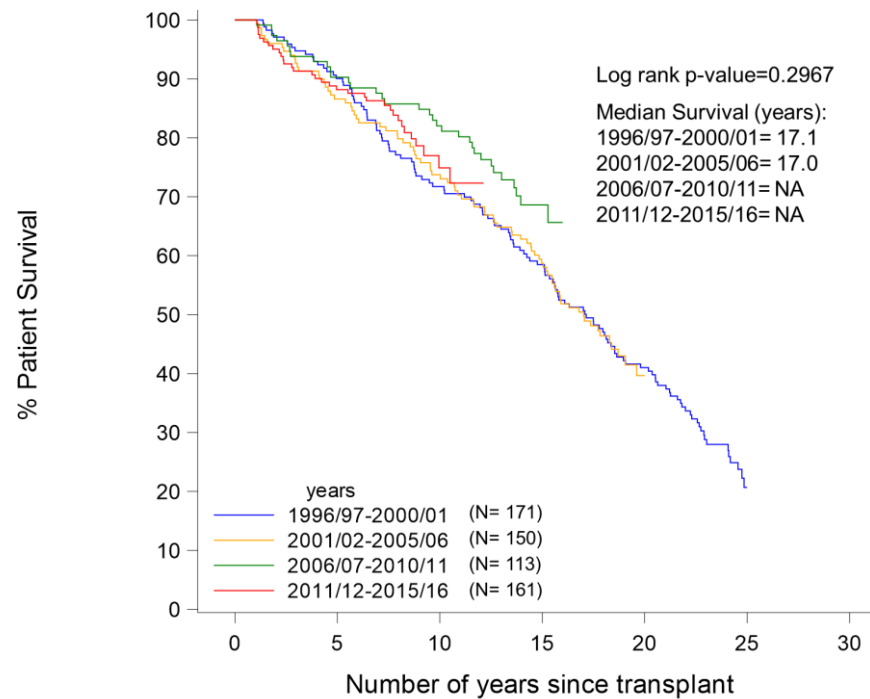
	Number at risk				
	0	5	10	15	20
1996/97-2000/01	105	92	73	53	31
2001/02-2005/06	77	67	55	41	11
2006/07-2010/11	75	68	63	7	
2011/12-2015/16	78	69	7		

Figure 8a Papworth long-term patient survival post-heart transplant stratified by era, for transplants performed 1 April 1996 - 31 March 2016



	Number at risk				
	0	5	10	15	20
1996/97-2000/01	209	154	120	97	68
2001/02-2005/06	178	128	108	86	19
2006/07-2010/11	130	100	88	26	
2011/12-2015/16	182	141	36		

Figure 8b Papworth long-term patient survival post-heart transplant, stratified by era and conditional on surviving the first year, for transplants performed 1 April 1996 - 31 March 2016



	Number at risk				
	0	5	10	15	20
1996/97-2000/01	171	154	120	97	68
2001/02-2005/06	150	128	108	86	19
2006/07-2010/11	113	100	88	26	
2011/12-2015/16	161	141	36		

LIMITATIONS/POSSIBLE FUTURE WORK

9. These analyses do not adjust for possible changes in risk factors overtime or between centres. Transplants in the earlier eras may not provide accurate estimates for patients transplanted today and transplants in the most recent eras have not accrued enough follow-up time to produce medians.
10. There are more sophisticated statistical methods that can be used to generate estimates of median survival times, including Weibull models for life expectancy and period analysis. These could be explored as possible future work.

CONCLUSIONS

11. This analysis shows that the overall UK median survival time following adult heart transplantation is 13.2 years, but after excluding those patients who died within the first year post-transplant, the median is 16.2 years. Considering just those patients transplanted in the most recent transplant era (2011/12-2015/16), the proportion of patients still alive is still above 50%.
12. The International Society for Heart and Lung Transplantation reported medians of 12.5 years, and 14.8 years conditional on surviving the first year, for transplants performed between 2002-2009. In a comparable transplant era 2001/02-2005/06, the UK estimates are 13.5 years and 16.3 years conditional on surviving the first year.
13. Centre-specific long-term survival curves, both conditional and non-conditional, are provided for interest.
14. Nationally, 64 patients survived beyond 25 years following heart transplantation.

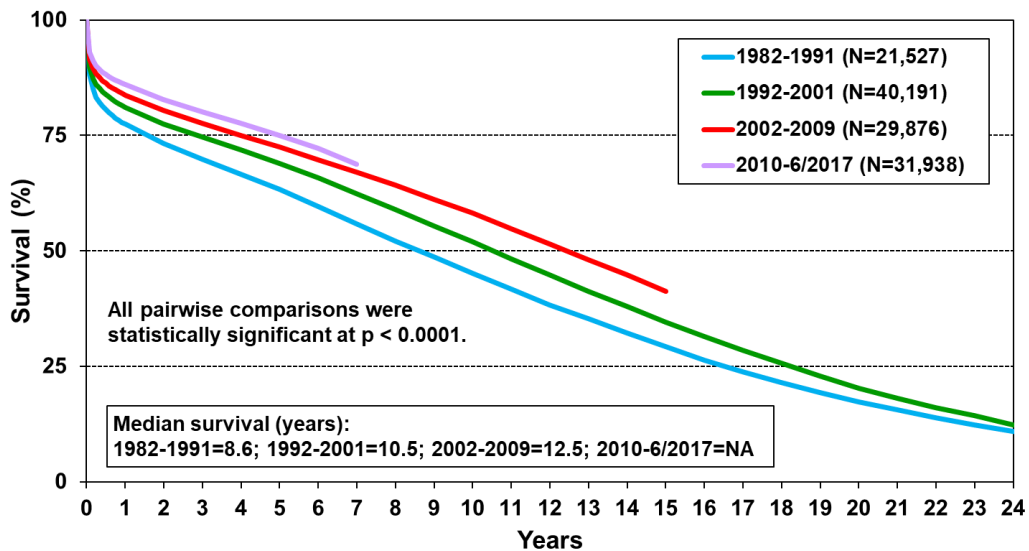
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Statistics and Clinical Research

October 2023

APPENDIX

Appendix A ISHLT: Long-term survival post-heart transplant, stratified by era of transplant

**Adult Heart Transplants
Kaplan-Meier Survival by Era**



Appendix B ISHLT: Long-term survival post-heart transplant, stratified by era of transplant and conditional on surviving the first year

**Adult Heart Transplants
Kaplan-Meier Survival by Era Conditional on Survival to 1 Year (Transplants: January 1982 – June 2017)**

