Impact of changing trend in cold ischaemic time on operating times in renal transplantation

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ABSTRACT

INTRODUCTION The European Working Time Directive (EWTd) is calling for reduction in the working hours of doctors. Renal transplantation is well-recognised as an out-of-hours specialty. Our study looks at whether our renal transplant centre's attempt to reduce cold ischaemic time (CIT) has impacted on the pattern of operating times since this may have implications on the surgeons' working hours.

PATIENTS AND METHODS We studied 883 adult cadaver kidney transplants performed between 1 January 1992 and 31 December 2002. CIT and time of surgery was obtained from a local audit database (<www.nwhta.org>) and that held by UK Transplant. Time of surgery was divided into 07:30–17:59 (day), 18:00–23:59 (evening) and 00:00–07:29 (night).

RESULTS CIT has decreased since 1992, with a significant reduction after 1998 ($P = 0.0001$). There was, however, no difference in the percentage of operations performed during the three time periods before and after 1998. Between 1999–2002, 51.4% of transplants took place out of hours (*i.e.* 18:00–07:29).

CONCLUSIONS Reduction in CIT does not appear to have impacted on our operating times. The large amount of out-of-hours work is, however, not compliant with EWTd requirements.

KEYWORDS

Cold ischaemic time – European Working Time Directive – Operating times – Renal transplantation

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Renal transplantation in our centre, and in most of the UK, is carried out on the emergency theatre list, competing for priority amongst other urgent, non-scheduled surgical procedures. This together with the 'randomness' in availability of donors has resulted in transplant surgery being known as an 'out-of-hours' specialty.

It is well-established that a short cold ischaemia time (CIT) is an important factor for both the short-term but, more importantly, the long-term outcome of renal allograft function and survival.^{1,2} Attempting to achieve shorter CIT has, therefore, become an important aim for our unit. In this study, we tried to establish how successful we have been in achieving this over the last 11 years bearing in mind the constraints of limited facilities. During this period, our centre provided renal transplantation services to the whole of the north-west region of England, covering patients from four adult dialysis centres and an adult population of 4.5

million. On average, 110 cadaveric, adult, renal-only transplants and 55 organ retrievals were carried out in a year.

The other prompt for our study was the European Working Time Directive (EWTd). In 1998, the UK Government decided to implement the EWTd as health and safety legislation law. Amongst medical practitioners, the original legislation applied to consultants only. This has, however, extended to trainees. The aim is to reduce the working hours of doctors in training gradually, eventually to 48 h/week, including on-call, by the year 2009.⁵ We showed in a previous study that just over half of the renal transplants in our centre between 1998 and 2001 were performed outside normal working hours. The majority of operations performed within normal working hours as well as out-of-hours involved trainee surgeons; indeed, two-thirds were performed in the absence of a consultant.⁴ Implementing the EWTd will certainly have a major impact on the current practice of renal transplantation in the UK.

Our study looked to see if, through the years, our centre has been successful at reducing CIT and, particularly, whether the attempts to reduce CIT has impacted on the pattern of operating times and the amount of out-of-hours operations performed.

Patients and Methods

Study population

A total of 1197 cadaveric kidney transplants into adult recipients were performed at our centre between 1 January 1992 and 31 December 2002.

Parameters

Cold ischaemic time (CIT) was obtained from a local audit database (<www.nwhta.org>). The time of surgery, indicated by the out-of-ice time, was obtained from data recorded by our centre and held at UK Transplant. We designated three time periods assuming that surgery was completed on average 1.5 h after the stated out-of-ice time.

1. 07:30–17:59. Day. This would be within a 12-h working period as stated by the EWTD.
2. 18:00–23:59. Evening. Considered acceptable operating times by surgeons to allow for a 6-h uninterrupted rest period.
3. 00:00–07:29. Night. Considered to be the rest period and hence less acceptable.

Statistical analysis

The chi-square test was used to compare categorical variables. Mann-Whitney U or Kruskal-Wallis tests were used for continuous variables. Cold ischaemic times were expressed as median (minimum–maximum) since distribution was not always normal. *P*-values <0.05 were considered to be statistically significant. The SPSS statistical package (Chicago, IL, USA) was used for all calculations.

Results

Only complete data sets were analysed. This gave a total number of 883 patients over the 11-year period. For each individual year, more than two-thirds of patients were analysed (range, 67.7–92.5%), with the exception of 1997 when only 56/106 (52.8%) of patients had complete data sets. Overall, 883/1197 (73.8%) of patients were analysed. Less than 5% of incomplete data was due to missing CIT, the rest were due to lack of recording of out-of-ice time.

Cold ischaemic time

There has been a reduction in CIT over the years (Fig 1). There appears to be two step-wise decreases, in 1996 and 1999, respectively. The reduction in CIT is significantly

different between the 1992–1998 group, median = 24.00 h (range, 10–48 h; *n* = 539) compared to 1999–2002, 20.25 h (range, 3–42 h; *P* = 0.0001). CIT for 1992–1995 versus 1996–1998 was not significantly different.

Figure 2 Percentage of operations performed within each year for each time period. The time periods are coded as shown.

Operating times

Figure 2 shows the percentage of transplants performed within the years 1992–2002 for each of the three time periods.

Comparing the percentage of transplants occurring during the day, evening and night before and after 1998, we see that these were almost identical for each time period (Fig. 3). The largest number of operations occurred within normal working hours (48.6%), but as many as 36.8% occurred in the evening. Considering the two out-of-hours time periods together (*i.e.* 18:00–07:29), between 1999–2002, 51.4% of transplants took place out-of-hours.

CIT versus operating time

Figure 4A–C shows the distribution of CIT for each time period. The distribution was normal for the night and evening. However, for the day, there was a bimodal distribution with two peaks around 18 h and 36 h.

If the years were divided into before 1998 and after, the distribution for each was similar to the total except that CIT was significantly lower after 1998 for day and evening. For both daytime and evening, $P = 0.0001$. However, for night-time, this was not significant (Table 1).

If we divide CIT into ≤ 24 h versus > 24 h (*i.e.* short and long CIT), there is a significant difference in percentage within each time period of these two CIT groups both before 1998 ($P = 0.30$) and after ($P = 0.0001$). For each time period, there were more kidneys with CIT ≤ 24 h than CIT > 24 h, except for night-time. Comparing ≤ 1998 and > 1998 , the only significant increase in CIT ≤ 24 -h kidneys was for evening ($P = 0.0001$; Table 2).

Discussion

We know from our previous study that operating out-of-hours has no significant impact on incidence of surgical complications, nor on peri-operative mortality.⁴ The importance of

Table 1 CIT within each time period for 1992–1998 compared to 1999–2002

	1992–1998	1999–2002
00:00–07:29 ($P = 0.154$)	25.30 (12–38) $n = 81$	24.10 (12–34) $n = 48$
07:30–17:59 ($P = 0.0001^*$)	24.00 (10–47) $n = 261$	19.20 (10–43) $n = 168$
18:00–23:59 ($P = 0.0001^*$)	23.00 (10–48) $n = 197$	20.00 (3–42) $n = 128$

CIT values are in hours, median (minimum–maximum).

P -values (Mann-Whitney U-test) are for the difference in CIT within the same time period before and after 1998.

*Denotes statistical significance.

n , number of operations.

Table 2 The number of kidneys with CIT ≤ 24 h versus > 24 h within each operating time period for 1992–1998 compared to 1999–2002

1992–1998 (<i>P</i> = 0.030*)				1999–2002 (<i>P</i> = 0.0001*)			
	00:00–07:29	07:30–17:59	18:00–23:59		00:00–07:29	07:30–17:59	18:00–23:59
≤ 24 (<i>n</i> = 298)	44.4%	54.0%	61.4%	≤ 24 (<i>n</i> = 235)	50.0%	61.9%	83.6%
> 24 (<i>n</i> = 241)	55.6%	46.0%	38.6%	> 24 (<i>n</i> = 109)	50.0%	38.1%	16.4%

P -values (chi-squared test) are for the difference in the two CIT groups across the three time periods before and after 1998.

*Denotes statistical significance.

Number of operations done within the time period is shown in parentheses.

lowering CIT for optimal allograft outcome is well-established.² This has been the aim in our centre for the last 5 years. Our findings in this study suggest that we have succeeded in our aim. This, however, does not appear to have been at the expense of more operations occurring out-of-hours.

A high percentage of cases (~20%) was not analysed due to missing out-of-ice time data. Only < 5% was due to missing data on cold ischaemic time. Between 1992–1998, excluding 1997 when about half of the data was incomplete, 22.5% of out-of-ice data was missing while between 1999–2002, only 9% of out-of-ice data was missing. We admit that a bias may be introduced if this was a function of operating time though we have no cause to suspect that this was the case.

Looking at the trend in CIT over the 11 years, there appeared to be two step-wise decreases, one in 1996, the second in 1999. The importance of lowering CIT was brought to light by our group and others in 1995.^{1,2} One of the aims of our unit was then to reduce CIT. We were, therefore, interested as to whether we had been effective in achieving this. Our analysis showed that while the trend in CIT appeared to be lower from 1996, this did not achieve statistical significance until after 1998.

It appears that the reduction in CIT was most successful in the 18:00–23:59 time period. There was a bimodal distribution of CIT for 07:30–17:59 and we failed to reduce CIT significantly in the 00:00–07:29 time period. With the implementation of emergency theatres since the National Confidential Enquiry into Peri-Operative Deaths report in 1997,⁵ renal transplant surgeons have had improved access to theatre facilities. The fact that the bimodal distribution pattern was seen before 1998 suggests that this distribution is not related to theatre access nor associated with our understanding of the importance of lowering CIT. Our failure to lower CIT during the night-time suggests that the reason(s) for reduction in CIT was not or could not be implemented for this time period. We also did not significantly increase the percentage of short ischaemic time kidneys (≤ 24 h) transplanted between 07:30–17:59. Both success in lowering CIT and better theatre access do not, however, appear to have impacted on our operating practices, with the percentage of operations occurring within each time period remaining unchanged through the years. Why this is so is unclear.

Some groups have shown that one of the most effective ways to minimise CIT before transplantation is to perform as much of the histocompatibility testing (HLA typing, ABO,

and preliminary cross-matching) as possible prior to kidney retrieval including the final cross-match. This is dependent on the co-operation of organ procurement co-ordinators, HLA technologists, renal placement co-ordinators and organ procurement organisation pilots.⁶ Other groups have shortened the time needed to perform the various histocompatibility testing (Class I and II typing, cross-match, etc.).⁷⁻⁹

There has been a rapid and sustained rise in the number of adult patients treated with renal replacement therapy over the past two decades. Renal transplantation provides the best quality of life and survival for suitable renal replacement therapy patients. The National Renal Workforce Planning Group 2002 (<www.britishrenal.org>) aims for the number of transplants to double between now and 2010.¹⁰ The man-power required for this means that the current number of transplant surgeons needs to increase from 81 to 131. A minimum of 5 surgeons are required per centre to allow for a workable on-call rota, the current median number of surgeons per unit is 3 (range, 1–6). Even then, this ‘workable’ rota is compliant only with current working practices. With the recommendation that organ procurement be consultant-led, this will not meet the criteria set by the EWTD.

We know that day-time emergency operating lists reduces the need to operate out-of-hours.¹¹ This involves emergency and elective surgical activity being separate, with different teams of surgeons. This also provides a better environment for teaching and training.¹² Transplantation is highly-specialised with a small core of trained surgeons, and even smaller number of trainees. The ‘up all night’ reputation contributes to its unpopularity as a career choice.¹³ Reducing the amount of out-of-hours work may induce more to enter the specialty.

Conclusions

There are increasing targets for renal transplants, and the need for more transplant surgeons. There is also the need to meet the EWTD requirements while at the same time reducing the CIT. There would hence appear to be a need to change operating practices. We believe that in order to achieve both these aims, we need to have a dedicated

theatre for transplantation. Whether financing this can be considered a priority by the strategic health authority is another question.

References

1. Peters TG, Shaver TR, Ames 4th JE, Santiago-Delpin EA, Jones KW. Cold ischaemia and outcomes in 17,937 cadaveric kidney transplants. *Transplantation* 1995; **59**: 191–6.
2. Connolly JK, Dyer PA, Martin S, Parrott NR, Pearson RC, Johnson RWG. Importance of minimizing HLA-DR mismatch and cold ischaemic time in cadaveric renal transplantation. *Transplantation* 1996; **61**: 709–14.
3. Burke D. Making the European Working Time Directive a reality. *BMJ* 2002; **325**: S66.
4. Seow YY, Alkari B, Dyer P, Riad H. Cold ischaemic time, surgeon, time of day and surgical complications. *Transplantation* 2004; **77**: 1386–9.
5. Campling EA, Devlin HB, Hoile RW, Ingram GS, Lunn JN. *Who operates when? A report by the National Enquiry into Peri-operative Deaths 1 April 1995 to 31 March 1996*. London: National Enquiry into Peri-operative Deaths, 1997.
6. Bryan CF. Cold ischaemic time added to kidneys can be minimized by completing the final cross-match before organs are taken from the operating room. *Clin Transplant* 2003; **17**: 58–64.
7. Breton SR, Breggia AC, Emmons RA, Szarkowski MA, Mahoney RJ. Immunomagnetic bead cell isolates reduce kidney donor cold ischaemic time, STAT crossmatch time and histocompatibility test cost. *Clin Transplant* 1997; **11**: 569–73.
8. Vaidya S, Orchard P, Schroder N, Haneke R, Brooks K, Thomas A *et al*. *Clin Transplant* 1995; **9**: 165–70.
9. Gnant MF, Rosenmayr AM, Wamser P, Goetzinger P, Sautner T, Laengle F *et al*. Pre-nephrectomy tissue typing using donor lymph node cells. A reliable and safe way of shortening cadaver kidney ischaemia time. *Transplant Proc* 1991; **23**: 2683–4.
10. National Renal Workforce Planning Group. *The renal team, a multi-professional renal workforce plan for adults and children with renal disease*. Recommendations of the National Renal Workforce Planning Group. London: 2002.
11. Scriven MW, Pye JK, Masoud A, Crumplin MK. The use and impact of a daily general surgical emergency operating list in a district general hospital: a prospective study. *Ann R Coll Surg Engl* 1995; **77** (Suppl): 117–20.
12. Addison PD, Getgood A, Paterson-Brown S. Separating elective and emergency surgical care (the emergency team). *Scott Med J* 2001; **46**: 48–50.
13. Darby CR. Transplant surgeons in training: the present and their future? *Ann R Coll Surg Engl* 1996; **78** (Suppl): 7–10.