

# Comparison of nighttime and daytime operation on outcomes of kidney transplant with deceased donors: a retrospective analysis

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## Abstract

**Background:** Kidney transplant is always emergent operations and frequently need to be performed at nighttime to reduce cold ischemia time (CIT). Previous studies have revealed that fatigue and sleep deprivation can result in adverse consequences of medical procedures. This study aimed to evaluate whether nighttime operation has adverse impact on kidney transplant.

**Methods:** A retrospective analysis of recipients accepted kidney transplant from deceased donors in one center from 2014 to 2016 was performed. Daytime transplant was defined as operation started after 8 AM or ended before 8 PM and nighttime operation was defined as operation ended after 8 PM or started before 8 AM. The incidences of complications such as delayed graft function, acute rejection, surgical complications and nosocomial infections were compared between 2 groups. Student's *t*-test was used to analyze continuous variables such as serum creatinine (Scr) at 1-year of post-transplant. The Chi-square test was used to analyze categorical variables. Differences in recipients and graft survival were analyzed using Kaplan–Meier methodology and log-rank tests.

**Results:** Among the 443 recipients, 233 (52.6%) were classified into the daytime group and the others 210 (47.4%) were in the nighttime group. The 1-year survival rate of recipients was similar for the recipients in the daytime and nighttime groups (95.3% *vs.* 95.2%,  $P=0.981$ ). Although the 1-year graft survival rate in the nighttime group was slightly superior to that in the daytime group, the difference was not significant (92.4% *vs.* 88.4%,  $P=0.164$ ). Furthermore, Scr and incidence of complications were also not significantly different between the 2 groups.

**Conclusions:** Our results suggested that operation time of kidney transplant with short CIT has no significant impact on the outcome of kidney transplant. Nighttime operation of kidney transplant with short CIT could be postponed to the following day to alleviate the burden on medical staffs and avoid the potential risk.

**Keywords:** Kidney transplant; Delayed graft function; Donation after cardiac death; Nighttime transplant

## Introduction

Kidney transplant is often an emergent procedure to keep shorter cold ischemia time (CIT). Prolonged CIT will lead to higher graft failure.<sup>[1,2]</sup> Performance of kidney transplant from deceased donor largely depends on the time of kidney donation and transport. In general, when there is a donation, there will be a transplant.

In China, doctors often overwork and are in the condition of fatigue and sleep deprivation according to the report of occupational status for Chinese doctors in 2017 from the Chinese Medical Doctor Association and a survey in the most popular bio-medical website in China.<sup>[3,4]</sup> But very few studies have focused on the relationship of adverse clinical outcomes with overwork of Chinese medical staffs. In particular, the number of organs transplant from

donation after cardiac death (DCD) has dramatically increased to alleviate the organ shortage after initiation of DCD from 2010.<sup>[5,6]</sup> Undoubtedly, experts in kidney transplant will face great psychosomatic challenge from emergent operations. Therefore, we retrospectively collected data of kidney transplant after DCD from January 2014 to December 2016 in a single-center to explore whether operation time is associated with outcome of recipients and grafts in kidney transplant.

## Methods

### Study design and ethical approval

A single-center retrospective study was conducted in First Affiliated Hospital of Xi'an Jiaotong University, China. All courses of DCD were performed by the Organ Procure-

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ment Organization of the First Affiliated Hospital of Xi'an Jiaotong University and supervised by the Red Cross Society of Shaanxi Province. All allograft kidney transplants were approved by the Ethics Committee of the hospital. The process of DCD in China has been described previously.<sup>[7]</sup> Prospective data of donors and recipients were retrospectively collected from the Registry System of Organ Donation Database and Electronic Medical Record System. Recipients who received dual kidneys, children's kidney or combined liver transplant were excluded. At last, 443 patients received kidney transplant from DCD from January 1, 2014 to December 31, 2016 were collected. Transplant operations started after 8 AM or ended before 8 PM were assigned into the daytime group. In other words, daytime operations were only performed between 8 AM and 8 PM. Transplant operations that ended after 8 PM or started before 8 AM were classified into the nighttime group.

### Transplant procedures

All kidney transplants were operated by vice-chief or chief transplant surgeons in the Department of Kidney Transplantation of our hospital and started at skin incision and ended at skin closure. The donor's kidney was placed at iliac fossa of recipient outside the peritoneal cavity. Donor renal artery (arteries) was anastomosed to internal or external iliac artery (end-to-end or end-to-side) of the recipient. Conversely, donor renal vein was anastomosed to the external iliac vein of the recipient. Extra-vesical anti-reflexive technique was applied in the anastomosis between ureter and bladder. Routinely, suitable ureteral stent was placed to prevent stricture of uretero-vesical junction before uretero-vesical anastomosis.

### Outcomes

Surgical complications after kidney transplantation within the first year were analyzed. The complications only associated with operative procedures were considered as surgical complications including vascular, urological, wound complications and hematoma around graft. Graft artery stenosis and rupture, graft vein thrombosis and rupture, and dissection of artery were considered vascular complications. Ureteral stricture, ureteral thrombosis of graft, and urine leakage were considered as urological complications.

Patient and graft survival were followed up for 1 day to 48 months or from the operation day to January 2018 by outpatient follow-up and telephone follow-up with interquartile range of 18.5 months and median of 22 months. Restart of renal replacement therapy was the hallmark of graft failure. Graft function was analyzed based on the level of serum creatinine (Scr) at 1-year of post-transplant and 1-year graft survival. Delayed graft function (DGF), acute rejection (AR) and nosocomial infections were also analyzed. DGF was defined as i) need dialysis in the first week of post-transplantation and ii) Scr >221  $\mu\text{mol/L}$  (2.50 mg/dL) on the seventh day of post-transplantation. AR was diagnosed with graft tissue biopsy or clinical inference. Nosocomial infections refer to urological, respiratory, incision and catheter-associated infection after transplantation.

### Statistical analysis

Continuous variables with normal distribution were compared by Student's *t*-test and categorical variables were compared by chi-square ( $\chi^2$ ) test. The measurement data of skewed distribution were analyzed by nonparametric rank sum test. The survival rates of patients and grafts were estimated by Kaplan–Meier methodology and compared using log-rank tests. SPSS 18.0 (IBM Company, USA) was applied to analyze all data. The *P* value less than 0.05 with the 2-side tail test was considered as statistically significant.

## Results

### Baseline demographics

Totally 443 kidney transplant recipients from January 1, 2014 to December 31, 2016 met the enrollment criteria and their data were collected. Table 1 shows the basic characteristics of recipients and donors in the daytime and nighttime groups. Donors in daytime group were significantly older ( $P=0.012$ ) and had significantly higher body mass index (BMI) ( $P=0.018$ ) than those in the nighttime group. Male donors accounted for 79.2% in total. Expanded criteria donors (ECDs) were those >60 years old or 50 to 59 years old with two of the following conditions: hypertension, died from cerebrovascular disease, or Scr >133  $\mu\text{mol/L}$  (1.50 mg/dL) before donation.<sup>[8]</sup> Non-ECDs were standard criteria donors (SCDs). In total, 20.9% kidney grafts were from ECDs, and an increasing trend was shown in the number and ratio of ECD year after year [Figure 1]. Meanwhile, kidney transplant of deceased donors increased rapidly from 2014 to 2016 [Figure 1].

Among the 443 kidney transplants, 233 (52.6%) started after 8 AM and ended before 8 PM and assigned into the daytime group, while 210 (47.4%) ended after 8 PM or started before 8 AM and were classified into the nighttime group. The period from 8 AM to 10 AM was the most frequent time period for kidney transplant [Figure 2]. Duration of dialysis of recipients in daytime group was longer than that of nighttime group ( $P=0.029$ ). The longest CIT among all graft kidneys was 16 h, and CIT was significantly shorter in nighttime group than in daytime group ( $P<0.001$ ). In addition, 78.8% kidneys were preserved by hypothermic machine perfusion (HMP) and the rest were by static cold storage. Meanwhile, HMP was more frequently used in daytime group than in nighttime group ( $P=0.008$ ). End-stage renal disease (ESRD) was developed in most recipients due to chronic glomerulonephritis (79.0%) and IgA nephropathy (11.5%). Moreover, before transplant, 404 (91.2%) recipients had undergone hemodialysis, 37 (8.4%) accepted peritoneal dialysis and 2 (0.5%) did not initiate dialysis. Totally, recipients had been treated with dialysis for approximately 23 months in average before transplant. The HLA mismatch distributed similarly in daytime and nighttime groups. No significant difference was found in operative time between the 2 groups and the mean operative duration was around 178 minutes.

**Table 1: Baseline characteristics of the kidney transplant recipients.**

Characteristics	Daytime group (n=233)	Nighttime group (n=210)	Statistics	P
<b>Donor characteristics</b>				
Age (years)	41.9±16.0	37.9±17.8	2.520*	0.012
Gender, male	184 (79.0)	167 (79.5)	0.021†	0.886
BMI (kg/m <sup>2</sup> )	22.11±3.23	21.24±4.30	2.385*	0.018
ICU stay (day)	2.00 (1.00, 3.00)	3.00 (1.00, 4.00)	-2.112‡	0.035
Scr before procurement (μmol/L)	104.94±72.21	106.24±74.54	0.021*	0.851
Donor type (ECD)	56 (24.0)	37 (17.6)	2.741†	0.098
Year 2014	7/40 (17.5)	8/57 (14.0)	0.216†	0.642
Year 2015	19/77 (24.7)	14/84 (16.7)	1.581†	0.209
Year 2016	30/116 (25.9)	15/69 (21.7)	0.400†	0.527
<b>Recipient characteristics</b>				
Age (years)	36.1±10.2	36.0±10.4	0.148*	0.882
Gender, male	175 (75.1)	147 (70.0)	1.451†	0.228
BMI (kg/m <sup>2</sup> )	20.68±2.96	21.82±3.10	-1.734*	0.086
Duration of dialysis (months)	18.00 (10.00, 34.00)	16.00 (8.00, 26.00)	-2.180‡	0.029
Dialysis modality (HD)	211 (90.6)	193 (91.9)	3.224†	0.617
<b>Causes of ESRD</b>				
Chronic glomerulonephritis	187 (80.3)	163 (77.6)	0.464†	0.496
IgA nephropathy	24 (10.3)	27 (12.9)	0.709†	0.400
Purpura nephritis	8 (3.4)	6 (2.9)	0.120†	0.729
Polycystic kidney	5 (2.2)	4 (1.9)	0.032†	0.857
Hypertensive nephrosclerosis	6 (2.6)	3 (1.4)	0.729†	0.393
Diabetic nephropathy	1 (0.4)	2 (1.0)	0.450†	0.503
Others	2 (0.9)	5 (2.4)	1.646†	0.199
<b>HLA mismatch</b>				
0	18 (7.7)	17 (8.1)		
1	69 (29.6)	72 (34.3)		
2	100 (42.9)	75 (35.7)		
3	33 (14.2)	36 (17.1)		
4	12 (5.2)	6 (2.9)		
5	1 (0.4)	4 (1.9)		
Re-transplant	6 (2.6)	5 (2.4)	0.017†	0.896
<b>Transplant characteristics</b>				
WIT (min)	7.58±2.87	7.78±4.11	-0.591*	0.555
CIT (h)	7.97±3.04	5.40±2.31	9.787*	<0.001
Preservation (HMP)	195 (83.7)	154 (73.3)	7.088†	0.008
Multiple arteries	16 (6.9)	15 (7.1)	0.013†	0.910
Artery anastomosis (end-to-end)	85 (36.5)	74 (35.2)	0.074†	0.785
Operative duration (min)	176.85±49.73	178.50±41.96	-0.375*	0.708

Data were shown as mean ± standard deviation, medial (Q<sub>1</sub>, Q<sub>3</sub>), or n (%). \* *t* values. †  $\chi^2$  values. ‡ *Z* values. BMI: Body mass index; CIT: Cold ischemia time; ECD: Expanded criteria donor; ESRD: End stage renal disease; HD: Hemodialysis; HMP: Hypothermic machine perfusion; ICU: Intensive care unit; Scr: Serum creatinine; WIT: Warm ischemia time.

### Complications and graft function

Table 2 shows outcomes of the recipients. Among all recipients, 16.5% had surgical complications, 12.4% had reoperation, 15.4% had DGF, 10.2% had AR, and 16.9% had nosocomial infection. However, the incidence of complications was not significantly different between recipients in the daytime and nighttime groups. The level of Scr at 1 year of post-transplantation was 99.0±29.9 μmol/L and 104.2±32.7 μmol/L for recipients in the nighttime and daytime groups, respectively, showing no significant difference (*P*=0.113).

Figure 3 shows the long-term survival of recipients and grafts in the 2 groups. The difference in 1-year survival

rate of recipients was not significant in the daytime and nighttime groups (95.3% *vs.* 95.2%, *P*=0.981). The 1-year graft survival rate of recipients in the nighttime group was slightly higher than that in the daytime group by Kaplan-Meier method, but the difference did not reach statistical significance (92.4% *vs.* 88.4%, *P*=0.164). Figure 4 shows the 1-year survival of recipients and grafts for ECDs in the two groups. Similarly, the difference did not reach the significance (92.9% *vs.* 94.6%, *P*=0.713). For ECDs, the 1-year graft survival rate was not significant in the daytime and nighttime groups (82.1% *vs.* 86.5%, *P*=0.555). Cox regression analyses show that no single factor had significant impacts on the survival of recipients and grafts [Table 3].

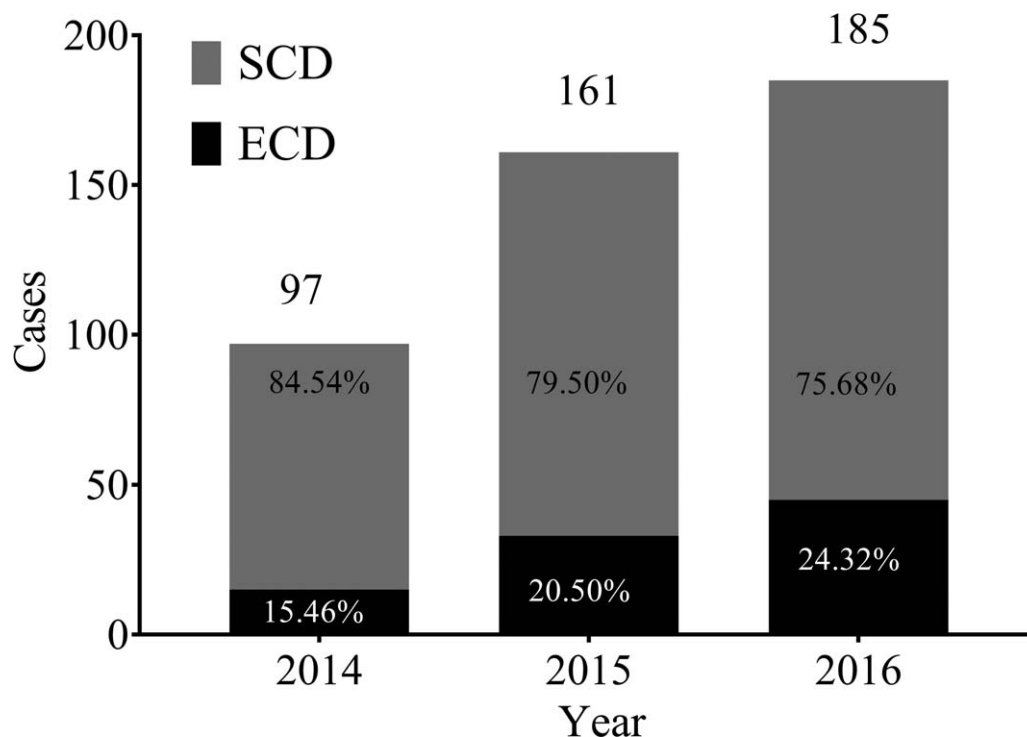


Figure 1: The number of DCD donors and ratio of ECD in our center from 2014 to 2016. DCD: Donation after cardiac death, ECD: Expanded criteria donor, SCD: Standard criteria donors.

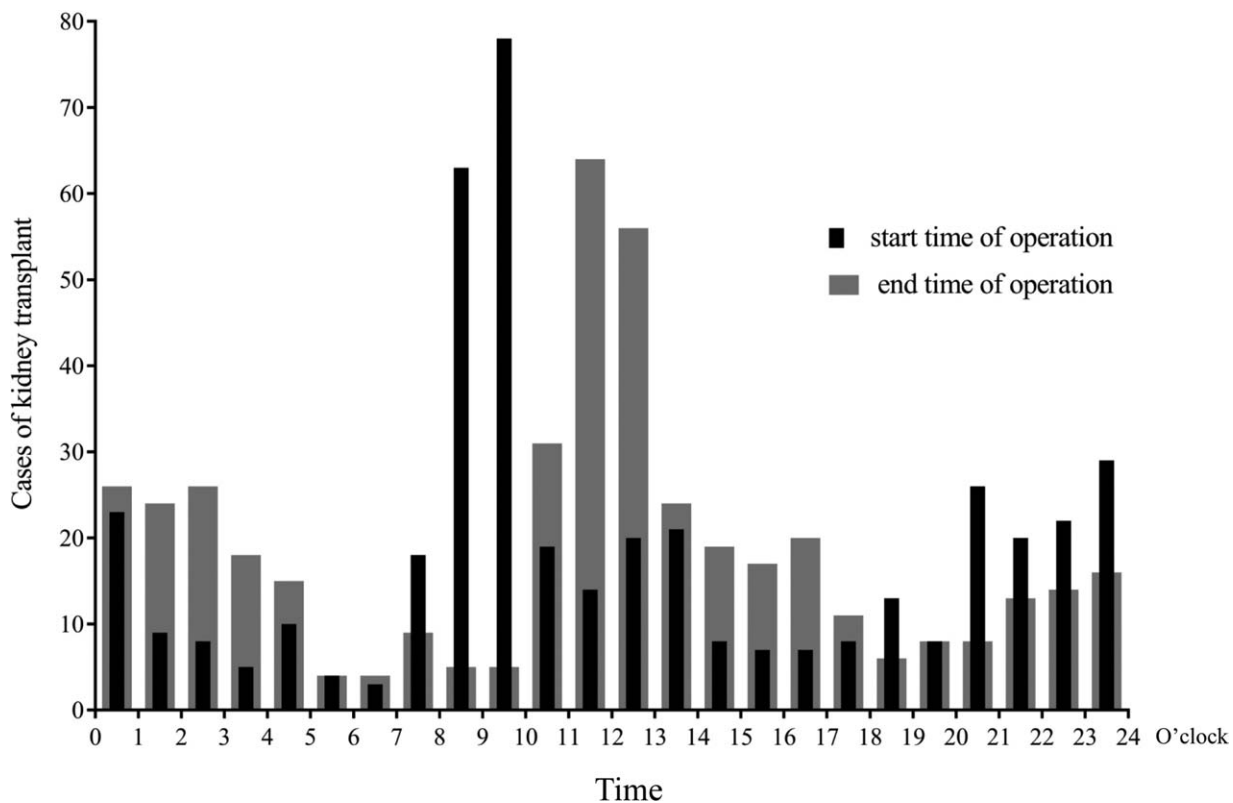


Figure 2: Distribution of beginning and end time of kidney transplant operation.

**Table 2: Outcomes of the kidney transplant recipients.**

Outcomes	Daytime group (n=233)	Nighttime group (n=210)	Statistics	P
Surgical complications	36 (15.5)	37 (17.6)	0.377*	0.539
Vascular	14 (6.0)	16 (7.6)	0.454*	0.501
Urological	14 (6.0)	19 (9.1)	1.480*	0.224
Wound	9 (3.9)	9 (4.3)	0.051*	0.822
Hematoma	4 (1.7)	3 (1.4)	0.059*	0.808
Reoperation	30 (12.9)	25 (11.9)	0.096*	0.757
DGF	41 (17.6)	27 (12.9)	1.909*	0.167
AR	26 (11.2)	19 (9.1)	0.539*	0.463
Biopsy proven	13 (5.6)	6 (2.9)	1.994*	0.158
Clinically inferred	13 (5.6)	13 (6.2)	0.075*	0.785
Nosocomial infection	36 (15.5)	39 (18.6)	0.765*	0.382
Scr at 1 year of post-transplant (μmol/L)	104.21±32.69	99.01±29.85	1.607†	0.113
Hospital stay (day)	23.50±14.86	22.60±9.59	0.748†	0.444

\*  $\chi^2$  values. † *t* values. AR: Acute rejection; DGF: Delayed graft function; Scr: Serum creatinine.

## Discussion

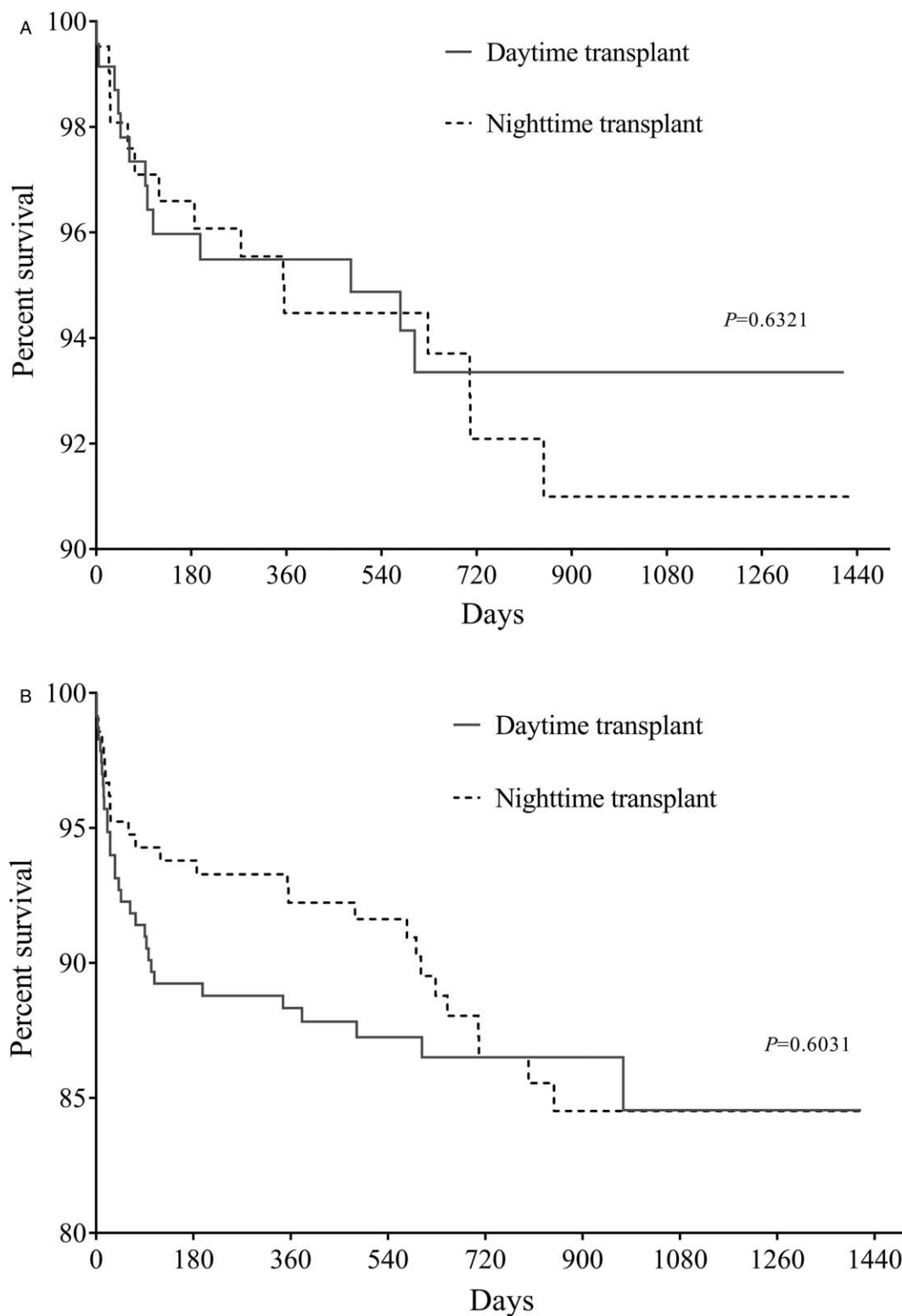
Because of limited time for preservation of kidney grafts, kidney transplant is often an emergent operation to shorten CIT, which is considered as a key risk factor for DGF, AR and even survival in many researches.<sup>[1,2,9-13]</sup> Therefore, it has been common that kidney transplant was operated inevitably at off hours or night, especially with the number of deceased organ donation increasing in China.<sup>[5]</sup> Medical errors caused by fatigue or sleep deficiency were mostly occurred during surgical procedures, but their relationship with poor clinical outcomes and operative time was controversial.<sup>[1,14-17]</sup>

Organ procurement surgeries are usually performed during evening or night because decisions of potential organ donors and diagnosis of brain death are usually made during work hours.<sup>[18]</sup> Procedures before kidney transplantation including allocation, organ transport and recipient's preparation take much time.<sup>[19,20]</sup> Thus, 30% to 36% kidney transplantations started at nighttime (8 PM – 8 AM),<sup>[1,21,22]</sup> which inevitably requires surgeons majoring in kidney transplant work for excessive duty hours. Some studies showed that sleep deprivation and fatigue result in reduced cognitive and psychomotor performance and risky decisions in doctors, drivers and pilots.<sup>[16,23,24]</sup> Moreover, 98,000 deaths resulted from medical errors annually from the report in the Institute of Medicine could be prevented.<sup>[25]</sup> It seems plausible that sleep loss and fatigue due to heavy workload may be risk factors in medical operations for surgeons. Evidences from kidney transplant, cardiothoracic, general and vascular surgeries showed that increased surgical complications were associated with after-hours or nighttime work.<sup>[16,17,22,26]</sup> However, 3 studies in kidney transplantation did not support the link between sleep deprivation and surgical complications,<sup>[1,27,28]</sup> in consistency with our results, but not with the finding of Brunschot *et al*<sup>[21]</sup> that less graft failure excluding non-surgical factors happened in nighttime transplant.

CIT plays a critical role in prognosis of graft and recipients in kidney transplant. In most transplant cases, 18-h-period

has been considered as the safe cutoff of CIT.<sup>[1,10,29]</sup> In our cohort, although daytime transplant had significantly longer CIT, the longest CIT (16 hours) and median CIT (6 hours) were still shorter than the safe cutoff. In one hand, China has a vast territory and organ transportation largely, even completely depends on automobiles in some areas, which could lead to great variation in CIT at traffic congestion. On the other hands, China has donation policies superior to western countries for organ transplantation, which will greatly save the time spent in organ transportation. All donors in this study were from Shaanxi Province, which facilitated organ transportation and shortened CIT to some degree. Incidence of DGF in the daytime group with longer CIT did not differ significantly from that in the nighttime group (17.6% *vs.* 12.9%). Therefore, short CIT maybe an explanation for lower DGF incidence in our cohort than in other studies with mean CIT of 14.8 to 17.3 hours (15.35% *vs.* 31.1%–61.6%).<sup>[11,30]</sup> What's more, controlled DCD was performed under the circumstance that brain death was not approved by legislation in China, which had positive effects on outcome of grafts and recipients.<sup>[31]</sup>

As mentioned above, CIT limited within 18 hours would result in better outcomes. Because the longest CIT in our cohort was still shorter than 18 hours, the 2.5 hours longer CIT of the daytime group did not increase DGF and complications. Similarly, Seow *et al*<sup>[28]</sup> also showed that prolonged CIT did not increase the incidence of surgical complications. Besides, other studies also showed no difference in survival and complications between nighttime and daytime kidney transplants,<sup>[1,27,28]</sup> which is in discrepancy with the result of Brunschot *et al*<sup>[21]</sup> that less pure technical failure happened in the nighttime kidney transplant, which may had bias from experienced surgeons at night. However, studies have shown that nighttime work produced risks for patients in surgery<sup>[16,17,22]</sup> and bad effects on doctors with risk of breast cancer and obesity.<sup>[32,33]</sup> With the rapid increase in donors from citizen's death,<sup>[5]</sup> much more burden would be imposed upon transplant surgeons. Considering the issues above, it seems worthwhile to postpone transplant of organs with

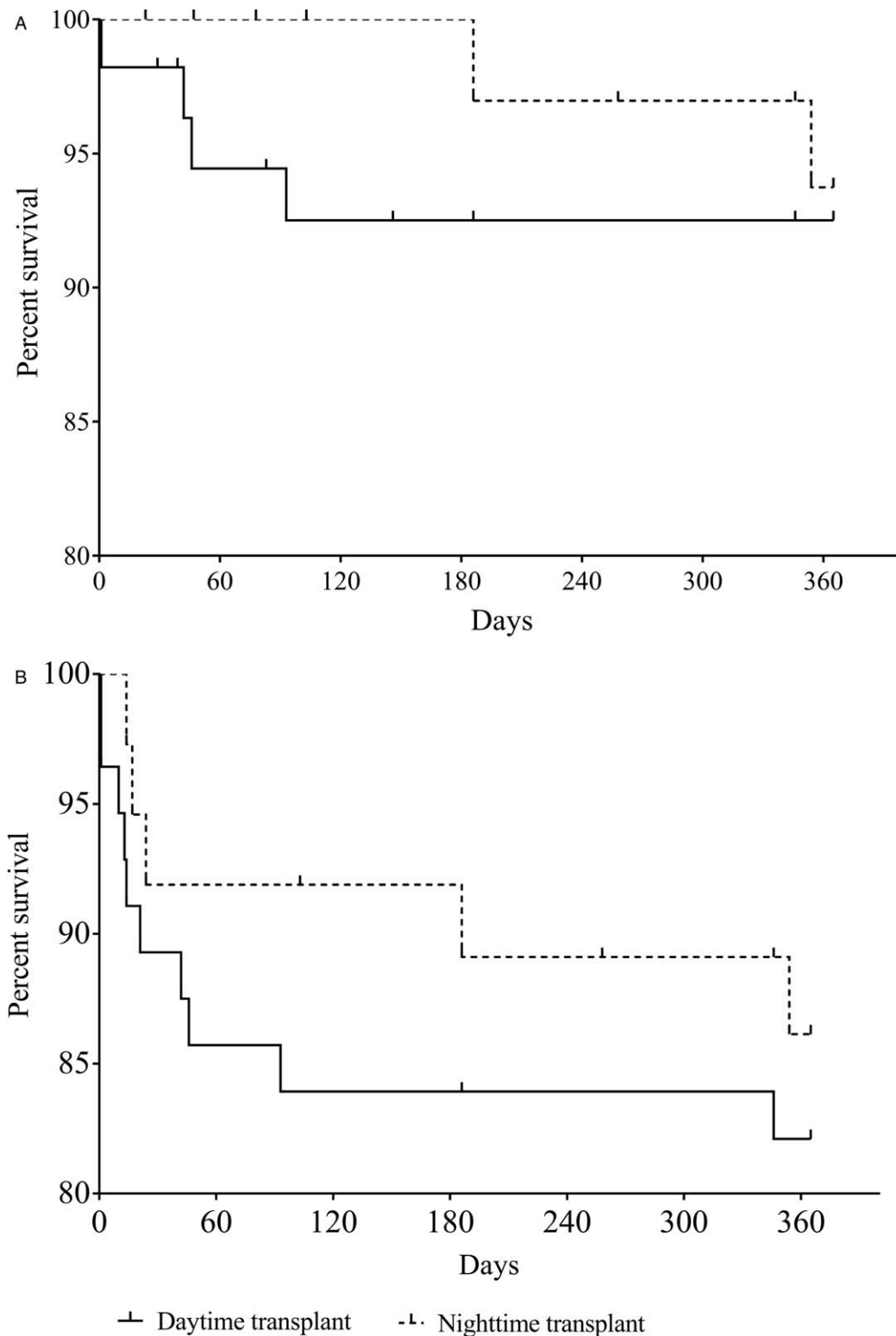


**Figure 3:** Recipient survival (A, log rank  $\chi^2=0.229$ ,  $P=0.632$ ) and graft survival (B, log rank  $\chi^2=0.270$ ,  $P=0.603$ ).

CIT <18 hours after elongation to the next day as a sub-emergent operation.

ESRD patients who accepted ECD kidney transplant had better outcome than those who were still in dialysis waiting for SCD even DCD kidney transplant.<sup>[8]</sup> In China, 20.99%

ECD grafts were used in our transplant, which was roughly equivalent to 19% of the USA decade ago.<sup>[34]</sup> But at present, clinical use of ECD grafts has been increasing rapidly up to 43% in the United Kingdom and 50% in the USA.<sup>[8]</sup> Therefore, increasing ECDs seems an effective way to alleviate the dilemma of organ shortage in China. But



**Figure 4:** One-year survival of (A) recipients ( $\chi^2=0.135, P=0.713$ ) and (B) grafts ( $\chi^2=0.348, P=0.555$ ) from ECDs. ECD: Expanded criteria donor.

actually, the majority of studies revealed worse graft survival and higher risks of DGF and AR in ECD kidney transplant.<sup>[8]</sup> Among the 47 factors associated with DGF, DCD donor, age of donor, Scr of donor, BMI of donor and recipient, cardiac function and dialysis duration of recipients were crucial.<sup>[12]</sup> HMP has been confirmed to

have advantages such as offering nutrients, washing out byproducts and micro-thrombosis, and assessing graft viability according to machine parameters, which reduce DGF, AR and primary non-function.<sup>[35-40]</sup> In our center, HMP is applied to 78.78% of patients, which may be another reason to explain the low incidence of DGF.

**Table 3: Cox regression analyses for recipients and grafts.**

Parameters	For recipients		For grafts	
	HR (95% CI)	P	HR (95% CI)	P
Group	1.200 (0.523–2.750)	0.667	0.798 (0.448–1.419)	0.442
Age of donors	0.979 (0.953–1.006)	0.131	1.010 (0.992–1.029)	0.261
BMI of donors	1.018 (0.912–1.136)	0.746	0.985 (0.908–1.069)	0.724
CIT	1.018 (0.885–1.171)	0.800	0.957 (0.866–1.058)	0.390
Preservation	0.829 (0.309–2.224)	0.709	0.888 (0.439–1.797)	0.742

CI: Confidence interval; CIT: Cold ischemia time; HR: Hazard ratio.

**Table 4: Characteristics of ECDs and recipients accepted ECD grafts.**

Characteristics	Daytime group (n=56)	Nighttime group (n=37)	Statistics	P
<b>Donor characteristics</b>				
Age (years)	59.4±5.3	58.6±4.7	0.736*	0.464
Male	49 (87.5)	29 (78.4)	1.370†	0.242
BMI (kg/m <sup>2</sup> )	22.42±2.50	22.76±2.66	-0.643*	0.522
ICU stay (day)	2.00 (1.00, 3.00)	3.00 (2.00, 8.00)	-3.351‡	0.001
Scr before procurement (μmol/L)	97.16±54.58	113.87±102.58	-1.021*	0.310
<b>Recipient characteristics</b>				
Age (years)	38.79±9.08	35.62±7.82	1.736*	0.086
Male	42 (75.0)	27 (73.0)	0.048†	0.827
BMI (kg/m <sup>2</sup> )	21.19±3.06	22.10±3.70	-0.620*	0.542
Duration of dialysis (months)	19.50 (12.00, 32.25)	13.00 (10.50, 28.00)	-1.619‡	0.105
Dialysis modality (HD)	49 (87.5)	33 (94.3)	1.113†	0.474
Causes of ESRD			2.470†	0.967
Chronic glomerulonephritis	44 (78.6)	30 (81.1)		
IgA nephropathy	7 (12.5)	4 (10.8)		
Others	5 (8.9)	3 (8.1)		
HLA mismatch			5.286†	0.354
0	4 (7.1)	2 (5.4)		
1	16 (28.6)	13 (35.1)		
2	30 (53.6)	15 (40.5)		
3	4 (7.1)	6 (16.2)		
4	2 (3.6)	0		
5	0	1 (2.7)		
Re-transplant	2 (3.6)	1 (2.7)		
<b>Transplant characteristics</b>				
WIT (min)	7.61±2.69	6.92±2.22	1.293*	0.199
CIT (h)	8.47±3.46	4.93±2.34	5.453*	<0.001
Preservation (HMP)	49 (87.5)	30 (81.1)	0.718†	0.397
Multiple arteries	7 (12.5)	3 (8.1)	0.107†	0.735
Artery anastomosis (end-to-end)	23 (41.1)	10 (27.0)	2.779†	0.218
Operative duration (min)	188.30±46.77	197.30±52.11	-0.867*	0.388

Data were shown as mean±standard deviation, medial (Q<sub>1</sub>, Q<sub>3</sub>), or n (%). \* t values. † χ<sup>2</sup> values. ‡ Z values. BMI: Body mass index; CIT: Cold ischemia time; ECD: Expanded criteria donor; ESRD: End stage renal disease; HD: Hemodialysis; HMP: Hypothermic machine perfusion; ICU: Intensive care unit; Scr: Serum creatinine; WIT: Warm ischemia time.

Although older donors with higher BMI had increased risk of DGF in the daytime group, HMP with protective effect on grafts was applied more in the daytime group, leading to explainable results of DGF and AR between the daytime and nighttime groups [Tables 4 and 5]. Moreover, ECD kidney transplant was often delayed to the following morning because of the poor perfusion parameters of Lifeport, indirectly leading to much longer CIT in the daytime group.

In our study, group assignment was based on both beginning and end of the operation, which was different from that of other kidney transplant cohorts, in which grouping merely depended on the beginning of the operation.<sup>[1,21,22]</sup> Elective surgery starts at 8 AM on weekday, that is why we chose 8 AM as the cutoff of the daytime group. The mean duration of operation in our cohort was 178 minutes, similar to about 3-h operative time in other 2 studies.<sup>[1,27]</sup> As a result, some operations



**Table 5: Outcomes of the recipients who accepted ECD grafts.**

Outcomes	Daytime group (n=56)	Nighttime group (n=37)	Statistics	P
Surgical complications	8 (14.3)	7 (18.9)	1.422*	0.533
Reoperation	7 (12.5)	5 (13.5)	0.020*	0.887
DGF	9 (16.1)	8 (21.6)	0.459*	0.498
AR	8 (14.2)	5 (13.5)	1.114*	0.593
Scr at 1 year of post-transplant ( $\mu\text{mol/L}$ )	113.41 $\pm$ 30.42	114.65 $\pm$ 43.56	0.162 <sup>†</sup>	0.873
Hospital stay (day)	19.00 (16.00, 27.50)	21.00 (18.50, 29.00)	-1.694 <sup>‡</sup>	0.090

Data were shown as mean  $\pm$  standard deviation, medial (Q<sub>1</sub>, Q<sub>3</sub>), or n (%). \*  $\chi^2$  values. <sup>†</sup> t values. <sup>‡</sup> Z values. AR: Acute rejection; DGF: Delayed graft function; Scr: Serum creatinine.

started before 8 PM may continue to midnight and most operations were concluded in the period of 8 PM – 8 AM. Thus, the period beginning after 8 AM and end before 8 PM could be more scientific for definition of daytime work from our point of view.

Our single-center retrospective study has some limitations. Some prospective studies are still needed to explore the relationship between clinical outcomes and nighttime transplant. The negative results in the association of nighttime transplant with poor clinical outcomes may be explained as follows. Firstly, the proportion of surgeons varied in each transplant, which was an indefinite factor for evaluating the impact of surgical technique between the daytime and nighttime work. Secondly, the degree of sleep deprivation for each surgeon was not described retrospectively. Rothschild *et al*<sup>[41]</sup> found that sleep less than 6 hours for a whole day would be detrimental for complications in surgical process. However, the duration of sleep for each surgeon was hard to know in the past. Surgeons for night surgery would always have a rest when they had obtained the reliable inform of transplant. Surgeons who stayed up late due to various reasons could take an unpredictable transplant on the next day and it was really complicated to evaluate fatigue. Thirdly, all operators were chief or vice-chief surgeons who have experienced decades' training in kidney transplant. The beginning time of operation had little or minimal impacts on the outcome of surgeries. Meanwhile, they may have adapted to irregular work physiologically (including sleep or work at any time) to some extent. At last, due to the potential detriment of night work for doctors and patients, we have been attempting to delay transplant of some kidneys with short CIT to the following day, which explained why graft kidneys in the daytime group have significantly longer CIT than those in the nighttime group. In addition, some grafts perfused with unsatisfying parameters, especially from ECDs, were worthy to be perfused longer to achieve better perfusion,<sup>[42,43]</sup> which could explain why the mean age of donors in the daytime group significantly exceeded that in the nighttime group: that is, the proportion of ECDs was higher in the daytime group.

In conclusion, our results suggest that operation time of kidney transplant with short CIT has no significant impact on the outcome of kidney transplant. Because nighttime work predisposes adverse conditions to both doctors and patients, nighttime transplant of kidneys with short CIT could be postponed to the following day to alleviate burdens on medical staffs.

### Conflicts of interest

None.

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