Factors Affecting the Long-Term Survival of Kidney Transplantation in Northeastern of Iran between 2000 and 2015

Rasoul Alimi [1], Maryam Hami [2], Monavar Afzalaghaee [3], Fatemeh Nazemian [4], Mahmood Mahmoodi [1], Mehdi Yaseri [1], *Hojjat Zeraati [1]

1. Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
2. Kidney Transplantation Complications Research Center, Ghaem Hospital, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
3. Management & Social Determinants of Health Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
4. Department of Internal Medicine, Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran

*Corresponding Author: Email: zeraatih@tums.ac.ir

Abstract

Background: Graft and patient survival are of great importance after transplantation. This study aimed to determine the long-term survival rate of kidney transplantation and its effective factors among transplanted patients in Mashhad transplantation centers in northeastern Iran.

Methods: Overall, 618 kidney transplant recipients were examined in different transplantation centers during the years from 2000 to 2015 in a historical cohort study. The Kaplan-Meier method and the Log-rank test were used to calculate the survival rate of the kidney transplant, and to check the difference between survival curves respectively. Modeling of effective factors in survival rate was performed using Cox regression model.

Results: Overall, 1, 3, 5, 7, 10, and 15-year survival rate of kidney transplantation were 99%, 98%, 97%, 93%, 88 and 70% respectively. The adjusted hazard ratio indicated that variables such as recipient age >40 yr [HR=0.22, 95% CI=(0.071,0.691)], serum creatinine after transplantation >1.6 Mg/dl [HR=3.03, 95% CI=(1.284,7.125)], history of hypertension [HR=6.70, 95% CI=(2.746,16.348)], and BMI [HR (normal weight versus underweight)=0.26, 95% CI=(0.088,0.761), HR (over weight versus underweight)=0.13,95% CI=(0.038,0.442)] were significant factors on kidney transplant survival rate.

Conclusion: The short-term transplant survival rate was good in transplant patients. What's more, through a consideration of variables such as age, creatinine serum after transplantation, history hypertension and body mass index, as well as proper planning to control their effect, it is possible to improve the long-term graft survival rate.

Keywords: Kidney transplantation; Graft survival; Proportional hazards models; Kidney failure; Chronic; Survival rate

Introduction

One of the consequences of chronic kidney disease (CKD) is leading to end-stage renal disease.

The number of such patients has been increasing in recent years (1, 2). Prevalence of end-stage re-

nal disease (ESRD) in Iran was 137 per million populations (pmp) in 1997, 274 pmp in 2004, 357 pmp in 2006, and 531.7 pmp in 2011(1, 3, 4). Renal transplantation is the most effective treatment for patients with this condition, because it is more economical than dialysis, and while it reduces the risk of mortality in patients in ESRD, it also improves their life quality (5-7). Apart from mortality rate in transplant patients, another major source of concern has to do with allograft failure, as graft loss increases mortality and health care in the community (8).

Over the past two decades, application of new therapeutic systems has been associated with a reduction in the prevalence of acute graft rejection and an approximately one-year improvement in graft survival (9, 10). However, despite successful renal transplantation surgeries, long-term graft survival has not been consistent with recovery expectations as opposed to short-term survival rates (11, 12).

Since new renal transplantation is carried out under certain conditions, it is important to know risk factors associated with kidney survival, which are mostly predictable and preventable. An analysis of kidney transplant data can contribute to the effectiveness of transplantation activities, as well as the assessment of the expenditure in the health care system in the future (13).

Although several studies have been conducted in different transplantation centers in Iran to estimate the survival rate of kidney transplantation, there are still differences in the causes of reversible rejection in renal transplantation in these studies (14-17). Therefore, it is essential to determine the effective factors in improving the survival rate of the first transplant in different transplantation centers in Mashhad as a major transplantation center in Northeast Iran.

We aimed to evaluate the long-term survival of renal transplantation as well as the known prognostic factors for graft survival.

Methods

In this historical cohort study, the medical records of 731 renal transplant patients in transplan-

tation centers were examined across15 years, from Jul 2000 to Dec 2015. Patients who followed for less than three months and had undergone renal transplantation more than once were excluded. Recipients with other kinds of organ transplants, such as liver, pancreas, or heart, were also excluded. The exact time of transplant was regarded as the initial event and reversible rejection in renal transplantation leading to the individual's return to dialysis, and in some cases to death, counted as the final event. The cases with the end event due to the end of the study, the loss of follow-up, or the patient's death for reasons other than transplant rejection were used as censored data. Allograft failure was defined as creatinine greater than 6 mg/dL for more than 3 months or clinical diagnosis and the need for peritoneal dialysis or hemodialysis (18). To obtain accurate estimates of graft survival, the end time of the study was 2 years after the last transplant (Dec 2015).

Survival rates were estimated using lifetime tables, calculated using the Kaplan-Meier method and compared in subgroups using the Log-rank test. To determine the effective factors affecting graft survival, the significant variables with a significant level of less than 0.2 in the univariate analysis with the assumption that the risk ratio is fixed underwent Cox multivariate model. Adjusted hazard ratios were calculated using Cox stepwise relative risk model and were reported with a 95% confidence interval. The analyses were performed using the survival package with R software (ver. 2.15.1) (the R Foundation for statistical calculations, Vienna, Austria). The significant level for all the analyses was 0.05.

The following risk factors were examined in Cox regression model based on patients records: age of recipients (less than 40 yr versus above 40), recipient gender (male and female), delivery type (live, cadaver), hypertension (systolic hypertension greater than 140 or diastolic hypertension greater than 90), serum creatinine level within one month after transplantation (greater than 1.6 versus less than 1.6 mg/dL), duration of dialysis (less than 2 yr versus more than 2 yr), type of immunosuppressant drugs (patients receiving

prednisolone, Cellcept and cyclosporine were marked with "1", and patients who received prednisone, cyclosporine and Imuran were indicated by "2"). Categorization of the variables is based on similar research (19, 20). Moreover, the body mass index (BMI) on the last visit (body-weight by per kilogram to height per square meter [kg/m2]) was recorded. Individuals with a BMI less than 18.5 were considered as underweight, from 18.5 to 24.9 as normal, and those over 24.9 as overweight (21).

The proposed study was approved by the Ethics Committee of the Vice-Chancellor of Research of [deleted by editor] University of Medical Sciences under code of IR.MUMS.REC.1395.232.
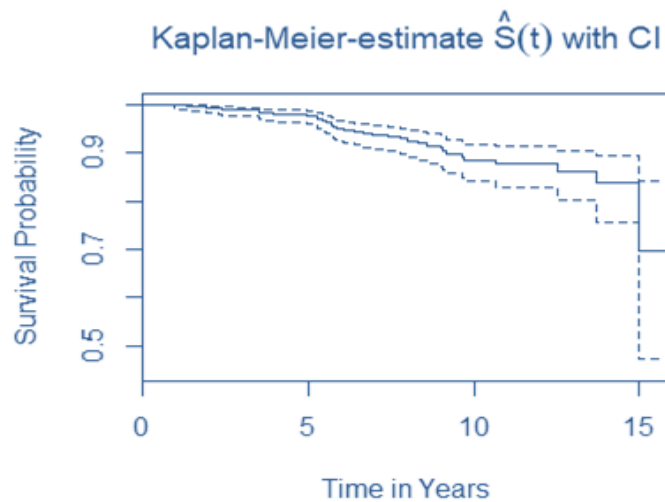
Results

The survival rate of 618 cases out of 731(84.5%) was successfully followed up during the time. Among the follow-up patients, 35 (5.7%) of cases of irreversible rejected graft resulted in dialysis,

and 7 others (1.1%) in death. The median follow-up time (interquartile range) was 6.36 (4.97) years. The mean age of the patients at the time of transplantation was 34.8 ± 12.6 yr and most of them (67.5%) were under 40 years. In 94.2% of cases, the drug of group 1 (cyclosporine, Cellcept and prednisolone) was used. The rest of information concerning the research variables is presented in Table 1.

Only in 86 (13.9%) of patients' files had been recorded the cause of ESRD, which was hypertension (47 cases) and diabetes (13 cases), as well as some other causes, such as urinary tract infections, glomerulonephritis, and urolithiasis. For this reason, that is, because of the unspecification of a large number of items, the information concerning this factor was not included in the modeling.

As shown in Fig. 1, survival rates of 1, 3, 5, 7, 10 and 15 yr were 99, 98, 97, 93, 88 and 70 percent, respectively. Given the chart, graft survival is almost constant over the first 5 years, but then it falls into a steady decline.

Fig. 1: The survival rate of kidney transplantation from the time of surgery to the time of rejection using the Kaplan-Meier curve with 95% confidence interval

As presented in Table 1, based on the results of the Log-rank test, the cumulative survival rate during the study was significantly higher in patients over 40 yr than those under 40 (P=0.001). The survival rate for recipients with serum creat-

inine levels below 1.6 was significantly higher than those with serum creatinine higher than 1.6 (P<0.001). The survival rates were significantly lower in recipients with a history of hypertension compared to the rest of recipients (P=0.001). The

cumulative survival rate in recipients with a BMI less than 18.9 (underweight) was significantly lower than recipients with a BMI greater than 18.9 (normal and overweight) ($P<0.05$).
In the present study, the cumulative survival rate of renal transplantation indicated no significant difference in the following cases: gender of recipients ($P=0.400$), delivery type ($P=0.077$), duration of dialysis before transplantation ($P=0.702$), living place of transplant recipients ($P=0.838$) and the type of immunosuppressive drugs ($P=0.082$).

Table 1: Graft survival rates at different times after kidney transplantation relative to studied variables

Variables		No. (%)	Survival rates						P-value (log-rank test)
			1 yr	3 yr	5 yr	7 yr	10 yr	15 yr	
Sex of recipients	Male	341 (55.2)	1.00	0.98	0.96	0.93	0.87	0.72	0.400
	Female	277 (44.8)	1.00	0.99	0.98	0.94	0.90	0.64	
Age of recipients	<40	409 (67.5)	0.99	0.98	0.97	0.91	0.85	0.62	0.011
	>40	197 (32.5)	1.00	0.99	0.99	0.98	0.95	0.92	
Serum creatinine within one month after transplant	<1.6	503 (81.4)	1.00	0.99	0.98	0.95	0.92	0.89	<0.001
	>1.6	115 (18.6)	0.99	0.97	0.96	0.87	0.74	0.32	
Hypertension	Yes	269 (43.5)	0.99	0.97	0.95	0.89	0.84	0.51	0.001
	No	349 (56.5)	1.00	1.00	0.99	0.96	0.91	0.78	
Delivery type	Live	420 (70.8)	1.00	0.99	0.98	0.95	0.91	0.87	0.077
	Cadaver	173 (29.2)	0.99	0.98	0.97	0.90	0.84	0.84	
BMI at last visit	Under-weight	33 (8.3)	1.00	0.97	0.90	0.80	0.66	0.66	0.006
	Normal	197 (49.5)	1.00	0.98	0.96	0.95	0.89	0.62	
	Overweight	168 (42.2)	1.00	0.99	0.99	0.97	0.93	0.93	
Time of dialysis at pre-transplantation	<24	447 (76.7)	0.99	0.98	0.97	0.94	0.89	0.68	0.702
	>24	136 (23.3)	1.00	1.00	0.98	0.93	0.89	0.89	
Living area	Mashhad	316 (54.5)	1.00	0.99	0.98	0.94	0.88	0.69	0.838
	Other cities	264 (45.5)	0.99	0.97	0.96	0.94	0.88	0.70	
Type of immuno-suppressant's drugs[1]	1	582 (94.2)	0.99	0.98	0.97	0.94	0.89	0.70	0.082
	2	36 (5.8)	1.00	1.00	0.97	0.85	0.79	0.71	
Total			0.99	0.98	0.97	0.93	0.88	0.70	

[1]Patients who received prednisone, Cellcept and cyclosporine are marked with the code "1" and patients who received prednisone, cyclosporine and Imuran, are marked with the code "2"

Univariate analysis showed that the recipient age, serum creatinine in the transplant, hypertension, and BMI are among the risk factors associated with transplant rejection.

Adjusted results of Cox multiple regression showed that the factors affecting transplant rejection are as follows: The rejection rate in the 40-year-old age group was about 80% lower than the age group younger than 40 yr old [risk ratio (HR)=0.22, 95% CI=(0.071,0.691)]. Regarding serum creatinine levels after transplantation, the risk of transplant rejection is about 3 times higher for patients with serum creatinine levels greater than 1.6 mg/dL [HR=3.03, 95% CI=(1.284,7.125)]. The rate of irreversible kidney transplantation in individuals with a history of hypertension is about 6 times higher than those without it [HR=6.70, 95% CI= (2.746, 16.348)]. In the case of BMI, multivariate results indicated that the survival rate of the transplant was higher in subjects with normal weight [HR (normal weight versus underweight) =0.26, 95% CI= (0.088, 0.761)] and overweight [HR (overweight versus underweight) =0.13,95%CI=(0.038,0.442)] than underbody subjects (Table 2).

Table 2: Demographic and clinical characteristics associated with graft failure in kidney transplantation patients using univariate and multivariate Cox proportional hazard model (n=618)

Variable	Univariate analysis			Multiple analysis[a]		
	Crude HR	95% CI	*P*-value	Adjusted HR	95% CI	*P*-value
Sex of recipients (male versus female)	1.30	0.701-2.411	0.405			
Age of recipients (≥40 versus <40)	0.34	0.143-0.810	0.015	0.22	0.071-0.691	0.009
Serum creatinine at transplant (≥1.6 versus <1.6)	3.53	1.911-6.517	<0.001	3.03	1.284-7.125	0.011
Hypertension (yes versus no)	2.70	1.441-5.049	0.002	6.70	2.746-16.348	<0.001
Delivery type (cadaver versus live)	1.82	0.928-3.587	0.082	0.77	0.288-2.066	0.606
BMI (normal weight versus underweight)	0.40	0.154-1.030	0.058	0.26	0.088-0.761	0.014
(over weight versus underweight)	0.18	0.059-0.568	0.003	0.13	0.038-0.442	0.001
Time of dialysis before transplantation (>24 months versus ≤24 months)	0.85	0.376-1.929	0.721			
Living area (Other cities versus Mashhad)	1.07	0.571-2.000	0.838			
Type of immunosuppressant's drugs	2.11	0.887-5.010	0.091	1.13	0.333-3.859	0.841

a multivariate analysis with the forward selection method

Discussion

In this historical cohort study, the survival rate of graft after 1, 3, 5, 7, 10 and 15 years of transplantation was estimated to be 99, 98, 97, 93, 88 and 70 percent respectively during a 15-year timespan. Graft survival is very high in the first 5 years after the transplant. After that time, a sustained decrease is observable in the graft survival rate.

In a similar study conducted between 1994 and 2011 in western Iran, the graft survival rate after 1, 5, 10, and 15 years of transplantation was estimated to be 97.9, 92.3, 86.2, and 77.6 percent respectively (17).

Based on the results of the largest graft survival analysis in the country between 1984 and 2005, the survival rate after 1, 3, 5, and 10 years was reported to be 85, 76.4, 68.3, 46.4 and 23.8 percent respectively (18). In a similar study in South Korea on 620 patients who received transplants from live donors between 1979 and 2002, the survival rate at 1, 5 and 10 years was reported to be 92.6, 82.4 and 76.1 percent respectively (22). Overall, 1308 Spanish patients were examined between 1981 and 2008, and the 6-year survival rate of kidney transplantation was reported to be 89% (23). In general, the differences may be due to the lack of concurrence of these studies and changes in the methods of transplantation or prescribed drugs and the type of immunosuppressant drugs over time (17).

Type 2 diabetic nephropathy and hypertension constitute two major causes of ESRD in developed countries (24, 25). A few studies have been conducted to determine the initial causes of ESRD in Iran, indicating that DM and HTN are the major ones (1, 26). Compared to the United States and other developed countries, the cause of ESRD in most patients in Iran is due to unknown factors (13). In Iran as well as many other developing countries, patients with chronic kidney disease are referred to hospital when they suffer severe symptoms, a time that it is not possible to determine the initial cause of ESRD at (27).

The probability of kidney transplant rejection in older recipient age groups is lower than the younger recipient age groups. This result has also been reported by previous studies, some being following the results of ours (28, 29). However, there was no significant relationship between recipient age and graft survival (27, 30), which can be due to the lower age range of transplant recipients.

The amount of Creatinine at the time of discharge from hospital is another important factor in the graft survival rates, known as a predictor of graft survival (14, 17, 20, 31) in most important studies.

The risk of rejection in subjects with BMI lower than the normal was higher than others. Some studies are confirming the finding that receptor weight affects graft failure (19, 32). It has been shown in a meta-analysis study examining the effect of BMI on transplantation survival that BMI of more than 30 in the recipient causes a graft failure (33). In this study, the number of individuals with a BMI greater than 30 was very low, with the individuals being included in the overweight group. No significant correlation was observed between BMI and graft failure in some studies (17, 20).

The duration of dialysis before transplantation was not significantly related to the graft survival rate, a result confirmed by several other studies (14, 17, 27). However, longer duration of dialysis before transplantation had a significant relationship with a lower survival rate (19, 34).

In this study, there was no significant relationship between the graft survival rate and donor type. This is in accordance with a few studies (15, 35). However, in a few other studies, the percentage of irreversible rejection of the transplant that led to the initiation of dialysis was greater in recipients from a Cadaver (17, 36). This may be either due to differences in the transplant system, or the ischemic time of the kidney, as increased ischemic time reduces graft survival (16).

In recent decades, with the advancement in immunosuppressant drugs, the survival rate has increased. In general, there is no relationship between the type of immunosuppressant drug used and the survival rate (14, 37, 38). However, there was a significant relationship between rejection and use of immunosuppressant drugs, the difference between which was not significant according to the multivariate Cox model (17). In this study, the long-term survival of the second treatment group is better than that of the first treatment group. However, a well-designed controlled clinical trial is needed to measure the effectiveness of these two drug therapies.

The ineffectiveness of gender for kidney transplants was observed in our study. This is also known as an ineffective factor in transplant survival rates in most studies (28, 29). At the same time, the recipient's gender had to do with graft survival (8, 19, 39). However, most studies have reported univariate estimates (CRUDE) compared to ADJUSTED values, which may explain the inconsistency between the results of various studies.

Using the results of multivariate modeling, hypertension as one of the major causes of ESRD has been shown to increase the risk of transplant rejection, which contrary to another study (40), was consistent with other studies (31, 41).

This study had some limitations. First, estimates of survival and its prognostic factors require reliable sources from a prospective plan, but our study was a historical cohort study and medical records were used in it instead. Secondly, some patients were excluded from the study during a long follow-up, and thus the occurrence of a favorite event (rejection of the transplant) was not clear in their case of them, which may affect our results. Other limitations of this study are as follows: lack of record or incomplete recording of other important variables such as ischemic time, age, cause of ESRD, failure to record HLA typing of patients and impossibility to assess their effect on the graft survival rate.

Conclusion

The short-term transplant survival rate was good in transplant patients. What's more, through a consideration of the variables of age, creatinine serum after transplantation, history of hypertension and body mass index, and proper planning for controlling their effect, it is possible to improve long-term graft survival.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

Conflict of interest

The authors state that there are no conflicts of interest.

References

1. Aghighi M, Mahdavi-Mazdeh M, Zamyadi M, et al (2009). Changing epidemiology of end-stage renal disease in last 10 years in Iran. *Iran J Kidney Dis,* 3(4):192-6.
2. Auglienė R, Dalinkevičienė E, Kuzminskis V, et al (2017). Factors influencing renal graft survival: 7-Year experience of a single center. *Medicina (Kaunas),* 53(4):224-232.
3. Khajehdehi P, Malekmakan L, Pakfetrat M, et al (2014). Prevalence of chronic kidney disease and its contributing risk factors in southern Iran: a crosssectional adult population-based study. *Iran J Kidney Dis,* 8(2):109-15.
4. Nafar M, Mousavi SM, Mahdavi-Mazdeh M, et al (2008). Burden of chronic kidney disease in Iran: a screening program is of essential need. *Iran J Kidney Dis,* 2(4):183-92.
5. Hage FG, Smalheiser S, Zoghbi GJ, et al (2007). Predictors of survival in patients with endstage renal disease evaluated for kidney transplantation. *Am J Cardiol,* 100(6):1020-5.
6. Hassanien AA, Al-Shaikh F, Vamos EP, et al (2012). Epidemiology of end-stage renal disease in the countries of the Gulf Cooperation Council: a systematic review. *JRSM Short Rep,* 3(6):38.
7. Weber M, Faravardeh A, Jackson S, et al (2014). Quality of life in elderly kidney transplant recipients. *J Am Geriatr Soc,* 62(10):1877-82.

8. Go AS, Chertow GM, Fan D, et al (2004). Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. *N Engl J Med,* 351(13):1296-305.

9. Pascual M, Theruvath TOM, Kawai T, et al (2002). Strategies to improve long -term outcomes after renal transplantation. *N Engl J Med,* 346(26):2089-92.

10. Woodroffe R, Yao GL, Meads C, et al (2005). Clinical and cost-effectiveness of newer immunosuppressive regimens in renal transplantation: a systematic review and modelling study. *Health Technol Assess,* 9(21):1-179.

11. Irish WD, Ilsley JN, Schnitzler MA, et al (2010). A risk prediction model for delayed graft function in the current era of deceased donor renal transplantation. *Am J Transplant,* 10(10):2279-86.

12. Wang W, Li XB, Yin H, et al (2011). Factors affecting the long-term renal allograft survival. *Chin Med J (Engl),* 124(8):1181-4.

13. Mousavi SSB, Soleimani A, Mousavi MB (2014). Epidemiology of End-Stage Renal Disease in Iran : A Review Article. *Saudi J Kidney Dis Transplant,* 25(3):697-702.

14. Ghanei E, Nasrolahi A, Razaghi M (2011). Evaluation Short and Long term Graft and survival rates in kidney transplanted patients between 1995-2011. *J Army Univ Med Sci.,* 9:251-55.

15. Hashiani AA, Rajaeefard A, Hassanzade J, et al (2006). Survival analysis of renal transplantation and its relationship with age and sex. *koomesh,* 11(4):302-306.

16. Hassanzadeh J, Hashiani AA, Rajaeefard A, et al (2010). Long-term survival of living donor renal transplants: A single center study. *Indian J Nephrol,* 20(4):179-84.

17. Saatchi M, Poorolajal J, Amirzargar MA, et al (2013). Long-term survival rate of kidney graft and associated prognostic factors : A retrospective cohort study. *Ann Transplant,* 18:153-60.

18. Einollahi B, Pourfarziani V, Davoudi F, et al (2007). Iranian Model of Renal Allograft Transplantation In 3028 Recipients : Survival and Risk Factors. *Transplant Proc,* 39(4):907-10.

19. Mirzaee M, Azmandian J, Zeraati H, et al (2014). Short-term and Long-term Survival of Kidney Allograft Cure Model Analysis. *Iran J Kidney Dis,* 8(3):225-30.

20. Soltanian A, Mahjub H, Taghizadeeh-afshari A, et al (2015). Identify Survival Predictors of the First Kidney Transplantation : A Retrospective Cohort Study. *Iran J Public Health,* 44(5): 683–689.

21. World Health Organization. Global Database on Body Mass Index.; Available from:

a. http://www.assessmentpsychology.com/icbmi.htm

22. Kwon OJ, Kwak JY (2004). The Impact of Sex and Age Matching for Long-Term Graft Survival in Living Donor Renal Transplantation. *Transplant Proc,* 36(7):2040-2.

23. Pita-Fernandez S, Valdes-Canedo F, Seoane-Pillado T, et al (2010). Influence of early graft function after renal transplantation and its impact on long-term graft and patient survival. *Transplant Proc,* 42(8):2856-8.

24. Cho H, Yu H, Shin E, et al (2014). Risk Factors for Graft Failure and Death following Geriatric Renal Transplantation. *PLoS ONE,* 11(4): e0153410.

25. Collins AJ, Foley RN, Chavers B, et al (2012). United States Renal Data System 2011 Annual Data Report: Atlas of chronic kidney disease & end-stage renal disease in the United States. *Am J Kidney Dis,* 59(1 Suppl 1):A7, e1-420.

26. Malekmakan L, Haghpanah S, Pakfetrat M, et al (2009). Causes of chronic renal failure among Iranian hemodialysis patients. *Saudi J Kidney Dis Transpl,* 20(3):501-4.

27. Galabada DP, Nazar ALM, Ariyaratne P (2014). Survival of Living Donor Renal Transplant Recipients in Sri Lanka : A Single-Center Study. *Saudi J Kidney Dis Transpl,* 25(6):1334-40.

28. Courtney AE, McNamee PT, Maxwell AP (2008). The evolution of renal transplantation in clinical practice: for better, for worse? *QJM,* 101(12):967-78.

29. Feyssa E, Jones-Burton C, Ellison G, et al (2009). Racial/ethnic disparity in kidney transplantation outcomes: influence of donor and recipient characteristics. *J Natl Med Assoc,* 101(2):111-5.

30. Fuggle SV, Allen JE, Johnson RJ, et al (2010). Factors affecting graft and patient survival

after live donor kidney transplantation in the UK. *Transplantation,* 89(6):694-701.

31. Morales JM, Marcén R, Castillo D, et al (2012). Risk factors for graft loss and mortality after renal transplantation according to recipient age : a prospective multicentre study. *Nephrol Dial Transplant,* 4(Suppl 4):iv39-46.

32. Chang SH, Coates PTH, McDonald SP (2007). Effects of Body Mass Index at Transplant on Outcomes of Kidney Transplantation. *Transplantation,* 84(8):981-7.

33. Lafranca JA, Ijermans JNM, Betjes MGH, et al (2015). Body mass index and outcome in renal transplant recipients : a systematic review and meta-analysis. *BMC Med,* 13:111.

34. Shahbazi F, Ranjbaran M, Karami-far S, et al (2015). Graft survival rate of renal transplantation during a period of 10 years in Iran. *J Res Med Sci,* 20(11): 1046–1052.

35. Javanrouh Givi N, Alimi R, EsmailyH, et al (2013). Assessment of effective factors on renal transplantation survival and estimation of rejection hazard for transplanted in Mashhad Qaem hospital. *JNKUMS,* 5(2): 315-321.

36. Matas AJ, Payne WD, Sutherland D, et al (2001). 2,500 living donor kidney transplants: a single-center experience. *Ann Surg,* 234(2): 149–164.

37. Meier-Kriesche H-U, Morris JA, Chu AH, et al (2004). Mycophenolate mofetil vs azathioprine in a large population of elderly renal transplant patients. *Nephrol Dial Transplant,* 19(11):2864-9.

38. Remuzzi G, Cravedi P, Costantini M, et al (2007). Mycophenolate mofetil versus azathioprine for prevention of chronic allograft dysfunction in renal transplantation: the MYSS follow-up randomized, controlled clinical trial. *JASN,* 18(6):1973-1985.

39. Chon SE, Lee KW, Joh JW, et al (2003). Factors affecting the graft survival in cadaver donor kidney transplantation. *Transplant Proc,* 35(1):147-8.

40. Veroux M, Grosso G, Corona D, et al (2012). Age is an important predictor of kidney transplantation outcome. *Nephrol Dial Transplant,* 27(4):1663-71.

41. Mirzaee M, Mohammad K, Mahmoodi M, et al (2014). Multi-state survival analysis in renal transplantation recipients. *Iran J Public Health,* 43(3):316-322.

Available at: http://ijph.tums.ac.ir