

Dialysis adequacy of chronic hemodialysis patients in Zanjan-Iran, 2016

Yosefi Kh¹, Dinmohammadi MR^{2*}, Moosaeifard M³, Faghihzadeh S⁴

¹MSc. Dept. of Critical Care Nursing, School of Nursing and Midwifery, Zanjan University of Medical Sciences, Zanjan, Iran

²PhD. Dept. of Critical Care Nursing, Assistant Professor, School of Nursing and Midwifery, Zanjan University of Medical Sciences, Zanjan, Iran

³PhD. Student, Dept. of Critical Care Nursing, School of Nursing and Midwifery, Zanjan University of Medical Sciences, Zanjan, Iran

⁴Professor of Biostatistics, Zanjan Social Dept. of Health Research Center, Zanjan University of Medical Sciences, Zanjan, Iran

***Corresponding Author:** Dept. of Critical Care Nursing, Assistant Professor, School of Nursing and Midwifery, Zanjan University of Medical Sciences, Zanjan, Iran

Email: mdinmohammadi@zums.ac.ir

Received: 7 Aug 2016 **Accepted:** 29 Aug 2017

Abstract

Background: Dialysis adequacy is one of the most important factors in determining the survival rate and mortality of dialysis patients.

Objectives: The aim of this study was to determine the dialysis adequacy of patients undergoing chronic hemodialysis at dialysis centers located in the province of Zanjan, located in northwest Iran.

Methods: This descriptive cross-sectional study was performed on 257 patients undergoing chronic hemodialysis with an available sampling method in 6 dialysis centers in the province of Zanjan. The hemodialysis sessions were performed for 3 to 4 hours using via synthetic filters and bicarbonate dialysate. To determine the adequacy of dialysis, serum BUN levels were assessed before and after dialysis. The standard software provided by the Ministry of Health was used to calculate the adequacy of dialysis and Kt/V was considered to be at least 1.2.

Results: The most common underlying causes of chronic dialysis were hypertension (41.2%) and diabetes mellitus (35.8%), respectively. Mean Kt/V and URR were 1.26 ± 0.34 and $63.55 \pm 9.5\%$, respectively. The difference among these indexes was significant between men and women ($p < 0.05$). Also, dialysis adequacy was significantly associated with increased dialysis frequency, blood flow rate, interdialytic weight gain, vascular access and dialysis shift ($p < 0.05$).

Conclusion: Despite the relatively favorable dialysis adequacy among patients, this index is highly variable based on patient gender, the dialysis center, location, frequency of dialysis, blood flow rate, interdialytic weight gain, type of vascular access and dialysis shift. Therefore, serious attention and greater caution are recommended among the dialysis centers of the province.

Key words: dialysis adequacy, hemodialysis, urea reduction ratio, Kt/V, Zanjan

Introduction

In chronic renal failure, kidney function is gradually reduced, the irreversible reduction of renal function and glomerular filtration rate (GFR) ultimately result in end-stage kidney disease (ESRD) [1]. Available treatments for ESRD patients include kidney transplantation and

dialysis. Due to certain transplantation difficulties (including donor rarity), dialysis is the only practical alternative to kidney transplantation and is performed in two forms, peritoneal dialysis, and hemodialysis [2]. Every year, 440,000 people begin renal replacement therapy [3]. The number of patients with ESRD is increasing day by day.

In 2006, more than 101,000 started hemodialysis treatment and about \$21 billion of the US medical budget was spent on taking care of these patients that year. In 2010, the prevalence of CRF in the United States was estimated to be 20 million, with a significant proportion of patients affected by ESRD [4]. The prevalence of ESRD cases in the United States amounted to 1981 per million in 2013, which is up 29% from 2000 and 1/4 from 2012 [5]. In 2009, 18,000 people underwent hemodialysis in Iran [6]. According to the latest statistics, this number reaches 29,500 in 2013, 40% of whom are affected by diabetes. It is anticipated that there will be 95,000 kidney patients in Iran by the year 2021 [7]. One of the important factors in determining the survival and mortality rates of dialysis patients is the adequacy of dialysis [8]. Dialysis adequacy refers to the amount of hemodialysis that is needed for maximum health and function of patients. In this definition, dialysis is optimal [9]. The long-term prognosis of hemodialysis patients is affected by the adequacy of dialysis [6]. Reducing Kt/V by 0.1 increases the relative risk of death by 0.7 and increases the annual rate of hospitalization by 11% [10]. This index is based on urea refinement and is calculated on the Kt/V scale [9]. In addition to dialysis adequacy (Kt/V), the urea reduction ratio (URR) is also used to assess the suitability of dialysis, with a normal Kt/V being at least 1.2 and URR being at least 65%. [11].

Studies performed in Iran indicate that dialysis adequacy is insufficient. In a study by Raiesifar et al. (2009) in Abadan, an average of Kt/V=0.9 and URR=53% were reported [12]. In another study by Amini et al. (2011) among hemodialysis patients in 127 dialysis centers in Iran, 56.7% of subjects had a Kt/V of less than 1.2 and 65.2% had URR less than 65% [13]. Also in a study by Mogharab et al. (2010) in Birjand-Iran, the mean of Kt/V and URR were reported to be 1.17 and 62.8% respectively [14]. In a study by Beladi Mousavi et al. (2012) in Abadan-Iran, 87% of subjects under study had a Kt/V of less than 1.2 [15]. Considering the importance of this index, the necessity of its monitoring in dialysis patients and its definite relationship with mortality rates, this study aimed to determine the dialysis

adequacy of patients under chronic hemodialysis in the dialysis centers of Zanjan province.

Methods

The present study is a descriptive cross-sectional study that was conducted in the summer of 2015, after gaining approval and obtaining the necessary permits from the vice chancellor of research in Zanjan University of Medical Sciences. Prior to the initiation of the study, the Ethics Committee approval was drafted and written consent was obtained from all patients. The population under study was all patients undergoing hemodialysis who were referred to the dialysis centers of Zanjan province, consisting of six centers (the dialysis centers of Zanjan, Abhar, Khoramdareh, Khodabandeh, Tarom, and Mahnesan). Overall 264 patients were undergoing dialysis in these centers. Due to the chronic nature of the disease, emergency patients and cases of acute renal failure (7 patients) were excluded in this study and 257 patients were evaluated. Demographical data including age, sex, level of education, economic status, the dialysis routine, comorbidity, frequency of dialysis sessions per week, blood flow rate, type of dialysis filter, type of vascular access and dialysate rate were collected via questionnaire. The adequacy of dialysis was measured in three consecutive sessions, the mean of which was the criterion. For this purpose, a blood sample of one milliliter was prepared for BUN measurement, once before and once after dialysis. The BT3000 auto analyzer and Pars-Azmoon company test kits were used to analyze the blood samples. The error rate for these kits was between 1.12 and 1.77 mg/dl. When the blood samples were taken to evaluate the adequacy of dialysis, the blood flow rate of the hemodialysis device was reduced to 50ml/min for two minutes and then the pump was stopped and was reset after sampling [11]. The hemodialysis devices were B-brown, Nipro, and Fresenius. To calculate the adequacy of dialysis indices (URR and Kt/V), the standard computer software offered by the Iran Ministry of Health (based on the Daugirdas II formula) was used and minimum Kt/V was considered to be 1.2. Finally, the data were analyzed using the descriptive statistics

(including central indexes and dispersion) and non-parametric tests (due to the abnormal distribution of variables) including Mann-Whitney, Kruskal-Wallis, and Spearman correlation coefficients via SPSS software version-22. In this study, a significant level of 0.05 was considered.

Results

The total number of hemodialysis patients in the dialysis centers of Zanjan province was 264. Cases of acute renal failure and emergency hemodialysis which included 7 patients were not included in the chronic hemodialysis study and the study was performed with 257 cases. Of these, 138(53.7%) were men and 119(46.3%) were women. The mean and standard deviation of patient's age was 60.44 ± 15.12 years and the minimum and maximum age of these patients was 21 and 93 years, respectively. About 154 people

(60%) were over the age of 60 years. 203 people (79%) were illiterate and 127(49.4%) had a history of hemodialysis between 1 and 4 years. The mean history of dialysis was 35.9 ± 32.38 months. The most common cause of ESRD was high blood pressure. 234 (91.1%) patients received dialysis three times a week and 22 (8.6%) twice a week. 217(84.4%) patients had an arterio-venous fistula and only 18 People (7%) had grafts. The mean of blood flow rate in the study samples was 280 ± 35 ml/min, and the lowest rate was at the Khodabandeh center of dialysis with an average of 233 ± 25 ml/min.

The mean of Kt/V patients was 1.26 ± 0.34 (Table 1), which was 1.18 ± 0.31 in males and 1.35 ± 0.34 in females. The mean of total URR was 63.55 ± 9.5 , which was 61.43 ± 9.21 and 66.01 ± 9.26 in men and women, respectively. The mean difference between men and women for Kt/V and for URR was significant ($P < 0.05$).

Table 1: The levels of Kt/V and URR in patients undergoing chronic hemodialysis in the dialysis centers of Zanjan province

Index	levels	absolute and relative frequency
Kt/V	<1.2	103(40.1%)
	1.2-1.4	93(36.2%)
	1.4<	61(23.7%)
URR	<65%	126(49%)
	65%<	131(51%)

Kruskal Wallis test showed a significant difference between the mean and standard deviation of Kt/V ($P=0.001$) and URR ($P<0.001$) in hemodialysis patients in dialysis centers of the province (Table 2), in a way that in the Mann-Whitney test the Kt/V index was significantly different between Khodabandeh dialysis center with the ones in Zanjan, Abhar, and Mahneshan ($P<0.001$) and Khoramdarah ($P=0.02$) and Tarom ($P=0.002$). Also, in terms of URR, there was a significant difference between the dialysis center in Khodabandeh with Zanjan, Abhar, Khoramdarah and Tarom ($P<0.001$). Mann-Whitney test showed that the Kt/V was significantly higher in the patients with dialysis performed at night ($P=0.04$) and in the subjects

with grafts and arteriovenous fistula ($P<0.05$). In addition, this test showed that the URR levels in dialysis patients undergoing dialysis at night were significantly higher than other times ($P=0.002$) and in subjects with fistula and arteriovenous graft compared to subjects with catheters ($P<0.05$). The Spearman test showed a positive significant correlation between Kt/V and weekly dialysis times ($r=0.03$, $P<0.05$), blood flow rate ($r=0.19$, $P=0.002$) and interdialytic weight gain ($r=0.15$, $P=0.017$), but there was no significant correlation between Kt/V and age or the history of dialysis ($P>0.05$). Also, the Spearman test showed a positive significant correlation between URR and blood flow rate ($r=0.21$, $P=0.001$) and interdialytic weight gain ($r=0.23$, $P<0.05$).

Table 2: The mean and standard deviation of dialysis adequacy (Kt/V and URR) of patients undergoing chronic hemodialysis in the dialysis centers of Zanjan

Dialysis Centers/index	Kt/V	URR
Zanjan	1.25±0.3	63.97±9.14
Abhar	1.29±0.21	65.57±6.94
Khoramdarah	1.4±0.58	66.1±13.19
Khodabandeh	1.05±0.19	55.33±6.61
Mahnesan	1.5±0.37	61.5±8.19
Tarom	1.31±0.17	68.44±4.61

Discussion

The aim of this study was to evaluate the adequacy of dialysis and its related factors in chronic hemodialysis patients in Zanjan province, Iran. The results showed that the mean of this index in patients undergoing hemodialysis in the province is within the acceptable limits. Other studies carried out inside and outside the country have shown similar or different results. For example, in a similar multicenter study in Iran by Shariati et al. (2012) in Golestan_Iran, Ghorbani Moghaddam et al. (2016) in Bushehr, Iran, and Davenport (2013) in London, the Kt/V index was at an optimal level (above 1.2) [16-18]. However, in a study by Amini et al. (2011) 57% of patient Kt/Vs were less than 1.2 and 65.2% of subjects had a URR of less than 65%, which could be due to the low average blood flow rate of patients in this study (242.9±39 ml/min in the study done by Amini compared to 281±35 ml/min in the present study) and the ratio of women to men (41.4% female in the study, compared with 46.3% in the present study) [13], since the study showed that women exhibit better dialysis when compared to men. In a study by Beladi Mousavi et al. (2012) in Abadan, Iran, 87% of subjects had a Kt/V of less than 1.2 [15]. In the study by Mogharab et al. (2010) in Birjand, Iran, mean Kt/V and URR were 1.17 and 62.8%, respectively, due to the low female ratio (32%, versus 46.3% in the present study) and the lower number of weekly dialysis sessions compared with the present study (62% of dialysis patients were three times a week, versus 91.1% in the present study). [14.] In a study by Raiesifar et al. in Abadan-Iran, the mean of Kt/V was 0.9±0.21 and URR was 53±10%, due to less frequent dialysis sessions per week compared with this study (48.9% of dialysis patients were

three times a week, compared with 91.1% in the present study) [12]. Also, in the study by Roozitalab et al. (2013) in Yasuj, Iran the mean of Kt/V was 0.94±0.4 and URR equaled 50±0.69 [19]. The analysis of these results shows that the patients in this study are in a better state than the above studies. The improvement of dialysis adequacy indicators in this study and other recent studies could be due to the equipping of dialysis centers in our country with advanced dialysis machines and improving the quality of nursing care in these centers.

In this study, the mean of dialysis adequacy indices in the Khodabandeh center of dialysis was lower than other centers. This finding can be due to the lower average blood flow rate of this center compared to the total average of the province (with an average of 233 ml/min versus 280 ml/min for the province overall) and a lower number of dialysis sessions per week (30% of patients were twice a week) compared to other centers, since the study showed that there is a direct and significant relationship between the blood flow rate and the number of dialysis sessions per week with the adequacy of dialysis.

The mean of Kt/V in subjects with a history of dialysis of less than one year (3 months to one year) was 1.23±0.36 and in subjects with a history of dialysis of more than 7 years was 1.3±0.2. However, no significant association was found between the adequacy of dialysis with age and history of dialysis, which is consistent with the findings of Stolic et al. (2010) and Mogharab et al. (2010) [14,20].

The results of this study showed that there is a direct and significant correlation between the adequacy of dialysis with the number of dialysis sessions per week and blood flow rate, which was

found by El-Sheikh et al. (2015) in Egypt [21]. This finding can be due to the fact that the increased blood flow speed can increase the frequency of passing blood flow through the filter and result in improving the withdrawal of blood poisons and improving the adequacy of dialysis. In the study of Supasynth et al. (2009) in Thailand, it is also shown that increasing the frequency of dialysis sessions per week leads to an improvement in the adequacy of dialysis, which is consistent with the current study [22].

In this study, dialysis adequacy was found to be in the direct relationship with interdialytic weight gain, which could be due to the exacerbation of solvent drag phenomena during dialysis. In this phenomenon, with the passage of fluid beyond the hemodialysis filter, the toxins also pass through and remove the filter pores. This finding contradicts the results of a study by Chang et al. (2016) in Korea [23]. This contradiction can be explained by the lower blood flow rates (less than 250 ml/min) in the Chang study. In this study, there was a significant relationship between the adequacy of dialysis with gender ($P < 0.05$), which was found to be consistent with findings of Ashrafi et al. (2014) in the city of Shahrud, Iran [24]. But it contradicts the findings of Beladi Mousavi et al. (2012) [15]. This contradiction could be due to the low number of research samples in the study by Beladi Mousavi et al. (2012) ($n=54$) compared to this study ($n=257$). In the present study, the adequacy of dialysis in patients with a temporary catheter was less than patients with fistulas and arteriovenous grafts, which could be due to a low blood flow rate in patients with catheters, in order to prevent recirculation. In this study, the blood flow rate was significantly lower in patients with a catheter. The most common cause of ESRD in this study was hypertension which consisted with Beladi Mousavi et al. (2012) [15] and Ghorbani Moghaddam (2016) [17].

Although the adequacy of dialysis in the patients in the Zanjan province seems to be favorable, further analysis of the data with regard to the factors affecting the adequacy of dialysis (factors Related to the patient and the factors related to the disease and the treatment process), were provided; the results can be taken into consideration in the

planning and management of these patients by the authorities. Based on the results of this study, changes in some parameters such as the number of weekly dialysis sessions, blood flow rate in the hemodialysis apparatus, the proper estimation of the interdialytic weight gain and its application in dialysis sessions, and the use of arteriovenous fistulas instead of catheters could help to improve the quality of hemodialysis in patients and the experience of successful dialysis centers could be used to improve the conditions in other centers. In addition, a significant proportion of these patients are made up of elderly people, which is also of particular interest in this regard.

Acknowledgments

This article resulted from the Master's thesis of a critical care nursing student in the Nursing and Midwifery Faculty of Zanjan (No: A-11-85-3 & date: 2015/2/28) and was approved by the Vice-Chancellor of Research at Zanjan University of Medical Sciences with the University Medical Ethics Committee approval code of ZUMS.REC.1393.247. We would like to thank Zanjan University of Medical Sciences for the financial support and the technology required to conduct this study and the cooperation of the dialysis department personnel and the patients undergoing hemodialysis in Zanjan province.

Conflict of interest: There was no conflict of interest.

Funding:

Research and Technology Section of Zanjan University of Medical Sciences financially supported this study.

References

1. Kasper D, Fauci A, Braunweld E, et al. Principle of Harrisons internal medicine. 17thed. New York: McGraw-Hill Professional; 2008: 1752-62.
2. Chen Y-S. Modeling hybrid rough set-based classification procedures to identify hemodialysis adequacy for end-stagerenal disease patients. *Comput Biol Med.* 2013; 43(10): 1590-605.
3. Ortiz A, Covic A, Fliser D, et al. Epidemiology, contributors to, and clinical trials

- of mortality risk in chronic kidney failure. *Lancet*. 2014; 383(9931): 1831-43.
4. Andreoli TH, Benjamin I, Griggs R, Wing E. Cecil Essentials of Medicine. Ayati Firuzabadi m, gharuni M, behjatie ardakani j, et al. (Persian translator). 8th ed. Tehran: Andishe Rafae; 2010. [In Persian]
 5. UNITED STATES RENAL DATA SYSTEM. The 2016 USRDS Annual Data Report on kidney disease in the United States is now available [cited 2016 2016/4/1]. Available at: URL:<http://www.usrds.org>.
 6. Shahdadi H, Badakhsh M, Msynayy N, Heydari M, Rahnema M. The effect of increasing blood flow rate on complications and dialysis adequacy in hemodialysis patients with low Kt/V. *Nurs Res*. 2010; 5(17): 62-67. [In Persian]
 7. Mehrnews Agency. Increasing in patients with renal disease. [Cited 2014/11/14]. Available at: URL: <http://www.mehrnews.com>. [In Persian]
 8. Teixeira Nunes F, de Campos G, Xavier de Paula SM, et al. Dialysis adequacy and nutritional status of hemodialysis patients. *Hemodial Int*. 2008; 12(1): 45-51.
 9. White Y. Haemodialysis adequacy: looking for the Holy Grail. *REN SOC AUSTRALAS J*. 2013; 9(2): 94-99.
 10. Makadia P, Kelly F, Kaplan J, Benson P. Hemodialysis Principles and Controversies. 1st ed. INTECH Open Access Publisher; 2011.
 11. Tayebi A, Shasti S, Tadrissi SD, Sadeghi Shermeh M, Einollahi B. The effect of infusion hypertonic glucose on dialysis adequacy in non-diabetic hemodialysis patients. *J Crit Care Nurs*. 2013; 5(4): 188-95.
 12. Raiesifar A, Torabpour M, Mohsenizad P, Shabani H, Tayebi A, Masoumi M. Dialysis adequacy in patients of Abadan hemodialysis center. *Crit care Nurs*. 2009; 2(3): 87-90.
 13. Amini M, Aghighi M, Masoudkabir F, et al. Hemodialysis Adequacy and Treatment in Iranian Patients. *Iran J kidney Dis*. 2011; 5(2): 103-9.
 14. Mogharab M, Madarshahian F, Rezaei N, Mohammadi A. Dialysis adequacy in chronic hemodialysis patients in educational center Vali-Asr in Birjand. *J Birjand Univ Med Sci*. 2010; 17(3): 206-14. [In Persian]
 15. Beladi Mousavi S, Hosaini Nejad K, Zeraati A. The Evaluation of Dialysis Adequacy by KT/V in Hemodialysis Patients. *Jundishapur Sci Med J*. 2012; 11(1): 43-48. [In Persian]
 16. Shariati A, Asayesh H, Nasiri H, et al. To compare dialysis adequacy in patient's that referred to Golestan province hemodialysis centers. *J Health Promot Manag*. 2012; 1(3): 55-63. [In Persian]
 17. Ghorbani Moghaddam Z, Sharifi SH, Raese AR, Yazdankhah Fard MR, Mirzaee K, Bahraime M. Investigation of Hemodialysis Adequacy in Patients Undergoing Hemodialysis in the Shohada Hospital in Bushehr. *Iran South Med J*. 2016; 18(6): 1236-44. [In Persian]
 18. Davenport A. Differences in prescribed Kt/V and delivered haemodialysis dose-why obesity makes a difference to survival for haemodialysis patients when using a 'one size fits all' Kt/V target. *Nephrol Dial Transplan*. 2013; 28(4): iv 219-23.
 19. Roozitalab M, Mohammadi B, Najafi S, Mehrabi S, Fararouei M. KT/V and URR and the Adequacy of Hemodialysis in Iranian provincial hospitals: an evaluation study. *Life Sci J*. 2013; 10(12): 13-16.
 20. Stolic R, Trajkovic G, Stolic D, Peric V, Subaric-Gorgieva G. Nutrition parameters as hemodialysis adequacy markers. *Hippokratia*. 2010; 14(3): 193-97.
 21. El-Sheikh M, Al-Ghazaly G. Assessment of hemodialysis adequacy in patients with chronic kidney disease in the hemodialysis unit at Tanta University Hospital in Egypt. *Indian J Nephrol*. 2016; 26(6): 398-404.
 22. Supasynndh O, Satirapoj B, Seenamngoen S, Yongsiri S, Choovichian P, Vanichakarn S. Nutritional status of twice and thrice-weekly hemodialysis patients with weekly Kt/V > 3.6. *J Med Assoc Thai*. 2009; 92(5): 624-31.
 23. Chang KY, Kim S-H, Kim YO, et al. The impact of blood flow rate during hemodialysis on all-cause mortality. *Korean J Intern Med*. 2016; 31(6): 1131-39.
 24. Ashrafi Z, Ebrahimi H JS. The relationship between hemodialysis adequacy and quality of life and spiritual wellbeing in hemodialysis patients. *J Clin Nurs Midwifery*. 2014; 3(3): 44-51. [In Persian]