Original Article

Assessment of hemodialysis adequacy and its relationship with individual and personal factors

Ozra Rezaiee[1], Nahid Shahgholian[2], Shahrzad Shahidi[3]

Abstract

Background: Hemodialysis is the most common renal replacement therapy in the world, and hemodialysis adequacy is an important and influencial factor in the reduction of various complications experienced by these patients. Multiple factors influence hemodialysis adequacy. This study was conducted to determine hemodialysis adequacy and its relationship with individual and personal factors in patients undergoing hemodialysis in three hemodialysis centers of Isfahan, Iran.

Materials and Methods: This descriptive, cross-sectional study was conducted in partnership with 202 patients undergoing hemodialysis in three hemodialysis centers of Isfahan. The data were collected using a researcher-made questionnaire, and hemodialysis adequacy was measured using the urea reduction ratio (URR). Data analysis was conducted using Spearman's correlation coefficient, Mann–Whitney and Kruskal–Wallis tests, and descriptive statistics (frequency distribution). In this study, the level of significance was considered to be 0.05.

Results: Hemodialysis adequacy in 56.4% of patients was optimal, in 29.7% near optimum, and in 13.9% less than optimal. Statistical tests showed a significant correlation between hemodialysis adequacy and age ($P = 0.05$), prehemodialysis systolic blood pressure (BP) ($P = 0.02$) and diastolic BP ($P = 0.04$), the duration of hemodialysis in months ($P = 0.02$), and patients' sex ($P = 0.01$). There was no significant correlation between hemodialysis adequacy and the number of hemodialysis cessations per week ($P = 0.20$), interdialytic weight gain ($P = 0.40$), prehemodialysis blood urea nitrogen ($P = 0.40$), creatinine ($P = 0.10$), hemoglobin ($P = 0.20$), hematocrit ($P = 0.08$), venous access type ($P = 0.30$), needle distance and direction ($P = 0.70$), underlying causes of end-stage renal disease ($P = 0.50$), and personnel's shift ($P = 0.90$).

Conclusions: The results of the study showed that approximately half of the patients did not have an optimal level of hemodialysis adequacy, and multiple individual and personnel factors affect hemodialysis adequacy directly or conversely.

Key words: Hemodialysis, hemodialysis adequacy, Iran, nurses, nursing, urea reduction ratio

[1]Student Research Committee, Isfahan University of Medical Sciences, Isfahan, Iran, [2]Department of Critical Care Nursing, Isfahan Kidney Diseases Research Center, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran, [3]Isfahan Kidney Diseases Research Center, School of Medicine, Isfahan, Iran

Address for correspondence: Ms. Nahid Shahgholian, Department of Critical Care Nursing, Isfahan Kidney Diseases Research Center, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran. E-mail: shahgholian@nm.mui.ac.ir

Access this article online	
Quick Response Code:	**Website:** www.ijnmrjournal.net
	DOI: 10.4103/1735-9066.197673

Introduction

Hemodialysis is one of the alternative treatments used in patients with end-stage renal disease (ESRD).[1] Currently, 150000 sessions of hemodialysis are performed every month in Iran, with more than 13000 patients being treated through dialysis.[2] In Isfahan (Iran), 1500 patients are undergoing hemodialysis.[3] Hemodialysis treatment influences the lifestyle, health status, and role of the individual within the family and community. Despite the significant advances

How to cite: Rezaiee O, Shahgholian N, Shahidi S. Assessment of hemodialysis adequacy and its relationship with individual and personal factors. Iranian J Nursing Midwifery Res 2016;21:577-82.

made in this treatment process, these patients still do not have a satisfactory quality of life (QOL).[4]

Patients undergoing hemodialysis face mental, physical, and social problems because of the specific conditions caused by the treatment and the disease.[5] Therefore, the treatment plan causes impairment in the economic and employment status and confidence of the patients and effects the degree of their dependence on the health system.[6] These patients experience fatigue, infertility and sexual dysfunction, bone disease, anemia, cardiovascular problems, digestive disorders,[7] depression, and anxiety. These side effects result in frequent hospitalization and increased mortality rate.[5]

Hemodialysis adequacy is an important and effective factor in reducing these side effects.[6] In addition, numerous studies have shown that with higher hemodialysis adequacy, the patients' health status is improved, their life expectancy is increased, and the rate of mortality is reduced. Thus, increasing the adequacy of hemodialysis is one the challenges of the hemodialysis treatment process.[8]

A urea reduction ratio (URR) equivalent to 65% is considered the minimum standard criteria for adequate hemodialysis, URR of 65% and higher is considered optimal hemodialysis adequacy, URR of 55–64.99% is considered relatively favorable, and URR of less than 55% is considered undesirable hemodialysis.[9] Moreover, a URR of less than 65% is associated with increased morbidity and mortality among patients.[9] It has been shown that for every 5% increase in URR, mortality rate decreased up to 11%.[10] Furthermore, low efficiency of hemodialysis increases the need for more hemodialysis sessions, longer hospitalizations, and increased hospital costs.[11] Thus, monthly assessment of hemodialysis adequacy is recommended.[8]

Studies conducted in Iran and the world have shown that many factors affect hemodialysis adequacy, and they have emphasized the importance of individual and personnel factors in this respect.[12] These studies reported the failure to comply with the hemodialysis program, hemodynamic instability, premature cessation of hemodialysis,[8] blood recirculation,[10] and ineffective filter[13] as factors influencing hemodialysis adequacy. Many of these factors can be modified by nurses. The results of some studies, such as Borzou *et al*., showed that nurses' failure to adjust the pump round can lead to hemodynamic instability and hypotension during hemodialysis and premature cessation of hemodialysis, which will have a negative effect on hemodialysis adequacy.[8] The results of the study by Shariati *et al*. also showed that incorrect insertion of the arteriovenous needle, in terms of distance and direction, by hemodialysis nurses was the leading cause of recirculation,

and hemodialysis nurses should be trained in this regard.[10] Nurses can improve hemodialysis adequacy by prevention of hemodialysis complications (hypotension) that lead to inadequate hemodialysis,[14] correct and standard insertion of needles,[10] provision of necessary training on compliance with medication regimen before hemodialysis and dietary regimen,[2] accurate preparation and elimination of dead spaces of the filter,[13] and compliance with the accurate duration of each hemodialysis session.[2]

Evaluation of hemodialysis adequacy has been conducted in most cities of Iran such as Kashan, Rasht, Sari, Tehran, and Jahrom. The results showed that more than half of the patients did not have a satisfactory hemodialysis adequacy. However, no studies were conducted in this regard in Isfahan. Optimal hemodialysis adequacy will result in the prevention of frequent hospital admissions, repeated hemodialysis sessions, increased workload of nurses, high economic costs imposed on the health system, and reduction of the rate of mortality among patients undergoing hemodialysis. Achieving adequate hemodialysis is not possible without knowledge of the present status of hemodialysis adequacy among these patients and factors effective on its variation. Therefore, assessment of the adequacy of hemodialysis seems to be necessary in each city. Hence, this study was conducted to determine hemodialysis adequacy and its relationship with individual and personnel-related factors in patients undergoing hemodialysis in three hemodialysis centers in Isfahan in order to obtain the necessary information to improve the quality of nursing services.

MATERIALS AND METHODS

This was a cross-sectional study on 202 patients undergoing hemodialysis at hemodialysis centers of Alzahra, Amin, and Hojatiyeh Hospitals of Isfahan. The participants had a constant and active record, at least 3 months of hemodialysis history,[15] were not hospitalized, did not have infections, fever, diarrhea, or vomiting,[16] and underwent hemodialysis containing bicarbonate solution and dialysate containing 2 meq/l of potassium.[17] The subjects were selected via census method.

Data were collected using a researcher-made questionnaire which consisted of two parts including individual and personnel factors. Individual factors included age, gender, prehemodialysis blood pressure (BP), vascular access type and location, preliminary diseases of ESRD, number of hemodialysis sessions per week, duration of hemodialysis (months), and interdialytic weight gain. Personnel factors included the distance and direction of the arteriovenous needle (in case of a fistula or graft) and the working shift

of the personnel, which were recorded by the researcher. The validity of this questionnaire was confirmed through content validity method. In the view of professors, based on the contents of the questionnaire, the confirmation of its reliability was not required. The study objectives were explained to the patients who met the inclusion criteria and written informed consent forms were obtained. In order to minimize the frequency of blood sampling, the dates of sampling for the study were coordinated with the dates of the hospitals' routine sampling. Laboratory parameters [hematocrit (HCT), hemoglobin (Hb), creatinine (Cr), blood urea nitrogen (BUN)] were measured on the day of sampling before the hemodialysis session. After the hemodialysis session on the same day of the session, the patients' BUN was tested again to determine the URR. On the sampling day, before the hemodialysis session, the patients' weights were measured and recorded using a weight that was calibrated with standard 500-gram weights. Before hemodialysis, a 2 ml blood sample was obtained from the arterial line of the patient and was sent to the laboratory for BUN, Cr, Hb, and HCT calculation. The questionnaire was completed for each patient. Then, at the end of the same hemodialysis session, the pump round was set at 50–100 ml per min for 10–20 s and then stopped and blood samples were obtained from the arterial line.[18]

The samples were sent to a laboratory for post-hemodialysis BUN examination. The examination results of each patient were recorded in their questionnaire, and the URR formula was used to obtain hemodialysis adequacy.[8] It should be noted that, in this study, a URR of 65% was considered the minimum standard of hemodialysis adequacy, URR of 65% and higher was considered optimal hemodialysis adequacy, URR of 55–64.99% was considered relatively favorable, and URR of less than 55% was considered undesirable hemodialysis.[9] Data analysis was conducted using Spearman's correlation coefficient, Mann–Whitney and Kruskal–Wallis tests, and descriptive statistics (frequency) in Statistical Package for the Social Sciences software (version 18, SPSS Inc., Chicago, IL, USA). Then, the relationship between the patients' hemodialysis adequacy and personnel and individual factors were evaluated.

Ethical considerations

The patients were informed of the goals of the study and completed an informed consent. In order to minimized the frequency of blood sampling, the dates of sampling for the study were coordinated with the dates of hospital's routine sampling.

RESULTS

The mean age of the patients was 59.6 ± 14.45 years. Of the 202 participants, 135 (66.8%) were men and

Table 1: Frequency distribution of hemodialysis adequacy in patients

Variable	Number	Percentage
Hemodialysis adequacy		
Optimal	114	56.4
Near optimum	60	29.7
Less than optimal	28	13.9
Total	202	100

67 (33.2%) were women. The most common underlying disease was diabetes [112 (55.4%)] and the most common vascular access type was fistula [99 (49%,)]. The obtained hemodialysis adequacy is presented in Table 1.

Spearman's correlation coefficients showed that hemodialysis adequacy had an inverse relationship with the variables of age ($P = 0.05$), prehemodialysis systolic BP ($P = 0.02$) and diastolic BP ($P = 0.04$), and a direct statistical relationship with the duration of hemodialysis (months) ($P = 0.02$). According to the result of the Mann–Whitney test, there was a statistically significant relationship between hemodialysis adequacy and gender ($P = 0.01$). Women had a more satisfactory hemodialysis adequacy than men. Nevertheless, according to Spearman's correlation coefficient, no statistically significant relationship was observed between hemodialysis adequacy and the number of hemodialysis sessions per week ($P = 0.20$), interdialytic weight gain ($P = 0.40$), prehemodialysis amount of BUN ($P = 0.40$), Cr ($P = 0.10$), Hb ($P = 0.20$), and HCT ($P = 0.08$), and the distance of the arteriovenous needle injection (in the case of a fistula or graft) ($P = 0.70$). Based on Kruskal–Wallis test results, no significant relationships were observed between vascular access type ($P = 0.30$), preliminary diseases of ESRD ($P = 0.50$), the shift of the hemodialysis personnel ($P = 0.90$), and hemodialysis adequacy. According to Mann–Whitney test results, no significant relationship was found between the direction of the arteriovenous injection needle (in the case of a fistula or graft) ($P = 0.70$) and hemodialysis adequacy.

DISCUSSION

The results of this study showed that based on URR, more than half of the patients had desirable hemodialysis adequacy, and the rest of the patients had relatively favorable or unfavorable hemodialysis adequacy. However, in the study conducted by Borzou *et al*., based on URR, hemodialysis adequacy was favorable in 35.7%, relatively favorable in 38.1%, and poor in 26.6% of the patients.[8] The results of the study by Raeisifar *et al*. in Abadan showed that 97.8% of the patients had poor hemodialysis adequacy and only 2.2% of the patients had favorable hemodialysis adequacy.[11] Therefore, these results indicated that the hemodialysis

adequacy in hemodialysis centers of Isfahan were more favorable compared to the mentioned centers. It appears that the increased awareness of the patients and frequent education of the hemodialysis personnel of these centers provided favorable conditions; thus, the patients benefited from a higher quality of hemodialysis. It also prevented the increased frequency of hemodialysis due to uncontrolled levels of waste in the blood and clinical symptoms of the patients, increased hospitalizations, increased hospital costs,[11] and mortality among these patients.

Among the factors affecting the adequacy of hemodialysis was the patient's age. The results showed that hemodialysis adequacy had an inverse relationship with age; and older patients had less hemodialysis adequacy. The results of the studies by Moura *et al*.[19] and Anees *et al*.[20] showed that the adequacy of hemodialysis decreased with increased age of the patients. This decrease had a negative impact on the QOL of these patients, and the results of these studies were consistent with the present study. Nevertheless, the results of some studies, such as Shariati *et al*., showed no significant correlation between hemodialysis adequacy and age.[10] It appears that the differences in sampling method and the number of studied subjects were the cause of this discrepancy. Moura *et al*. believed that URR was not an independent variable and was influenced by multiple factors including protein intake, and the increase in age resulted in poor nutrition conditions including hypoalbuminemia; these conditions usually reduce hemodialysis adequacy.[19]

The results of this study showed an inverse relationship between prehemodialysis BP and hemodialysis adequacy. The higher the patient's BP before hemodialysis, the lower the hemodialysis adequacy. The results of the study by Tayyebi *et al*. showed no linear correlation between prehemodialysis systolic and diastolic BP and hemodialysis adequacy.[21] The results of the mentioned study was not consistent with the present study results. In this study, the maximum BP of the patient before hemodialysis was reported to be 130/80,[21] which was in the normal range based on the definition of high BP of the Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNCVI). However, in the present study, the maximum BP of the patient before hemodialysis was 204/115, and the BP of the patients before hemodialysis and hemodialysis adequacy were inversely correlated. BP is an important vital sign in patients treated with hemodialysis, its fluctuations are regularly recorded by nurses during hemodialysis sessions, and it is in direct relation with many of the problems that reduce hemodialysis adequacy.[21]

Patients with high BP at the beginning of hemodialysis suffer greater fluctuations in BP during hemodialysis and

are faced with problems such as premature cessation of the hemodialysis session. This is the reason that high BP before hemodialysis can affect its adequacy.

Other results of the study showed a significant direct relationship between duration of hemodialysis (months) and hemodialysis adequacy. Patients who had longer hemodialysis sessions had a more satisfactory hemodialysis adequacy. However, Roozitalab *et al*. did not find this significant relationship, and showed that over time, the quality of hemodialysis is reduced.[22] The results of these studies were not consistent with the present study. In the present study, the duration of treatment ranged from 3 months to 14 years and had a wide range, whereas in the abovementioned study, this range was more limited, which could be the cause of this discrepancy. It seems that longer hemodialysis treatment duration results in increased adaptation of patients with the hemodialysis process and higher hemodialysis adequacy.

Another finding of this study was the significant relationship between gender and hemodialysis adequacy; women had more satisfactory hemodialysis adequacy than men. This fact was shown in different studies, including the study by Hojjat.[2] The results of this study was consistent with the present study, but the results of the study by Tayyebi *et al*. showed no significant relationship between gender and hemodialysis adequacy.[21] This difference was due to the differences in gender distribution in various studies. Factors such as muscle mass, less physical activity, and better compliance with dietary regimen in women led to more satisfactory hemodialysis adequacy.[23]

The number of hemodialysis sessions per week varied between subjects and, based on the results obtained, had no significant relationship with hemodialysis adequacy. Results of some studies such as Hashemi and Garshad also confirmed these findings.[24] Nevertheless, Mogharab *et al*. found a significant relationship between the number of weekly hemodialysis sessions and hemodialysis adequacy.[25] This conclusion is not implausible because hemodialysis dose is calculated based on each patient individually and is not based on a predetermined fixed pattern. In the present study, hemodialysis dose was determined for each patient based on their requirements.[26]

No significant relationship was found in the present study between hemodialysis adequacy and interdialytic weight gain and the findings of Roozitalab *et al*. also confirmed this result.[22] However, Vahedparast and Ravanipour showed, in their study, that overweight patients had lower hemodialysis adequacy. These researchers noted that the treatment facilities and hemodialysis machines at the studied hemodialysis centers did not respond to 4 h

of hemodialysis for each session; therefore, overweight patients were faced with a lack of hemodialysis adequacy.[27] Nonetheless, because, in the present study, the centers had flexible hemodialysis hours based on the hemodialysis requirements of the patients, which varied between 4 and 4.5 h, these results were obtained.

The laboratory parameters in this study were variable. Based on the results, hemodialysis adequacy and prehemodialysis BUN, Cr, Hb, and HCT had no significant relationship. Results of other studies were consistent with the present study results.[21,24,28]

The most common vascular access type in the present study was fistula, and the results showed no significant relationship between hemodialysis adequacy and access type. The results of the studies by Shariati *et al.* and Alison *et al.* also confirmed this finding.[10,29] However, because other studies have shown that other access types, such as subclavian, femoral, and permacath access, had a negative impact on hemodialysis adequacy,[30,31] it is necessary to conduct studies involving patients with the same distribution of access.

Among the factors affecting the adequacy of hemodialysis was the correct insertion of the arteriovenous needle. Based on the study results, no relationship was found between distance and direction of the arteriovenous needle and hemodialysis adequacy. However, Shariati *et al.* rejected this relationship. The lower number of subjects in the present study compared to their study (202 versus 389) might be the reason for this difference. Recirculation was an important factor in reduced hemodialysis adequacy and lack of accurate arteriovenous needle placement was one of the reasons for recirculation. The needle insertion technique was an important factor affecting the adequacy of hemodialysis.[10]

In this study, the most common underlying disease causing ESRD was diabetes, and the results showed no significant relationship between hemodialysis adequacy and this factor. The results of the study by Movahed *et al.* also confirmed this finding.[23] Hemodialysis personnel were working in three shifts (morning, afternoon, and evening). Based on the study results, no significant relationship existed between adequacy of hemodialysis and dialysis personnel's shifts. The findings of Monfared *et al.* also confirmed this finding.[15] This indicated that working shifts do not affect the work quality of nurses. Because factors affecting the adequacy of hemodialysis were studied in this research, reviewing the effects of different shifts on the patients' hemodialysis adequacy was not possible. Therefore, it is recommended that

further studies be performed to evaluate the adequacy of hemodialysis for patients treated in a period of 3 months in Iran in order to develop a detailed plan to improve hemodialysis adequacy and QOL and to reduce mortality among these patients.

CONCLUSION

The results showed that more than half of the patients had desirable hemodialysis adequacy and the remaining patients had relatively favorable or unfavorable hemodialysis adequacy. Some individual and personnel factors directly or inversely affected the adequacy of hemodialysis. Therefore, in designing nursing care services for these patients, it is essential to consider these factors in order to increase hemodialysis adequacy.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Bjorg Th, Keith MS, Molly AF, Paul SM, Amy WW. Are there alternatives to hemodialysis for the elderly patient with End-Stage Renal Failuure?. Myo Clin Proc 2012;87:514-160.
2. Hojjat M. Hemodialysis adequacy in patients with chronic renal failure. Iran J Crit Care Nurs 2009;2:61-6.
3. Mojdeh S, Karimi S, Mehrabi A, Bakhtiari S. Etiology of renal failure and peritoneal dialysis complications in Isfahan. Health 2013;5:1702-05.
4. Saei A, Mazhari M, Tayybi A, Ebadi A. The effect of continuous care model on dialysis adequacy in hemodialysis patients of selected Iranian army hospitals. J Mil Med 2012;1:105-12.
5. Jaber BL, Lee Y, Collins AJ, Hull AR, Kraus MA, McCarthy J, *et al.*, Effect of daily hemodialysis on depressive symptoms and postdialysis recovery time: Interim report from the FREEDOM (Following Rehabilitation, Economics and Everyday-Dialysis Outcome Measurements) Study. Am J Kidney Dis 2010;56:531-9.
6. Shasti S, Babahaji M. The assessment of dialysis adequacy among hemodialysis patients in Tehran City. EBNESINA 2011;14:23-7.
7. Tayyebi A, Savari S, Nehrir B, Rahimi A, Eynollahi B. The effect of Vitamin B12 supplemention on fatigue in hemodialysis patients. Iran J Crit Care Nurs 2013;6:39-48.
8. Borzou R, Ghlyaf M, Amini R, Zandiyan M, Torkaman B.

Evaluation of dialysis adequacy in hemodialysis Ekbatan Hospital. Hamadan 2006;13:53-7.

9. Brenner BM, Maarten W, Taal GMC, Philip A. Marsden K, Alan SL. The Kidney. Lippincott, Williams and Wilkins: Elsevier; 2012 p. 2314-18.

10. Shariati AR, Asayesh H, Nasiri H, Tajbakhsh R, Hesam M, Mollaee E, *et al*. To compare dialysis adequacy in patient's that referred to Golestan province hemodialysis centers. Health Inf Manage 2012;1:56-64.

11. Raiesifar A, Torabpour M, Mohsenizad P, Shabani H, Tayebi A, Masoumi M. Dialysis adequacy in patients of Abadan hemodialysis center. J Crit Care Nurs 2009;2:87-90.

12. Lambie SH, Taal MW, Fluck RJ, McIntyre CW. Analysis of factors associated with variability in haemodialysis adequacy. Nephrol Dial Transplant 2004;19:406-12.

13. Oshvandi KH, Kavyannejad R, Borzuo R, Gholyaf M, Salavati M. Dialysis adequacy with high flux membrane in hemodialysis patients at Shahid Beheshti hospital, Hamedan. J Urmia Nurs Midwifery Fac 2012;10:541-8.

14. Mottahedian TE, Najafi MS, Samiey S, Einollahi B, Mohammadi E. Effect of programmed nursing care in prevention of hemodialysis complications. J Crit Care Nurs 2009;2:55-9.

15. Stolic R, Trajkovic G, Stolic D, Peric V. Nutrition parameters as hemodialysis adequacy markers. Hippokratia 2010;14:193-7.

16. Kaysen GA, Chertow GM, Adhikarla R, Young B, Ronco C, Levin NW. Inflammation and dietary protein intake exert competing effects on serum albumin and creatinine in hemodialysis patients. Kidney Int 2001;60:333-40.

17. Hekmat R, Mojahedi MJ, Garevani H. The effect of hemodialysis solution buffer on the control of blood pressure and efficacy of hemodialysis in chronic hemodialysis patients. Tehran Univ Med J 2008;65:33-7-11.

18. Elhafiz M, Imam ME, Omran O, Gabar AA, Miskeen E. Hemodialysis, plea of availability versus adequacy. Sudan J Med Sci 2009;4.

19. Teixeira NF, Decampos G, Xavier DSM, Mehri VA, Portero KC, Damotta DG, *et al*. Dialysis adequacy and nutritional status of hemodialysis patients. Hemodial Int 2008;12:45-51.

20. Anees M, Malik MR, Abbasi T, Nasir Z, Hussain Y, Ibrahim M. Demographic factors affecting quality of life of hemodialysis patients–Lahore, Pakistan. Pak J Med Sci 2014;30:1123-7.

21. Tayyebi A, Shasti S, Tadrisi D, Eynollahi B, Sadeghi SM. The relationship between blood pressure and dialysis adequacy in dialysis patients. Iran J Crit Care Nurs 2012;5:49-52.

22. Roozitalab M, Moohamadi B, Najafi SH, Mehrabi S. Determining the adequacy of hemodialysis in hemodialysis units of Kohgilouyeh and Boyerahmad hospitals in 2009. Armaghane Danesh 2010;15:273-82.

23. Jessica EM, Csaba PK, Allen RN, Rajnish M, Elani S, David VW, *et al*. Association of hemodialysis treatment time and dose with mortality and the role of race and sex. AMJ Kidney Dis 2010;55:100-12.

24. Raymond MH, Sharmeela S. Dialysis frequency versus dialysis time, that is a question. Kidney Int 2014;85:1024-9.

25. Mogharab M, Madarshahian F, Rezai N, Mohammadi A. Dialysis adequacy in chronic hemodialysis patients in educational center Vali-Asr in Birjand. J Birjand Univ Med Sci 2010;17:206-14.

26. Nadi E, Bashirian S, Khosravi M. Assessing of dialysis adequacy in patients under hemodialysis in dialysis department of Ekbatan Hospital in Hamadan. Sci J Hamadan Univ Med Sci 2003;10:27-33.

27. Parast HV, Ravanipour M. Assessing the adequacy of dialysis in patients undergoing hemodialysis in hemodialysis center in Boshehr city. Sci J Hamadan Nurs Midwifery Fac 2008;16:50-60.

28. Taziki A, Kashi Z. Determination of dialysis sufficiency in the patients referring to dialysis center of Fatemeh Zahrah Hospital of Sari in 2000. J Mazandaran Univ Med Sci 2003;13:40-6

29. Ma A, Shroff R, Hothi D, Lopez MM, Veligratli F, Calder F, *et al*. A comparison of arteriovenous fistulas and central venous lines for long-term chronic haemodialysis. Pediatr Nephrol 2013;28:321-6.

30. Sehgal AR, Snow RJ, Singer ME, Amini SB, DeOreo PB, Silver MR, *et al*. Barriers to adequate delivery of hemodialysis. Am J Kidney Dis 1998;31:593-601.

31. Sehgal AR, Leon JB, Siminoff LA, Singer ME, Bunosky LM, Cebul RD. Improving the quality of hemodialysis treatment: A community-based randomized controlled trial to overcome patient-specific barriers. JAMA 2002;287:1961-7.