

# BENEFITS OF TYPE MEMBRANE High-Flux AND LOW-FLUX MEMBRANE IN EFFICACY OF HEMODIALYSIS IN PATIENTS WITH ESRD

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## Abstract

**Summary:** Chronic kidney disease, also called chronic kidney failure, describes the gradual loss of kidney function. Your kidneys filter wastes and excess fluids from your blood, which are then excreted in your urine. When chronic kidney disease reaches an advanced stage, dangerous levels of fluid, electrolytes and wastes can build up in your body. In the early stages of chronic kidney disease, you may have few signs or symptoms. Chronic kidney disease may not become apparent until your kidney function is significantly impaired. Treatment for chronic kidney disease focuses on slowing the progression of the kidney damage, usually by controlling the underlying cause. Chronic kidney disease can progress to end-stage kidney failure, which is fatal without artificial filtering (dialysis) or a kidney transplant. End-stage kidney disease is the last stage of chronic kidney disease. This is when your kidneys can no longer support your body's needs. End-stage kidney disease is also called end-stage renal disease (ESRD). The kidneys remove waste and excess water from the body. ESRD occurs when the kidneys are no longer able to work at a level needed for day-to-day life. The most common causes of ESRD in the United States are diabetes and high blood pressure. These conditions can affect your kidneys. ESRD almost always comes after chronic kidney disease. The kidneys may slowly stop working over 10 to 20 years before end-stage disease results. CKD can get gradually worse over time and eventually the kidneys may stop working altogether, but this is uncommon. Aim of this paper: This study aimed to investigate the dialysis efficacy of low-flux versus high-flux membranes in hemodialysis patients. Material and methods: Eighty patients hemodialysis ( $N^o=80$ ) participated in this cross-over clinical trial. Two sessions of low-flux and high-flux membrane dialysis were performed consecutively, in the first and second stage of the trial. In both stages, blood samples before and after the dialysis were taken and sent to the laboratory for assessment. Blood urea nitrogen (BUN),  $KT/V$  and the urea reduction ratio (URR) indexes were used to determine dialysis efficacy. Data were analyzed using t test and paired t test. Results: The mean  $KT/V$  was  $1.25 \pm 0.26$  in high-flux and  $1.10 \pm 0.30$  in low-flux membrane which, these differences were statistically significant for  $p=0.015$ ). The mean of URR was  $0.62 \pm 0.08$  in high-flux and  $0.60 \pm 0.12$  in low-flux membrane, which these differences were not statistically significant for  $p=0.220$ . Results: The mean  $KT/V$  was  $1.25 \pm 0.26$  in high-flux and  $1.10 \pm 0.30$  in low-flux membrane which, these differences were statistically significant for  $p=0.015$ ). The mean of URR was  $0.62 \pm 0.08$  in high-flux and  $0.60 \pm 0.12$  in low-flux membrane, which these differences were not statistically significant for  $p=0.220$ . Conclusions: The high-flux membrane had better dialysis adequacy, so we suggest using high-flux membrane in hemodialysis centers. Compared to low-flux haemodialysis, high-flux haemodialysis has little or no effect on total mortality but lowers. In conclusion, we found that HD using high-flux dialysis membranes had survival benefit in patients with ESRD treated with long term hemodialysis. Many people with kidney disease are able to live long, largely normal lives. CKD can be caused by: high blood pressure, diabetes, high cholesterol, kidney infections, glomerulo-nephritis - kidney inflammation, polycystic kidney disease - an inherited condition where growths called cysts develop in the kidneys, blockages in the flow of urine - for example, from recurrent kidney stones or an enlarged prostate, long-term, regular use of certain medicines - such as lithium and non-steroidal anti-inflammatory drugs (NSAIDs). Inadequacy of dialysis is one of the main causes of death in hemodialysis patients. Some studies have suggested that high-flux membrane improves the removal of moderate-sized molecules.

**Term index:** Hemodialysis, High-Flux Membrane, Low-Flux Membrane, Dialysis, Efficacy.

## 1 INTRODUCTION

Hemodialysis is a treatment for kidney failure that uses a machine to filter your blood outside your body. At the start of a hemodialysis treatment, a dialysis nurse or technician places two needles into your arm. Once trained by the health care team, some people prefer to insert, or put in, their own needles. A pump on the hemodialysis machine draws your blood through one of the needles into a tube, a few ounces at a time. Your blood travels through the tube to the filter, called a dialyzer. Inside the dialyzer, your blood flows through thin fibers that filter out. The dialyzer is the "artificial kidney." Blood enters at the top of the dialyzer, in this case, and is forced into multiple, very thin, hollow fibers made of a semi-permeable membrane. Each fiber is about the size of a human hair. As blood passes through the hollow fibers, dialysis solution passes in the opposite direction

on the outside of the fibers.

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In the less than one second it takes for the blood to pass from the top of the dialyzer to the bottom, waste products diffuse out of the blood and into the dialysis solution. In hemodialysis, an artificial kidney (hemodialyzer) is used to remove waste and extra chemicals and fluid from your blood. To get your blood into

the artificial kidney, the doctor needs to make an access (entrance) into your blood vessels. This is done by minor surgery to your arm or leg. Sometimes, an access is made by joining an artery to a vein under your skin to make a bigger blood vessel called a fistula. However, if your blood vessels are not adequate for a fistula, the doctor may use a soft plastic tube to join an artery and a vein under your skin. This is called a graft. , an access is made by means of a narrow plastic tube, called a catheter, which is inserted into a large vein in your neck. This type of access may be temporary, but is sometimes used for long-term treatment. The single-pool urea kinetic model (UKM), utilizing "Kt/ V"(the normalized whole body urea clearance), is widely used to help assess the adequacy of hemodialysis (HD). The Kt/V value represents dialyzer clearance (K), distribution volume of urea (V), and dialysis duration (t).<sup>1</sup> In the classic Gotch-Sargent urea kinetic model, the dialysis parameters are used for prescribing the dose of dialysis therapy (prescribed Kt/V).<sup>2</sup> The estimation of Kt/V by various formulae utilizing preandpostdialysis blood urea concentrations provides a simple technique for calculating the delivered Kt/V value.<sup>3</sup> The National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (K/DOQI) recommends use of the Daugirdas second-generation formula for delivered dialysis dose (Kt/V) calculation.<sup>4</sup> Numerous studies have confirmed the association between the adequacy of the delivered dose of HD and patient outcome.<sup>5</sup> Most of the published reports have shown improved patient survival with higher levels of delivered dialysis dose.<sup>6</sup> The important role of Kt/V in predicting subsequent hospitalization rates and mortality has been demonstrated.<sup>7</sup> Mortality risk is lower by 7% with each 0.1 higher level of delivered Kt/V . Dialysis dose," a concept developed by Sargent and Gotch based on urea kinetic modeling, is a useful and recognized tool that is used to quantitate dialysis. Despite that, Qe value has been proposed as a technical hemodialysis parameter called "dialysis efficacy" . This is an additional parameter which provides useful information on technical HD efficacy. The term "dialysis efficacy"(Qe) should

be distinguished from term "dialysis adequacy" or "dialysis quantity"(Kt/V). Patients who weigh > 81 kg may experience inadequate dialysis despite longer, more efficient dialysis sessions. The principal determinant of dialyzer urea clearance is blood flow rate. Actual blood flow rates are frequently less than the nominal blood flow rate displayed by the dialysis machine, particularly at higher flow rates, leading to lower than expected urea clearances. Delivered blood flow during hemodialysis is often significantly less than prescribed blood flow . The blood flow indicated by the dialysis blood roller pump is always greater than the delivered blood flow, and this difference is in turn conditioned by the negative pressure induced by the blood roller pump in the arterial blood line. CKD is more prevalent in the elderly population. However, while younger patients with CKD typically experience progressive loss of kidney function, 30% of patients over 65 years of age with CKD have stable disease. CKD is associated with an increased risk of cardiovascular disease and chronic renal failure. Kidney disease is the ninth leading cause of death in the United States. The Kidney Disease Outcomes Quality Initiative (KDOQI) of the National Kidney Foundation (NKF) established a definition and classification of CKD in 2002. The KDOQI and the international guideline group Kidney Disease Improving Global Outcomes (KDIGO) have subsequently updated these guidelines. These guidelines have allowed better communication among physicians and have facilitated intervention at the different stages of the disease. The guidelines define CKD as either kidney damage or a decreased glomerular filtration rate (GFR) of less than 60 mL/min/1.73 m<sup>2</sup> for at least 3 months. Whatever the underlying etiology, once the loss of nephrons and reduction of functional renal mass reaches a certain point, the remaining nephrons begin a process of irreversible sclerosis that leads to a progressive decline in the GFR. Hyperparathyroidism is one of the pathologic manifestations of CKD. See the image below (34-36).

## 2 Matherial and Methods

Eighty patients hemodialysis ( N<sup>o</sup>=80 ) participated in this cross-over clinical trial. Two sessions of low-flux and high-flux membrane dialysis were performed consecutively, in the first and second stage of the trial. In both stages, blood samples before and after the dialysis were taken and sent to

the laboratory for assessment. Blood urea nitrogen (BUN), KT/V and the urea reduction ratio (URR) indexes were used to determine dialysis efficacy. Data were analyzed using t test and paired t test.

Table nr.1 Presentation of patients by gender, age average and control group ± SD

Gender	Total number N <sup>o</sup> = 80 (100%)	Average age	Control group
Male	45 ( 55 %)	57.40± 11.00	56.80 ± 12.40
Female	35 (45 %)	56.80±12.00	58.00 ± 11.80

The average age of male patients was 57.40±11.00 while the female gender was 56.80±12.00 ,the difference of average age between male and female according to statistics is not significant with p = 0.005 , which indicates for a homogeneous groups ( table nr. 1 ) .

This research is a cross-over clinical trial study. Sample size was calculated based on a previous study in which House et al. (16) have studied the effect of high-flux vs. low-flux hemodialysis on homocysteine and lipids. Inclusion criteria were as follows: participants' age between 18 to 60 years, dialysis treatment for at least 6 months with conventional HD, using fistula or graft as vascular access, at least three times a week 4-hour dialysis session per week, consciousness for participation in study, hemoglobin ≥ 9.5 mg/dL, interdialytic weight gain less than 3-3.5 kg. Exclusion

criteria were as follows: hypotension (systolic BP ≤ 90 mm Hg), acute clinical conditions (myocardial infarction, congestive heart failure, stroke, recent surgery, or severe sepsis) during the study, any vascular access dysfunction, discontinuation of dialysis less than 4 hours, reduction in patient's consciousness, patient's restlessness and agitation, severe nausea and vomiting during dialysis, starting other treatments. During the research, the dialyzer was fixed and 500 mL/min bicarbonate solution was used as dialysate. The blood flow rate was fixed for each patient. Five thousand

units of heparin per session as an anticoagulant were used. The sodium density of dialysate was 135–145 meq/L with a stabilized temperature at 37°C. The amount of food and liquid taken for each participant throughout the study were the same and controlled. No blood transfusion was given to any patient during the study period. All haemodialysis treatments were carried out with a volumetric control machine allowing for a precise rate of fluid removal. Specifics of treatment, including duration, blood flow, ultrafiltration rate, dialysate temperature and flow were prescribed by the attending nephrologist, but no changes were made during the study period with the exception of target weight and dialysate potassium. Patients were weighed before and after each treatment, to determine the volume of ultrafiltration. All treatments utilized bicarbonate-based dialysate, and were carried out three times per week. The dialysis membranes were single-use only. In the first stage, all participants underwent dialysis three sessions per week in accordance with the guidelines of adequacy and efficiency of dialysis (16) by utilizing low-flux membrane (Fresenius Polysulfone® Low-Flux Dialysers (5 HPS), then, they attended another two sessions of dialysis in the following week by utilizing the high-flux membrane (Fresenius Polysulfone® High-Flux Dialysers F50S ). The members of the second group were treated similarly except that they attended the dialysis with the utilization of high-flux followed by the low-flux membrane based on the guidelines of the adequacy and efficiency of dialysis provided (19).

Blood samples were taken in the second dialysis session of each stage; the first sample was taken in the onset of dialysis from the arterial line (before dialysis sample) and the second sample was taken from the arterial line at the end of the dialysis session after 2 minutes and decreasing the blood flow rate to 80 mL/min (after dialysis sample). The samples were labeled and sent to the laboratory to determine the level of BUN. The lab technician was not informed about the study groups. The lab process and the technician in-charge for all samples were the same. The urea reduction ratio (URR) and the KT/V were utilized to investigate the adequacy of dialysis. In KT/V measure, K stands for the dialyzer clearance (mL/min), T stands for the time of dialysis (min), and V, the bottom part of the fraction, is the distribution of urea, which is equal to total body water (19). To determine the adequacy of the hemodialysis based on the KT/V, the Daugirdas formula was used ( $SP_{kt/v} = -\ln(R - 0.008 \times t) + (4 + 3.5R) UF$ ). In this formula, Ln stands for the natural logarithm, R is equal to the ratio of blood urea nitrogen pre-dialysis and post-dialysis. UF is the ultrafiltration per liter and T is the time of dialysis per hour. URR is estimated based on this formula:  $URR = (\text{urea pre-dialysis} - \text{urea post-dialysis}) / \text{urea pre-dialysis} \times 100$  (20-22). Data were collected by a questionnaire for demographic data (age, gender, interdialytic weight gain, kind of vascular access, dialysis history, etc.) and a checklist to record the BUN before and after dialysis, dialysis session time, blood flow rate, dialysate flow rate, and the ultrafiltration rate.

## Statistical analysis of the examined material

Statistical basic methods that were used are the arithmetic mean value and standard deviation  $X \pm SD$ . Comparative statistics and were analyzed and inferential statistics (t test for comparison of KT/V, URR and BUN in high-flux and low-flux membranes and paired-t test for comparison of pre-dialysis and post-dialysis BUN in high-flux and low-flux membranes). The dialysis adequacy was classified into three groups: inadequate dialysis ( $KT/V \leq 0.89$ , or  $URR \leq 0.60$ ); relatively adequate dialysis ( $KT/V = 0.90$  to  $1.29$  or  $URR = 0.61$  to  $0.70$ ); and the totally adequate dialysis ( $KT/V \geq 1.3$ , or  $URR \geq 0.70$ ). Statistical significance was considered at  $P$  value  $< 0.05$ - $0.0001$ . Lipid parameters between the two groups was analyzed by test called STUDENTOV and for examples of dependent or independent and non-parametric

tests were used the tests: Mann-Whitney and Wilcoxon's test. Statistically significant The differences between the Group of patients and control group obtained the values of lipid parameters analyzed the so-called „ Anonova Two-Factor "with the amounts of domestic statistics for  $p < 5\%$ , Namely  $p < \text{statistical } 0.0005$ . Dependence between parameters that are examined is calculated with linear regression formula ( $y = Bx + A$ ) it is also calculated the coefficient of correlation „ r "with statistical accuracy for „ p "of less than 1% Namely  $p < 0.0001$ . The amount of change (z) between the mean values of parameters analyzed / arithmetic averages and proportional / x, p /) were tested with accuracy higher than 95%, or rather, for Mr. > SEM 1.78.

## 3 Results

Most of participants (68.00 %) were male with the mean of  $56.00 \pm 14.00$  years old, 87.5% of the participants used fistula for dialysis. Eighty-five percent of the participants were living in urban areas, and forty percent had dialysis history for a period of three to four years. The mean of interdialytic weight gain was 2.0-3.5 kg. The blood flow rate was between 250-400 mL/min with a mean of  $276 \pm 18.95$  ml/min. Table 2. Comparison of Pre-dialysis and Post-dialysis BUN in High-Flux and Low-Flux Membranes

Membrane	Pre-dialysis BUN	Post-dialysis BUN	t test
Low-Flux	$93.90 \pm 20.51$	$36.87 \pm 13.16$	$t = 18.743, P = 0.001$

membrane			
High-Flux membrae	95.32 ± 19.69	32.35 ± 8.83	t = 21.982, P = 0.001

The mean of BUN before using the low-flux, (93.90 ± 20.51 mg/dL) and high-flux membrane (95.32 ± 19.69 mg/dL) were not significantly different (P = 0.725). Although the mean of BUN after high-flux dialysis (32.35 ± 8.83 mg/dL) was lower than the mean of the BUN after low-flux dialysis (36.87 ± 13.16 mg/dL), this difference was not statistically significant (P = 0.071) (Table 2). The URR was 60% to 80% for half of

the patients in low-flux dialysis; whereas, 70% of the patients in high-flux dialysis had the URR of 60% to 80%. The mean of URR for patients in low-flux dialysis was 0.65 ± 0.14, and in the high-flux dialysis was 0.65 ± 0.09. Although the adequacy of dialysis based on URR was higher in the high-flux dialysis, the difference was not statistically significant (P = 0.211) (Table 3).

Tabl.nr.3. Comparison of URR in High-Flux and Low-Flux membranes

URR	High-Flux membranes	Low-Flux membranes
0.40 – 0.59	22(27.5%)	22 (40 %)
0.60 – 0.79	50 (70%)	48 (50 %)
0.80 – 0.99	8 (2.5 %)	10 (5 %)
Mean ± SD	0.65 ± 0.09	0.61 ± 0.14
P	1.262	0.211

In high-flux dialysis, the most frequent (32.5%) of KT/V was 1.2 to 1.4 (mean 1.27 ± 0.28); while, in low-flux dialysis the most frequent (30%) of KT/V was 1 to 1.2 (mean 1.1 ± 0.32); these differences was statistically significant (P = 0.017) (Table 4), which reveals the relative adequacy of high-flux dialysis.

Tabl.nr. 4 :Comparison of KT/V index in High-Flux and Low-Flux membranes

KT/V	Patients with High-Flux	Patients Low-Flux
0.60 – 0.78	6	9
0.80 – 0.94	9	12
1.00 – 1.20	20	18
1.18 – 1.35	30	22
1.0– 1.60	7	7
1.60 – 1.75	5	5
1.78 1.95	2	4
2.00 – 2.20	1	3
T test	2.430	0.018

High-Flux dialysis was totally adequate in 50% of the cases and it was inadequate in 10% of patients based on KT/V values. The utilization of low-flux dialysis, however, showed the adequacy only in 20% of cases, and it was inadequate in the other 20%. In estimating the adequacy of dialysis based

on the URR, in high-flux dialysis, 25% of participants had totally adequate dialysis and 27.5% had inadequate dialysis. While in the low-flux dialysis, only 20% of participants had totally adequate dialysis and 42.5% had insufficient adequacy of dialysis (Table 5).

Tabela 5. Dialysis Adequacy Based on KT/V and URR in High-Flux and Low-Flux Membranes

	KT/V High-Flux	KT/V Low-Flux	URR High-Flux	URR Low-Flux
Inadequate	7 Pts	32 Pts	8 Pts	36 Pts
Insufficient	13 Pts	36 Pts	14 Pts	34 Pts
Totally adequate	60 Pts	12 Pts	58 Pts	10 Pts

Pts-Patients, Statistical indicators  $\chi^2 = 9.839, P = 0.043$   $\chi^2 = 7.180, P = 0.127$

## 4 Discussion

Chronic Renal Failure (CRF) is a serious disorder. Four hundred thousand people are suffering from CRF in the United States of America. Its universal incidence is reckoned to be 260 million people every year with an increase rate of 6% (1). These people will need hemodialysis (HD), peritoneal dialysis or kidney transplant to continue their lives (2). The principle of hemodialysis involves the clearance of solutes across a semi-permeable membrane through diffusion and ultrafiltration mechanisms. The utilized membranes are classified into two main groups: low-flux, which is based on using dialyzers with low permeability for water (3), and high-flux, non-cellulose membrane with increased permeability, which is capable of removing moderate-sized molecules between 10000 to 15000 Dalton, including many of the inflammatory proteins,  $\beta_2$  microglobulin, and apolipoproteins (4). The principle of hemodialysis includes cleaning of solutes through a semi-permeable membrane through the mechanisms of diffusion and ultrafiltration. The membranes used are classified into two main groups: low flow, which is based on the use of dialyzers with low permeability for water (5); and high-flux, non-cellulose membrane with increased permeability, which is capable of removing molecules of moderate size between 10000 15000 Dalton, including the amount of inflammatory proteins, microglobulin and lipoprotein  $\beta_2$  (6). A large number of studies have suggested that high-flux membrane improves the removal of moderate-sized molecules such as lipid profiles or homocysteine (5-7) while other studies have concluded it has no significant impact on these molecules such as homocysteine levels (8). Because of incomplete removal of uremic toxins, 90% of hemodialysis (HD) patients reveal symptoms of pathologic amyloidosis caused by  $\beta_2$  microglobulin after five years of dialysis. One of the most influential reasons to continue a certain treatment is the degree of its impact on the targeted disease; while, the inadequacy of dialysis has been recognized as a major reason for the mortality rate of the HD patients (11). If the efficiency of HD is not adequate, the level of blood toxins and the clinical symptoms of the patient are not controlled, which lead to either an increase in the duration of each dialysis session or the frequency of necessary dialysis per week. This will consequently increase the mortality and morbidity of the patients and the cost of dialysis (9,10,11). There are a number of factors, which influence the adequacy of the dialysis, such as the time of dialysis, the dialysate flow rate, the surface of dialyzer, and the blood flow rate. However, the employments of many of these factors are considered impossible, because they are neither beneficial, nor feasible. For example, increasing the duration of the dialysis over four hours is beyond the patient's tolerance and will increase the cost of dialysis to a large extent. Furthermore, increasing the dialysate flow rate do not have a significant effect on the adequacy of the dialysis (12).

With regard to the available capacity of the dialysis centers across the country and the increasing need for further facilities, it is clinically wise to limit the amount and time of dialysis to an optimal level. Therefore, reaching to certain level of dialysis adequacy is crucial, and it has led researchers to conduct some projects to obtain this adequacy. In spite of the emphasis on the employment of high-flux permeable membrane in the available research literature (13) and according to the crucial importance of using these membranes and the emphasis of the National Kidney Association on the necessity of these permeable membranes (14,15), there are still many wards utilizing low-flux permeable membranes. Biocompatibility is an important factor that involves the entire haemodialysis treatment playing a major role in the well-being of patients and may have short-and long-term clinical implications. In fact, the contact of blood components with the dialysis membrane can induce a chronic inflammatory state that is thought to adversely affect morbidity and mortality of patients on maintenance haemodialysis]. Some *in vitro* studies indicate that blood components are activated less by synthetic membranes than by membranes derived from cellulose; thus, synthetic membranes are considered to be more biocompatible than those made of cellulose. The type of dialysis membrane used for routine therapy has been recently shown to correlate with the survival of chronic hemodialysis patients(17,18). Although in this study, mean of KT/V in high-flux dialysis was more than our study (in our study 58.4% of patients had  $KT/V \geq 1.2$ ), and was not statistically different from the low-flux dialysis, in our research the adequacy was significantly better in high-flux dialysis. In Moslem et al. study, the vascular access, blood flow rate, and the type of used membrane were not mentioned. Furthermore, the size of the sample is relatively smaller than our study. Ponikvar et al. investigated the comparative efficiency of the high-flux with low-flux membranes in patients with acute renal failure in intensive care units. The results showed no statistically significant differences in using these two membranes which could reveal the inadequacy of high-flux membrane for these patients (19). This finding may relate to the acute or chronic phase of the disease. In chronic status of renal failure due to the accumulation of waste materials, the efficiency of high-flux membranes would be obvious compared to the low-flux membranes. El-Wakil et al. investigated the effect of high-flux versus low-flux hemodialysis on serum  $\beta_2$  microglobulin, advanced oxidation protein products and protein carbonyl. In the first stage, 20 patients were dialyzed by using high-flux membranes for a period of 8 weeks. In the second phase, the patients were maintained on low-flux dialysis for the same period of 8 weeks. The results revealed that the high-flux was successful in reducing the  $\beta_2$  microglobulin and protein carbonyl. However, the high-flux membrane did not have any observable influence on reducing the advanced

oxidation protein products. In the same study, however, the use of low-flux membrane revealed all three indexes were significantly increased. The findings confirmed that the use of high-flux membrane will significantly better the diffusion of uremic toxins (20). This finding was consistent with our study. Oates et al. investigated the effects of flux on phosphor and the responses of erythropoietin. Also, they compared the influence of high-flux and low-flux membranes in dialysis adequacy. The results showed no significant difference between the membranes (21). But, Eknoyan et al. found that high-flux membrane improves the adequacy of dialysis in chronic renal failure (22). The findings of the present research are consistent with the findings of this study. Makar et al. compared the roles and influences of these two membranes on children hemodialysis patients. They reported no statistically significant differences in adequacy of these membranes (23,24). However, in our study, this difference was significantly important and provided supports for the use of high-flux membranes. Makar et al. study was conducted with participating children who requires certain arrangements such as low blood flow rate, low dialysate flow rate and used small diameter membranes to make it tolerable for the children. These factors could have some influences on the adequacy of dialysis. Santoro et al. investigated the effect of high-flux hemofiltration versus low-flux hemodialysis on the mortality

In our research, in low-flux membrane the mean of KT/V was  $1.1 \pm 0.32$  and the ratio of inadequacy was 20%, also another 20% of the participants had KT/V less than 1, and 55% of them showed URR more than 60%. For the high-flux membrane, the mean of KT/V was  $1.27 \pm 0.28$ , and the inadequacy was seen in 10% of patients, also 17.5% of patients had KT/V less than 1, and 72% of patients had URR  $\geq 60\%$ . The mean of KT/V in studies conducted in the USA, and Japan was  $1.30 \pm 0.29$  and  $1.30 \pm 0.2$ , respectively (31, 32). Other studies, revealed that 60% to 80% of patients had KT/V equal to or more than 1.2 (33). These values were higher than the values in our country as presented in the literature, showing the inefficient strategies in Iranian dialysis centers. One of the reasons which significantly contributes to the observed efficiency and adequacy of dialysis in developed countries, is the more use of high-flux membranes; while, in our country mostly used low-flux membranes in dialysis centers, and the patients do not ask for them due to their unfamiliarity or carelessness. Among the other reasons of the low quality of dialysis in Iran compared to the developed countries, are the vascular access problems (recirculation), the duration of the dialysis session, and the lack of sufficient number of dialyzers (30), the blood flow rate, the blood sampling method for determining the BUN, insufficient surface of the membranes and the type of membranes (12). Suitable setting and priming of membranes and hemodialysis set and removing the air from them as well as using high-flux membranes or low-flux membranes (with suitable size) could increase the dialysis adequacy. The use of high-flux membranes will improve the adequacy of dialysis. Moreover, due to the characteristics of these membranes in removing the middle size and large size molecules such as  $\beta_2$  microglobulin, using high-flux membranes thus allows improved removal of a wider spectrum of uremic toxins which may improve the quality of life of patients on chronic hemodialysis. According to the result of this study, using these high-flux membranes in other dialysis centers is recommended. The limitation of study was its short duration follow-up. It is recommended that further studies on comparison of high-flux and low-flux membranes be performed in longer periods (28-33).

## 5 Conclusions

of patients with chronic kidney failure. The results revealed that high-flux hemofiltration increased the survival and decreased in plasma  $\beta_2$  microglobulin level significantly (25). This study further supports the adequacy of high-flux membrane. In another study, Mohseni and Ilali investigated the adequacy of hemodialysis using bicarbonate dialysate participants. The findings revealed that the mean of KT/V was  $0.92 \pm 0.26$  and 86% of patients had inadequacy of dialysis (KT/V  $> 1.2$ ). Furthermore, the mean of URR was 47.84% and 90% of participants (45 patients) had URR index less than the minimum standard level (65%). Because of the unacceptable quality of dialysis in most patients, they recommended periodical evaluation of the quality of dialysis as well as conducting comprehensive studies in order to determine viable methods to improve the adequacy of dialysis (26). Malekmakan et al. found that only 32.1% of renal failure patients achieve the optimal KT/V level and have recommended using advanced dialyzers (27). In our research, however, the low-flux group revealed 35% of adequate dialysis of KT/V  $> 1.2$  and in the high-flux group over 60% of patients had KT/V  $> 1.2$ . These findings confirm the crucial importance of high-flux membranes in achieving the requirement of optimal dialysis. Taziki and Kashi reported the inadequacy of dialysis in Sari, Iran, by using low-flux membranes and 58% of patients had KT/V less than 1 (30, 32).

Documented and verifiable facts in numerous studies on the role of different types of membranes apolipoproteinave dializuese to profiles of patients with terminal chronic renal failure treated with hemodialysis replay. Membranes Biokompatibile (Polysulfon, PAN = AN69, PMMC) during their use in SEANS hemodialysis are shown extremely efficient (compared with membranes Bioinkompatibile), due to membranes bikompatibile further enable absorpbimin of ApolipoproteinesB-100 (cca 30%) of AGE and LDL-ch with what the significantly improve the overall profile apolipoproteinave. Using ,, hight flux "membranes dializuese (Polysulfon, PAN-AN69) membrane provides the mad apsorbim (above) to apolipoproteinave and improvement (correction) of the lipid profile, due to decreasing concentration, the apolipoiproteinesB-100 (for 30% and AGE patients with dijabet. Apolipoproteina-C uremik-III (APOC-III) of smadhon aterogjenitetin of VLDL particles with cancellation of their lipolizes Process prepared with the help of the inhibition of (clearance) hepatic clearance by blocking receptors for hepatic VLDL. Aproximality 30 % -75% of the particles of VLDL represent ApolipoproteinC-III, while while the inclusion of VLDL in the structure of LDL particles is only a very low percentage. The main factors that contribute to the reduction of catabolism include a reduced activity of lipolytic enzyme, compositional lipopro-teinemic abnormalities are also diminished lipolysis, and a receptor- which mediates in obtaining lipoproteins. Main characteristic dislipidemia of renal patients treated with HD is hipertriglyceridemia. There are documented facts that different modalities play important role in correcting dyslipidemia by reducing uremic toxicity. Thus, it is shown that the use of polysulfone or cellulose triacetate membranes with high flux instead of membrane with decreased flux was associated with a significant reduction in triglyceride levels of serum, as well as an increase of apolipoproteines A-1 and levels of HDL-cholesterol (37,38,39). Another factor that could potentially influence lipoprotein metabolism in HD patients is repeated use of heparin as an anticoagulant. Heparin releases LPL from endothelial surface and thus its chronic use may result in depletion of lipoprotein lipase and damaged lipoprotein catabolism.

The high-flux membrane had better dialysis adequacy, so we suggest using high-flux membrane in hemodialysis centers. In conclusion, we found that HD using high-flux dialysis membranes had survival benefit in patients with ESRD treated with long term hemodialysis. Many people with kidney disease are able to live long, largely normal lives. CKD can be caused by: high blood pressure, diabetes, high cholesterol, kidney infections, glomerulonephritis - kidney inflammation, - an inherited condition where growths called cysts develop in the kidneys, blockages in the flow of urine - for example, from recurrent kidney stones or an enlarged prostate, long-term, regular use of certain medicines such as lithium and non-steroidal anti-inflammatory drugs (NSAIDs). Inadequacy of dialysis is one of the main causes of death in hemodialysis patients. Some studies have suggested that high-flux membrane improves the removal of moderate-sized molecules.

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