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The relationship between anemia and Kt/V index in patients undergoing continuous ambulatory peritoneal dialysis and hemodialysis

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ABSTRACT

Introduction: Anemia in end-stage renal disease (ESRD) can cause serious problems for patients.
Objectives: The present study was conducted to investigate whether the type or adequacy of dialysis can affect the incidence of anemia in these patients.
Patients and Methods: This cross-sectional study was conducted on 57 patients with ESRD, who were referred to Qaem and Imam Reza hospitals, Mashhad, Iran. The patients were divided into two groups of continuous ambulatory peritoneal dialysis (CAPD) (n=37 patients) and hemodialysis (n=20 patients). Patients had no laboratory evidence of iron deficiency or hyperparathyroidism. Enrolled patients were received vitamin B12 and folic acid too. Hemoglobin concentration of under 11 mg/dL was considered as anemia. Adequacy of dialysis was evaluated by Kt/V index (>1.2 for hemodialysis and >1.7 per week for peritoneal dialysis). We compared different factors in these two groups, including anemia and Kt/V, and evaluated their relationship.
Results: Around 27% and 65% of the patients on CAPD and hemodialysis were anemic respectively ($P=0.005$). Adequacy of dialysis in CAPD was acceptable in 81.1% of the cases, while target Kt/V was achieved in 50% of the patients on hemodialysis. Dialysis adequacy was significantly higher in patients receiving CAPD ($P=0.014$). No significant correlation between the incidence of anemia and Kt/V in both types of dialysis was found ($P>0.05$).
Conclusion: Anemia was mostly observed in patients receiving hemodialysis as compared to CAPD. Regardless of the type of dialysis, adequacy of dialysis did not affect the incidence of anemia in any of the groups.

Implication for health policy/practice/research/medical education:
In a study on 57 patients with ESRD on continuous ambulatory peritoneal dialysis and hemodialysis, we found anemia was mostly observed in patients receiving hemodialysis as compared to continuous ambulatory peritoneal dialysis. Regardless of the type of dialysis, adequacy of dialysis did not affect incidence of anemia in any of the groups.
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Introduction

Anemia is a serious disease characterized by reduction in the total amount of red blood cells (RBC), hemoglobin level (1,2). The presence of anemia in hemodialysis patients can increase the mortality rate in this group of patients (3). It can cause fatigue, asthenia, and dyspnea, however, in some cases, the symptoms of anemia may quickly develop with higher intensity (4). Anemia, a symptom of chronic kidney disease (CKD), is one of the most important indices that can be related to many interfering factors (5). Lack of erythropoietin, iron deficiency, and inflammation are the three main causes of anemia in end-stage renal disease (ESRD) patients (6).

Anemia in ESRD patients can cause serious problems for patients. Therefore, physicians use all rational options to detect etiology of the disease and alleviate them. The patients with ESRD may need to be treated with dialysis as a substitute for the normal function of the kidney or receive kidney transplant (7).

There are three types of dialysis including hemodialysis (HD), peritoneal dialysis (PD), and hemofiltration (8). Continuous ambulatory peritoneal dialysis (CAPD) is the treatment modality used for 14% of the world's dialysis population. CAPD and HD are associated with different

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advantages and disadvantages (9).

Erythropoietin (EPO) is a hormone produced by the kidneys, which helps with management of anemia and is known as the main global treatment during dialysis process. Commonly, before using EPO, the rate of blood transfusion is lower in patients undergoing PD as compared to those receiving HD (10). This leads to lower percentage of anemia in patients on PD in comparison with HD (11). In addition, treatment response to anemia is better in patients treated with PD compared to patients with HD (12). The production of EPO by peritoneal macrophages (6) and losing a little blood during dialysis procedure then in HD are some interacted factors. Additionally, continuous fluid replacement leading to hemoconcentration, and exodus of uremic inhibitors of EPO synthesis lead to better treatment of anemia in patients undergoing PD (10).

Anemia is usually associated with reduced exercise capacity, fatigue, generalized coldness, anorexia, insomnia, depression, cognitive dysfunction, decreased libido, development of left ventricular hypertrophy, and related problems in affected individuals (4). Kt/V index is a criterion applied to measure the quality of HD and PD adequacy, which is dependent on the pre- and post-dialysis urea concentration. There are few studies comparing the severity of anemia in patients on PD and HD by using Kt/v index.

Objectives

The present study was designed to investigate the effect of dialysis adequacy on the incidence of anemia.

Patients and Methods

Study patient

This cross-sectional study was performed on 57 *ESRD* patients, who were referred to Qaem and Imama-Reza hospitals, Mashhad, Iran. The participants were divided into two groups of CAPD (n=37) and HD (n=20). In the patients on CAPD (using the Twinbag system [Samen, Iran]), the mean duration of treatment was 25 months (range; 6-65 months) and those in the HD group were treated for at least six months three times a week, each time for 4 hours.

There was no evidence of iron deficiency (ferritin >100 ng/mL and transferrin saturation >20%) or hyperparathyroidism (parathyroid hormone <300 ρg/mL) in our patients. There was no history of a significant infectious disease (including peritonitis) among the patients. Patients had anemia (hemoglobin <11 g/dL) and were treated with recombinant human erythropoietin (rh-Epo) before entering the study. All the patients were receiving supplemental folic acid and vitamin B12. All the patients had acceptable nutritional condition, which was assessed by measuring serum albumin with a mean of 3.9 g/dL (range; 3.5-4.9 g/dL) in the CAPD group and 4.1 g/dL (3.6-4.6 g/dL) in the HD group.

The efficacy of blood purification was assessed based on the Kt/V index. KtV>1.2 for HD patients and Kt/V>1.7 per week for CAPD patients were considered adequate. Similar laboratory and commercial kits were used to examine the patients.

Ethical issues

The research followed the tenets of the Declaration of Helsinki. Informed consent was obtained. The ethical committee of Mashhad University of Medical Sciences approved the research (Ref # 98/116704). All patients' information remained confidential.

Statistical analysis

Data were imported into SPSS version 16 and analyzed using Pearson's correlation coefficient. Additionally, *P* value of less than 0.05 was considered statistically significant.

Results

The data showed that 54.1% of the patients undergoing CAPD were male and the mean age of this group of patients was 54.4 years (age range 20-85 years). In addition, 70% of patients in the HD group were male and their mean age was 42.8 years (age range; 18-75 years). In the CAPD group, ESRD was due to chronic glomerulonephritis, diabetic nephropathy, hypertensive nephropathy, adult polycystic kidney disease (ADPKD), and unknown etiologies in 10%, 30%, 22%, 14%, and 24 % of the cases, respectively. In the HD group, it was due to chronic glomerulonephritis, diabetic nephropathy, hypertensive nephropathy, ADPKD, and unknown etiologies in 5%, 25%, 35%, 10%, and 25 % of the cases, respectively. Descriptive statistics of the para-clinical data are shown in Table 1.

A statistically significant correlation between type and adequacy of dialysis in this study was found. Thirty (81%) patients on CAPD had Kt/V>1.7 per week, but only 10 (50%) of those on HD had Kt/V>1.2. There was a significant difference between two groups regarding of Kt/V index ($P=0.014$). About 27% of the patients in the

Table 1. Para-clinical data of patients

Para-clinical data	Groups			
	CAPD		HD	
	Mean	SD	Mean	SD
Ca (mg/dL)	9.1	0.6	9.5	0.4
P (mg/dL)	5.1	1.5	5.4	1.1
Ferritin (ng/mL)	362.1	206.7	476.5	370.4
Serum iron (µmol/L)	95.0	46.2	156.6	180.4
TIBC (µg/dL)	285.0	104.9	347.7	201.3
Transferrin saturation (%)	33.8	12.2	36.6	18.7
Albumin (g/dL)	3.9	0.3	4.1	0.3
PTH (pg/mL)	130.4	87.5	175.4	96.3

TIBC, total iron binding capacity; PTH, parathyroid hormone; HD, hemodialysis; CAPD, continuous ambulatory peritoneal dialysis.

CAPD group were anemic, while 65% of the patients in the HD group had anemia. There was a statistically significant relationship between type of dialysis and incidence of anemia ($P=0.005$). The severity of anemia was evaluated based on Kt/V index in all the patients and separately in each group, but the difference was not statistically significant ($P=0.934$), as demonstrated in Table 2.

Table 2. Anemia and Kt/V in all patients

Anemia statue		Kt/V		Total
		<1.2 h - <1.7 per week	≥1.2 h -≥1.7 per week	
Anemic	Count	7	16	23
	Within anemia (%)	30.4	69.6	100.0
	Within Kt/V (%)	41.2	40.0	40.4
	Total (%)	12.3	28.1	40.4
Normal	Count	10	24	34
	Within anemia (%)	29.4	70.6	100.0
	Within Kt/V (%)	58.8	60.0	59.6
	Total (%)	17.5	42.1	59.6
Total	Count	17	40	57
	Within anemia (%)	29.8	70.2	100.0
	Within Kt/V (%)	100.0	100.0	100.0
	Total (%)	29.8	70.2	100.0

Discussion

This study was the first attempt to evaluate the relationship between anemia and Kt/V index in ESRD patients undergoing CAPD and HD. According to our study, a statistically significant relationship was found between type and adequacy of dialysis. In other words, patients undergoing CAPD had higher Kt/V index compared to the patients on HD. In addition, a statistically significant association between type of dialysis and incidence of anemia was defected.

Our findings were in line with those of other studies. It is believed that anemia management is easier in patients receiving PD than in those on HD. Some studies revealed that anemia is controlled by lower EPO doses in patients receiving PD as compared to HD (10,13).

The reasons for blood loss are different in patients on PD as compared to HD. In PD, the extracorporeal circuit is used for carrying the blood outside the body. In addition, repeated venous puncture and entrapment of RBCs in the dialyzer are the other reasons behind lower blood loss in PD patients. Higher anemia severity in patients undergoing HD compared to those on PD is due to the maximal plasma volume expansion during blood sampling for hemoglobin (14).

Since anemia can be affected by dialysis quality (15), one of the issues of concern in this study was dialysis adequacy. In accordance with our study, the obtained results of Coronel et al (16), showed that the required EPO doses for correction of anemia were lower in patients on PD than in patients receiving HD. According to that study, to obtain the same hemoglobin level with the same administration dose, lower EPO doses were required in patients undergoing PD than in those on HD. As we know, EPO is a hormone produced by the kidneys that enhances RBC formation (10). Our study showed a statistically significant association between type of dialysis and incidence of anemia.

Some studies did not find any relationship between dialysis adequacy and EPO resistance (17). However, this is not an adequate reason to reject our findings, as this discrepancy may be as a result of unknown confounding variables. The role of Kt/V index in the occurrence of anemia and its relative importance is not clear yet. Several studies showed that a low Kt/V index indicates anemia, which necessitates higher EPO dose to maintain target plasma hemoglobin levels (18,19). However, some studies found no association between them (12). Our data showed no significant relationship between these variables, as well.

Anemia and a secondary need for recombinant human erythropoietin (rhEPO) increases during peritonitis in CAPD patients (20). Patients treated with angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers may show higher rate of anemia due to rh-EPO hypo-responsiveness (21). Some studies proposed a correlation between anemia (rh-EPO hypo-responsiveness) and hypoalbuminemia (18). According to the above-mentioned data, we designed the exclusion criteria so that these factors would not affect our results. Iron deficiency, blood loss, infection, and inflammation are considered as factors contributing to anemia (10, 22). The effect of albumin per se on hematocrit or erythropoiesis has not been proven yet. In accordance with other similar studies (13), serum albumin level was lower in the CAPD group when compared to the HD group in our study, however, it was normal in both groups. Additionally, ferritin level was higher in patients on HD in comparison with CAPD, which may be due to higher risk of developing iron deficiency in HD patients (10).

Coronel et al (16) investigated the parathyroid hormone level, which was higher in patients receiving HD than those undergoing PD. Although patients with more severe hyperparathyroidism were not significantly different in the two groups. In our study, none of the patients had hyperparathyroidism or evidence of iron deficiency. Therefore, the obtained results of this study can be used with more certainty to assess the relationship between anemia and type of dialysis.

We investigated the frequency of comorbidities in ESRD patients. Severe hyperparathyroidism is one of the leading causes of anemia. Nevertheless, some authors found no relationship between these variables (17).

Conclusion

As demonstrated in our study and several other clinical trials, anemia is observed in patients undergoing HD more commonly than those on CAPD, which can be deemed as a drawback for HD. However, we did not find

any significant relationship between anemia and dialysis adequacy.

Limitations of the study

This investigation was conducted on a limited proportion of dialysis patients and we suggest larger investigation on this aspect of HD patients. In our study, the patients in the two groups were different regarding age and dialysis duration. Therefore, our findings might be affected by differences between the groups.

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Authors' contribution

BHZ and MGS both conducted the research, searched the literature and analyzed the data and prepared the draft. All authors read, revised and approved the final manuscript.

Conflicts of interest

There were no points of conflict to declare.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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