Anemia in patients undergoing ambulatory peritoneal dialysis: prevalence and associated factors

Anemia em pacientes submetidos á diálise peritoneal ambulatorial: prevalência e fatores associados

Authors
Marisa Cristiane Cardoso de Oliveira [1]
Adriano Luis Ammirati [1]
Maria Claudia Andreolli [1]
Marco Antonio Justo Nadalleto [1]
Camila Barbosa Silva Barros [1]
Maria Eugênia Fernandes Canziani [1]

[1] Universidade Federal de São Paulo.

Submitted on: 06/24/2015.
Approved on: 09/24/2015.

Correspondence to:
Marisa Cristiane Cardoso de Oliveira.
Disciplina de Nefrologia, Universidade Federal São Paulo.
Rua Pedro de Toledo, nº 282, São Paulo, SP, Brazil. CEP: 04039-000.
E-mail: dialisefor@uol.com.br

DOI: 10.5935/0101-2800.20160012

ABSTRACT

Introduction: Anemia is a common complication in dialysis patients, scare studies have evaluated anemia in patients undergoing peritoneal dialysis (PD). **Objective:** This study aimed to investigate the prevalence of anemia and its associated factors in patients undergoing PD in a single center where patients have free access to agents stimulating erythropoiesis (ESA) and intravenous iron supplementation. **Methods:** Cross-sectional study analyzing the demographic, clinical and laboratory variables of 120 patients. Anemia was defined as hemoglobin (Hb) < 11 g/dl. **Results:** Patients were on PD for 17 months, and the majority of them (86%) received automated PD. The mean age was 58 ± 16.5 years, and 52% were female and 29% were diabetes. Anemia was present in 34 (28%) patients. When compared with those without anemia, patients with anemia received a higher dose of iron (p = 0.02) and had a lower concentration of triglycerides (p = 0.01). Hb levels correlated negatively with iron (r = -0.20; p = 0.03) and ESA (r = -0.23; p = 0.01) doses and positively with albumin (r = 0.38; p = 0.01), triglycerides (r = 0.24; p = 0.01) and transferrin saturation (r = 0.20; p = 0.03). In multiple analyses, only the albumin concentration (beta = 0.84; 95% IC = 0.38-1.31; p < 0.001) and ESA dose (beta = -0.06; 95% IC = 0.00-0.00; p = 0.02) were independently associated with Hb levels. **Conclusions:** Almost 30% of PD patients had anemia, even with free access to erythropoietin and intravenous iron. The transferrin saturation and nutritional status assessed by albumin, were the factors associated with the occurrence of anemia in this population.

Keywords: anemia; iron; malnutrition; peritoneal dialysis.

RESUMO

Introdução: A anemia é uma complicação frequente em pacientes em diálise e poucos estudos avaliaram sua ocorrência em pacientes submetidos à diálise peritoneal (DP). **Objetivo:** Este estudo teve como objetivo investigar a prevalência e fatores associados à presença de anemia em pacientes submetidos à DP de um único centro onde havia acesso irrestrito a agentes estimulantes da eritropoiese (AEE) e a suplementação de ferro intravenoso. **Métodos:** Estudo transversal que analisou variáveis demográficas, clínicas e laboratoriais de 120 pacientes. Anemia foi definida como hemoglobina (Hb) < 11g/dl. **Resultados:** Os pacientes estavam em DP por 17 meses, sendo 86% automatizada. A idade média foi de 58 ± 16,5 anos, 52% dos pacientes eram do sexo feminino e 29% diabéticos. Anemia esteve presente em 34 pacientes (28%). Quando comparados com pacientes sem anemia, aqueles com anemia recebiam maior dose de ferro (p = 0,02) e apresentavam menores triglicérides (p = 0,01). A Hb se correlacionou negativamente com as doses de ferro (r = -0,20; p = 0,03) e AEE (r = -0,23; p = 0,01), e positivamente com albumina (r = 0,38; p = 001), triglicérides (r = 0,24; p = 0,01) e índice de saturação da transferrina (r = 0,20; p = 0,03). Na análise múltipla, a concentração de albumina (coefβ = 0,84; 95% IC = 0,38-1,31; p < 0,001) e a dose de AEE (coefβ = -0,06; 95% IC = 0,00-0,00; p = 0,02) foram associadas de forma independente com a Hb. **Conclusões:** No presente estudo, anemia foi observada em aproximadamente 30% dos pacientes em programa de diálise peritoneal, com uso irrestrito de AEE e suplementação intravenosa de ferro. A saturação de transferrina e o estado nutricional, avaliado pela albumina, foram os fatores independentes associados à concentração de hemoglobina nesta população.

Palavras-chave: anemia; desnutrição; diálise peritoneal; ferro.

Introduction

Anemia is a common complications in patients with chronic kidney disease (CKD), and its occurrence has been associated with a worse outcomes.[1] If left untreated, anemia related to CKD is associated with several abnormalities, including decreased release and use of oxygen in tissues, increased cardiac output, increased heart area, ventricular hypertrophy, angina, congestive heart failure, reduce cognition and mental acuity, changes ins menstrual cycles and impaired response imunoolig.[1-5] In addition, anemia may slow the growth in pediatrics patients.[6] Data from the Brazilian Society of Nephrology (SBN) in 2013 showed that the prevalence of anemia, defined by a concentration of Hb < 11g/dl in dialysis patients was 33%, even with free access to use of eritropoetin.[7]

Peritoneal dialysis (PD) is currently the renal replacement therapy of choice for more than 130,000 patients worldwide, representing approximately 15% of the worldwide population on dialysis.[8] In Brazil, 9.2% of the patients on renal replacement therapy were on peritoneal dialysis (PD) in 2013.[7] Data on anemia in PD patients are scarce and controversial.[9-11] Core Records Indicators Study, show that, despite 85% of the PD patients receiving erythropoiesis-stimulating agents (ESA), 40% had hematocrit levels lower than 33%.[9] The United States Renal Data System 2013 showed that 66% of PD patients on had Hb levels lower than 11 g/dL[12] and national patients on PD data showed that 49% of prevalent patients on dialysis present Hb levels below 11d/dl.[10] Factors associated with the occurrence of anemia in this population have yet to be determined. Therefore, the aim of this study was to investigate the prevalence of anemia and its associated factors in patients undergoing PD in a single center where patients have free access to erythropoietin and intravenous iron supplementation.

Method

Population

The study was a cross-sectional, retrospective design, with convenience sample, included all patients who had been in the PD in January 2010 in the Oswaldo Ramos Foundation, Federal University of São Paulo with at least three months of therapy were included, there was no exclusion criteria. In this study were analyzed 120 patients of both genders, older than 18 years.

The study was reviewed and approved by the Ethics Advisory Committee of the Federal University of São Paulo, and each patient signed the informed consent form.

Methods

Demographic, clinical and laboratory data were obtained from the patients' charts and included the following information: age, gender, race, education status, etiology of renal disease, previous and concomitant diseases, body mass index (BMI), residual renal function, previous predialysis treatment, length of renal replacement therapy (including time on HD, PD and renal transplant), Kt/V full and medications. The incidence of hospitalizations, infectious processes and presence of active bleeding in the last three months were recorded.

Data on the prescribed dose de ESA and iron supplementation were obtained from the patients records. According to our local protocol, all patients received iron intravenously in the dialysis unit and ESA administration was made by subcutaneously by the patients at his residence.

Laboratory tests

During the three months preceding the study, the mean values from the following laboratory tests were recorded: hemoglobin, hematocrit, ferritin, transferrin saturation (TSAT), total cholesterol and fractions, triglycerides, parathormone (PTH), albumin, potassium, ionic calcium and phosphorus.

Laboratory measurements were performed in the clinical laboratory Kidney and Hypertension Hospital. Anemia was defined as Hb < 11 g/dL.

Statistical Analysis

Data were expressed as the mean and standard deviation or median and interquartile range. The patients were divided into two groups according to the presence or absence of anemia. Comparisons between groups were performed using Student's *t* test and the Mann-Whitney test when appropriate. Chi-square or Fischer tests were used for comparisons of proportions. The average Hb values were correlated with other variables using the Spearman correlation coefficient. Logistic regression analysis was performed to assess the variables associated independently with the presence of anemia and multivariate linear regression was perfomed to assess the factors

associated independently with Hb concentrations. A *p* value of < 0.05 was considered statistically significant. All analyses were performed using SPSS version 13.0 for Windows (SPSS Inc, Chicago, IL).

Results

The characteristics of the 120 patients in the study are shown in Table 1. Patients were predominantly middle-aged and had been on PD for 17 months, and 86% of them in automated PD. Hypertension was present in almost all patients, and diabetes in 29% of them. Iron deficiency, defined as TSAT < 20% and/or ferritin < 100 µg/L, was present in 35% of the patients. Of note, 87.5% of the patients were using ESA, and 47.5% received intravenous iron supplementation.

Anemia was present in 34 patients (28.3%). Table 1 shows the comparison between patients with and without anemia. When compared to patients without anemia, those with anemia received higher doses of iron and had lower concentrations of triglycerides. There was a trend towards a higher prevalence of women in the anemic group. Notably, there was no menstrual bleeding recorded in the files. There was also a trend of lower TSAT and albumin in the anemic group. In the logistic regression analysis, no variables were independently associated with the presence of anemia when gender (p = 0.08; 95%IC = 0.18-1.11), albumin (p = 0.45; 95%IC = 0.23-1.92), TSAT (p = 0.23; 95%IC = 0.95-1.01), triglycerides (p = 0.05; 95%IC = 0.99-1.00) and iron dosage (p = 0.42; 95%IC = 0.99-1.00) were included in the model.

Hemoglobin level correlated negatively with iron and ESA dose and positively with albumin, triglycerides and TSAT (Figure 1). There was no relation between hemoglobin and other variables (Table 2). There was a correlation between albumin and triglycerides (r = 0.34; p < 0.001). In multivariate analyses, only the albumin concentration and ESA dose were independently associated with Hb levels (Table 3).

Discussion

In this study, anemia was observed in 30% of patients on peritoneal dialysis with unrestricted use of ESA and intravenous iron supplementation. The transferrin saturation and nutritional status assessed by albumin, were independent factors associated with hemoglobin concentration in this population.

The prevalence of anemia in CKD patients ranges from 7% to 86%.[2,13-15] This large variability could be partially explained by the different criteria used to define anemia and by the heterogeneity of the studied populations, including patients on predialysis and in different renal replacement therapies. In dialysis patients, contrary to the WHO definition, anemia is characterized by Hb values below the therapeutic target.[16] In studies with PD patients where the anemia was defined by Hb < 11 g/dL, prevalence ranged from 18% to 57%,[11,17] and when anemia was defined by Hb < 10 g/dL, ranged from 14% to 25%.[18-21] A Brazilian study involving over 2,000 patients in a PD program, the presence of anemia, defined as Hb < 11 g/dL, was found in 57% of patients starting dialysis and in 38% of patients after one year of follow-up.[17] In this study, the authors observed that the lack of adequate predialysis care and the presence of previous treatment in HD were the determinants factors of anemia. Notably, in this study, most of the patients had received predialysis care for a mean period of 25 months before the start DP, and one-third had received prior hemodialysis and none of these factors was associated with the presence of anemia.

The relative erythropoietin deficiency is the main cause of anemia in patients with CKD, however other factors contribute to the appearance of anemia in this population, iron deficiency is the most common.[22] This complication occurs in both patients with CKD in predialysis care as those undergoing dialysis, with prevalence ranging from 43%-70%.[14,22,23] Almost one-third of the patients had iron deficiency in the present study, and those with anemia had lower TSAT. Of note, 47% of the patients received iron supplementation; a similar rate has been described in other studies, ranging from 42%-74%.[17,20] However, different from the other studied populations, all patients received intravenous iron supplementation in this study.

According to the Brazilian Society of Nephrology, about 80% of dialysis patients received ESA in Brazil during 2010 and 2011.[24] Although 87.5% of the study population was using ESA, anemia was present in a third of these patients. The fact that ESA administration was performed subcutaneously by patients in yours homes does not allow the membership check to treatment in this population and decreased adhesion may have contributed to the occurrence of anemia. It should also be considered that

Table 1 Study population characteristics according to the presence of anemia

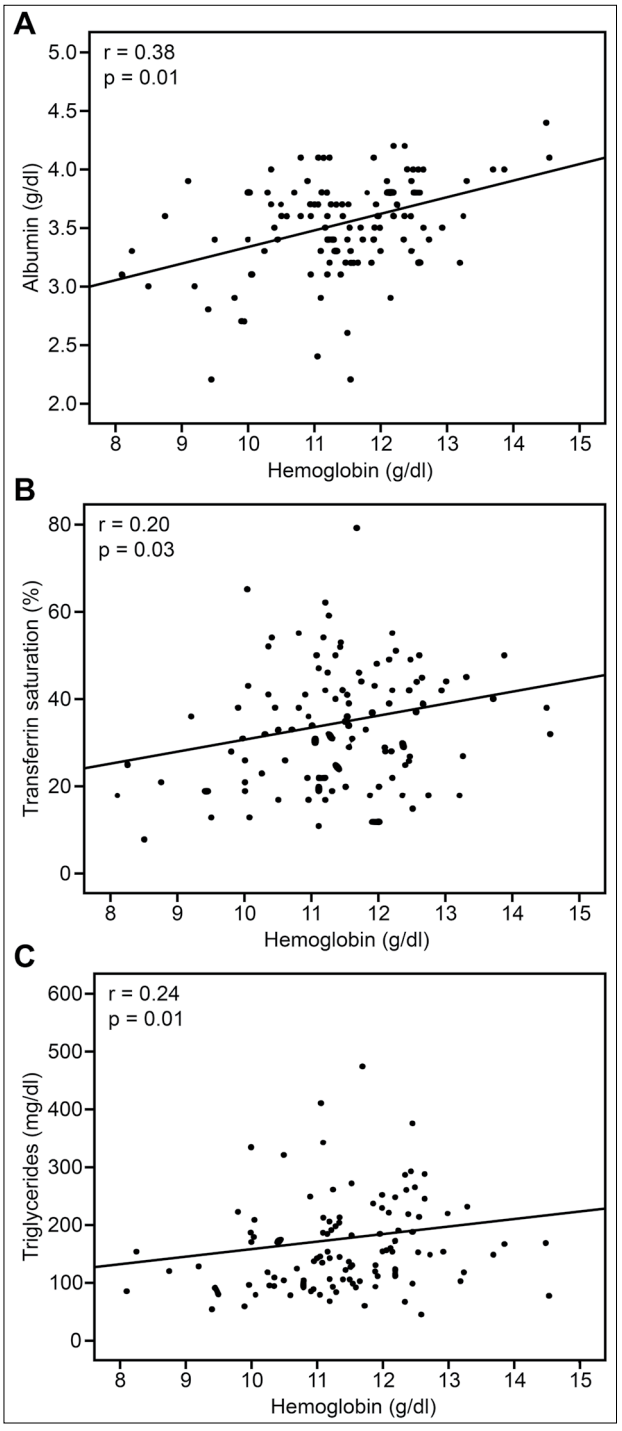
Variables	Total (n = 120)	Without anemia (n = 86)	With Anemia (n = 34)	*p*
Age (years)	58.1 ± 16.4	59.7 ± 14.3	56.1 ± 20	0.34
Gender female (%)	63 (52.5)	40 (47.6)	22 (64.7)	0.09
Diabetes (%)	35 (29.2)	27 (32.1)	8 (23.5)	0.35
Hypertension (%)	112 (93.3)	78 (92.9)	32 (94)	0.80
Chronic Kidney Disease Etiology				
Diabetes (%)	26 (22)	20 (24)	6 (18)	0.97
Hypertension (%)	15 (13)	11 (13)	4 (12)	
Pre dialysis therapy length (months)	12 (0-37)	11 (0-47)	7 (0- 24)	0.14
Peritoneal dialysis therapy length (months)	17 (8-37)	17 (9-36)	17 (8-44)	0.98
Hospitalization previous*	5 (5)	6 (7)	1 (3)	0,67
Infection previous*	20 (17)	14 (17)	6 (18)	0.89
Bleeding previous*	0	0	0	1.0
Kt/V > 1,7 (%)	96 (80)	69 (82.1)	26 (76.5)	0.71
Residual diureses (mL/24h)	320 (0-980)	340 (9-955)	280 (0-1060)	0.97
Characteristic membrane transport (%)				0.50
Low average l	51%	55%	41%	
High average	58%	25%	37%	
Body Mass Index (Kg/m^2)	25.5 ± 6.3	25.5 ± 6.5	25.7 ± 6	0.90
Weekly dose of erythropoietin (UI/week)	4000 (4000-8000)	4000 (4000-8000)	8000 (4000-11000)	0.22
Use of erythropoiesis-stimulating agents (%)	105 (87.5)	74 (88.1)	29 (85.3)	0.68
Weekly dose of iron hydroxide (mg/week)	0 (0-200)	0 (0-200)	200 (0-200)	0.02
Use of iron supplementation (%)	57 (47.5)	36 (42.9)	20 (58.8)	0.13
Hemoglobin (g/dL)	11.3 ± 1.1	11.9 ± 0.7	9.9 ± 0.7	0.01
Transferrin saturation (%)	34.8 ± 15.6	36.6 ± 16.2	30.3 ± 13.5	0.05
Ferritin (ug/L)	343 (128-631)	332 (158-646)	383 (108-708)	0.84
LDL-cholesterol (mg/dL)	98.2 ± 40	101 ± 41.6	91.5 ± 36.5	0.25
HDL-cholesterol (mg/dL)	40.1 ± 10.8	39.3 ± 10.2	42.5 ± 12.2	0.15
Triglycerides (mg/dL)	148 (103-212)	157 (121-224)	113 (89-173)	0.01
Parathormone (ng/dL)	402 (244-616)	405 (240- 597)	382 (264-681)	0.82
Albumin (g/dL)	3.5 ± 0.4	3.58 ± 0.4	3.41 ± 0.4	0.06

* Three months prior to the study.

increases and reductions in ESA doses according to the results of last months tests contribute significantly to variability in hemoglobin, which is very frequent in this population.[17]

The occurrence of hypoalbuminemia in about half of patients was similar to that described in populations on DP ranging from 34 to 49%.[10,25] Several studies have shown an association between low albumin levels and increased risk of morbidity and mortality in patients undergoing dialysis,[26-30] suggesting that albumin levels could indicate the presence of malnutrition and inflammation in this population.[30,31] Low levels of triglycerides have been linked to the presence of malnutrition in HD patients.[31] In this study, we observed a correlation between triglycerides and albumin. Interestingly, we observed an association between low levels of triglycerides and the presence of anemia, which suggests that malnutrition may be an important component in the pathogenesis of anemia in this population. Moreover, a correlation between albumin concentrations and Hb was also observed, as previously described in a cohort of children on DP and patients in HD on the other hand albumin is a negative acute phase protein of inflammation and had no access to other inflammatory markers to confirm the contribution of inflammation anemia in these patients.[15]

Figure 1. Correlation between hemoglobin with albumin (A), transferrin saturation (B) and triglycerides (C).



Limitations of this study include the relatively small sample size, retrospective design, lack of other inflammatory markers and nutrition status, yet this study was able to identify factors associated with the occurrence of anemia in patients undergoing peritoneal dialysis.

Table 2 Correlation between hemoglobin and other variables

Variables	r	*p*
Age (years)	0.02	0.86
Previous predialysis treatment (months)	0.10	0.26
Length of peritoneal dialysis therapy (months)	-0.06	0.50
Length of renal replacement therapy (months)	-0.01	0.93
Body Mass Index (Kg/m^2)	0.06	0.50
Weekly dose of erythropoietin (UI/week)	-0.23	0.01
Weekly dose of iron hydroxide (mg/week)	-0.20	0.03
Transferrin saturation (%)	0.20	0.03
Ferritin (ug/L)	0.12	0.20
LDL- cholesterol (mg/dL)	-0.02	0.86
HDL- cholesterol (mg/dL)	-0.12	0.20
Triglycerides (mg/dL)	0.24	0.01
Parathormone (ng/dL)	-0.03	0.76
Albumin (g/dL)	0.38	0.01

Table 3 Logistic regression to determine factors associated with anemia

Variable	coefficient β	*p*	95% CI
Gender (male)	-0.26	0.20	-0.660 to 0.150
Albumin (mg/dL)	0.85	0.00	0.387 to 1.310
Transferrin saturation (%)	0.06	0.43	-0.008 to 0.019
Triglycerides (mg/dL)	0.95	0.91	-0.002 to 0.002
Weekly dose of ESA (UI/week)	-0.06	0.02	0.000 to 0.000
Weekly dose of Iron (mg/week)	-0.02	0.30	-0.003 to 0.001

References

1. Canziani MEF. Complicações da anemia na insuficiência renal crônica. J Bras Nefrol. 2000;22(5):13-4.
2. Ma JZ, Ebben J, Xia H, Collins AJ. Hematocrit level and associated mortality in hemodialysis patients. J Am Soc Nephrol 1999;10:610-9.
3. Foley RN, Parfrey PS, Kent GM, Harnett JD, Murray DC, Barre PE. Long-term evolution of cardiomyopathy in dialysis patients. Kidney Int 1998;54:1720-5. PMID: 9844150 DOI: http://dx.doi.org/10.1046/j.1523-1755.1998.00154.x
4. Marsh JT, Brown WS, Wolcott D, Carr CR, Harper R, Schweitzer SV, et al. rHuEPO treatment improves brain and cognitive function of anemic dialysis patients. Kidney Int 1991;39:155-63. PMID: 2002629 DOI: http://dx.doi.org/10.1038/ki.1991.20

5. Nissenson AR. Recombinant human erythropoietin: impact on brain and cognitive function, exercise tolerance, sexual potency, and quality of life. Semin Nephrol 1989;9:25-31.
6. Scigalla P, Bonzel KE, Bulla M, Burghard R, Dippel J, Geisert J, et al. Therapy of renal anemia with recombinant human erythropoietin in children with end-stage renal disease. Contrib Nephrol 1989;76:227-40.
7. Sociedade Brasileira de Nefrologia. Censo de diálise SBN 2013 [Internet]. São Paulo: Sociedade Brasileira de Nefrologia; 2013. [Cited 2015 May 6]. Available from: http://www.sbn.org.br/pdf/censo_2013-14-05.pdf
8. Gokal R. Peritoneal dialysis in the 21st century: an analysis of current problems and future developments. J Am Soc Nephrol 2002;13:S104-16.
9. Flanigan MJ, Rocco MV, Frankenfield D, Bailie G, Frederick P, Prowant B, et al. 1997 Peritoneal Dialysis-Core Indicators Study: Dialysis Adequacy and Nutritional Indicators Report. Am J Kidney Dis 1999;33:e3. PMID: 10352219 DOI: http://dx.doi.org/10.1016/S0272-6386(99)70170-8
10. Fernandes N, Bastos MG, Pecoits Filho R, Pereira LC, Franco M, Haddad SA, et al. A comparative analysis of the BRAZPD data with the Spanish dialysis guidelines: successes and failures. J Bras Nefrol 2008;30:22-31.
11. Rastogi A, Mcdougall IC, Nissenson AR. Anemia in PD patients. In: Khanna R, Krediet RT, eds. Nolph and Gokal's textbook of peritoneal dialysis. 3rd ed. New York: Springer; 2009. p.713-36.
12. United States Renal Data System. 2013 USRDS Annual Data Report: an overview of the epidemiology of kidney disease in the United States. Vol. 2, End-stage Renal Disease (ESRD) in the United States [Internet]. Bethesda (MD): National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2013. Chapter 1, Incidence, prevalence, patient characteristics, and treatment modalities; p. 215-28 [Cited: 2015 May 5]. Available from: http://www.usrds.org/2013/pdf/V2_Ch1_13.pdf
13. Recomendações da prática clínica da Sociedade Latino-Americana de Nefrologia e Hipertensão (SLANH) para o tratamento da anemia no paciente com doença renal crônica. Nefrol Latinoam 2009;13:15-21.
14. Levin A, Djurdjev O, Duncan J, Rosenbaum D, Werb R. Haemoglobin at time of referral prior to dialysis predicts survival: an association of haemoglobin with long-term outcomes. Nephrol Dial Transplant 2006;21:370-7. DOI: http://dx.doi.org/10.1093/ndt/gfi209
15. Farag YM, Keithi-Reddy SR, Mittal BV, Surana SP, Addabbo F, Goligorsky MS, et al. Anemia, inflammation and health-related quality of life in chronic kidney disease patients. Clin Nephrol 2011;75:524-33. PMID: 21612756 DOI: http://dx.doi.org/10.5414/CNP75524
16. Ribeiro-Alves MA, Gordan PA. Diagnosis of anemia in patients with chronic kidney disease. J Bras Nefrol 2014;36:9-12. DOI: http://dx.doi.org/10.5935/0101-2800.2014S003
17. Gonçalves SM, Dal Lago EA, de Moraes TP, Kloster SC, Boros G, Colombo M, et al.; BRAZPD Study Investigators. Lack of adequate predialyis care and previous hemodialysis, but not hemoglobin variability, are independent predictors of anemia-associated mortality in incident Brazilian peritoneal dialysis patients: results from the BRAZPD study. Blood Purif 2012;34:298-305. DOI: http://dx.doi.org/10.1159/000342618
18. Webb L, Gilg J, Wilkie M. Chapter 8 Haemoglobin, ferritin and erythropoietin amongst UK adult dialysis patients in 2010: national and centre-specific analyses. Nephron Clin Pract 2012;120:c145-74. PMID: 22964566 DOI: http://dx.doi.org/10.1159/000342851
19. van Stralen KJ, Krischock L, Schaefer F, Verrina E, Groothoff JW, Evans J, et al.; ESPN/ERA-EDTA Registry. Prevalence and predictors of the sub-target Hb level in children on dialysis. Nephrol Dial Transplant 2012;27:3950-7. DOI: http://dx.doi.org/10.1093/ndt/gfs178
20. Borzych-Duzalka D, Bilginer Y, Ha IS, Bak M, Rees L, Cano F, et al.; International Pediatric Peritoneal Dialysis Network (IPPN) Registry. Management of anemia in children receiving chronic peritoneal dialysis. J Am Soc Nephrol 2013;24:665-76. DOI: http://dx.doi.org/10.1681/ASN.2012050433
21. Li S, Foley RN, Collins AJ. Anemia, hospitalization, and mortality in patients receiving peritoneal dialysis in the United States. Kidney Int 2004;65:1864-9. DOI: http://dx.doi.org/10.1111/j.1523-1755.2004.00584.x
22. Abensur H. Anemia da doença renal crônica. J Bras Nefrol 2004;26:26-8.
23. Fishbane S, Pollack S, Feldman HI, Joffe MM. Iron indices in chronic kidney disease in the National Health and Nutritional Examination Survey 1988-2004. Clin J Am Soc Nephrol 2009;4:57-61. DOI: http://dx.doi.org/10.2215/CJN.01670408
24. Sesso R de C, Lopes AA, Thome FS, Lugon JR, Watanabe Y, Santos DR. Chronic dialysis in Brazil: report of the Brazilian dialysis census, 2011. J Bras Nefrol 2012;34:272-7. DOI: http://dx.doi.org/10.5935/0101-2800.20120009
25. Sharma AP, Gupta A, Sharma RK, Agarwal DK, Sural S, Wardhe DJ. Does serum albumin at start of continuous ambulatory peritoneal dialysis (CAPD) or its drop during CAPD determine patient outcome? Adv Perit Dial 2000;16:119-22. PMID: 11045275
26. Gaweda AE, Goldsmith LJ, Brier ME, Aronoff GR. Iron, inflammation, dialysis adequacy, nutritional status, and hyperparathyroidism modify erythropoietic response. Clin J Am Soc Nephrol 2010;5:576-81. DOI: http://dx.doi.org/10.2215/CJN.04710709
27. He T, An X, Mao HP, Wei X, Chen JH, Guo N, et al. Malnutrition-inflammation score predicts long-term mortality in Chinese PD patients. Clin Nephrol 2013;79:477-83. PMID: 23391316 DOI: http://dx.doi.org/10.5414/CN107659
28. Honda H, Qureshi AR, Heimbürger O, Barany P, Wang K, Pecoits-Filho R, et al. Serum albumin, C-reactive protein, interleukin 6, and fetuin a as predictors of malnutrition, cardiovascular disease, and mortality in patients with ESRD. Am J Kidney Dis 2006;47:139-48. PMID: 16377395 DOI: http://dx.doi.org/10.1053/j.ajkd.2005.09.014
29. Anand N, Chandrasekaran SC, Alam MN. The malnutrition inflammation complex syndrome-the micsing factor in the perio-chronic kidney disease interlink. J Clin Diagn Res 2013;7:763-7. DOI: http://dx.doi.org/10.7860/JCDR/2013/5329.2907
30. Combe C, McCullough KP, Asano Y, Ginsberg N, Maroni BJ, Pifer TB. Kidney Disease Outcomes Quality Initiative (K/DOQI) and the Dialysis Outcomes and Practice Patterns Study (DOPPS): nutrition guidelines, indicators, and practices. Am J Kidney Dis 2004;44:39-46. PMID: 15486873 DOI: http://dx.doi.org/10.1016/S0272-6386(04)01104-7
31. Fouque D, Kalantar-Zadeh K, Kopple J, Cano N, Chauveau P, Cuppari L, et al. A proposed nomenclature and diagnostic criteria for protein-energy wasting in acute and chronic kidney disease. Kidney Int 2008;73:391-8. DOI: http://dx.doi.org/10.1038/sj.ki.5002585