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ORIGINAL ARTICLE

ULTRAFILTRATION AND CRITICAL ACUTE KIDNEY PATIENTS ASSOCIATED WITH CLINICAL COMPLICATIONS DUE TO HEMODIALYSIS[1]

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ABSTRACT

Objective: To analyze the association between ultrafiltration and severity of patients diagnosed with acute renal injury with clinical complications resulting from hemodialysis. **Method:** A cross-sectional study was conducted in a teaching hospital in southern Brazil. We included all daily records of hemodialysis sessions of patients with acute kidney injury who underwent hemodialysis between September and November 2017. For data collection, an instrument was developed. A significance level of less than 5% was adopted. **Results:** The 103 patients under studywent through a total of 519 hemodialysis sessions. Most were male patients (66.7%) aged 60 years or older (51.5%). About half of the patients had mean ultrafiltration volume >1501ml (51.5%). Most were considered critical (72.8%). Among the complications, hypotension (69.9%) was the most prevalent. The performance of a higher volume of ultrafiltration was not associated with the studied complications. Patients with severity showed a higher chance of hypotension (p<0.001 and OR: 33.73). **Conclusion:** Hypotension during hemodialysis was a frequent complication, presented by nearly half of the patients. As it was not associated with larger ultrafiltration volumes, it is concluded that, possibly, the greater severity of the patient is an explanatory factor for the onset of this complication.

Keywords: Ultrafiltration. Patient Acuity. Acute kidney injury. Dialysis. Intensivecareunits.

INTRODUCTION

Acute renal injury (AKI) is described by an abrupt decrease, in a matter of hours or days, in renal function, with reduced glomerular filtration rhythm and/or urinary volume, and is frequently associated with hydro-electrolytic and acid-basic disorders[1] and has a great impact on patients' quality of life[2] and mortality rates. It is a common complication in the hospital environment, mostly partial or totally reversible, depending on the case's severity[3].

Critical patientsare more susceptible to the onset of AKI, usually associated with other diseases, use of vasoactive drugs (VAD), and mechanical ventilation (MV)[4]. Mortality due to AKI is related to risk factors, clinical outcomes, and multiple interventions in the critical patient[5]. Sepsis stands out as one of the main risk factors for AKI in critical patients, as it may lead to hemodynamic imbalance and decreaseof renal perfusion[6], besides the underlying inflammatory processes that lead to varying degrees of renal injury.

The incidence of AKI in hospitalized patients ranges from 1% to 7%[5]. In intensive care units (ICUs), this percentage may vary from 17% to 40%[3,5], with the need for dialysis therapy between 49% and 70% of patients[3], besides presenting high mortality (up to 90%)[7]. A global alert published in 2013 estimated that more than two million patients die from AKI yearly, and those who survive have a higher risk of developing chronic kidney disease (CKD)[8], which makes AKI a public health issue[1]. Death is prevalent (73%) in critical patients with AKI in dialysis therapy[5].

Critical patients have several complications

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and intercurrent situations associated with the severity of the clinical condition, AKI, and renal replacement therapy. The complications management that occurs during hemodialysis (HD) in the chronic dialysis patient is among the main competencies in nephrology[9], however, concerning AKI, there isn't plenty of information available. Many of these adverse symptoms may not be observed, may be recognized late, or may not be related to the procedure due to the already existing clinical condition[10].

Hypotension is the most recurrent and most severe complication among critical patients undergoing HD[10]. In HD sessions, the extracorporeal circuit, intravascular volume removal done by ultrafiltration (UF), faster and higher UF rates, among other factors, may contribute to hemodynamic instability[11,12]. Some measures may assist in hypotensioncontrol, such as increased sodium concentration and decreased dialysate temperature, and the use of volumes or lower rates of UF[10,13].

Given the magnitude of the problems that can affect patients with AKI submitted to HD, the relevance of the health team's role in the face of possible complications and the lack of evidence on the interaction between severity of the condition, UF volume, and clinical management of these patients, the study aimed to analyze the association between UF, and severity of patients diagnosed with AKI with clinical complications resulting from HD.

METHOD

An epidemiological, cross-sectional, retrospective, documentary study was conducted at a teaching hospital in southern Brazil. It is a large hospital, with 300 beds: 228 in the medical-surgical clinic, 40 in pediatrics, 25 in maternity, and 7 in neonatology. It has a dialysis unit (DU), with 10 beds suitable for performing HD in acute and chronic patients or at the bedside.

From January to March 2018, a nursing resident in adult intensive care carried out the data collection based on the analysis of daily records of HD sessions of patients with AKI, both from DU and from bedside HDs. We included all the daily records of HD sessions, filed in the DU of the institution, of patients with AKI submitted to HD between September and November 2017. The period was selected by convenience, without sample calculation. Chronic patients and/or patients with arteriovenous fistulas were excluded from the sample.

To obtain the data, a data collection instrument was developed with variables epidemiologically relevant to the research outcome, with a pilot test in the month before starting the collection. During the test, 50 daily HD sessions sheets were analyzed, requiring 20 minutes for each form.

The research instrument consisted of characterization variables of patients and HD sessions, clinical complications, UF volume, and severity of patients. Independent variables were considered: the severity of the patients and UFvolumein the HD sessions described in the care forms. We adopted as a critical patient the one in use of VAD and/or MV (whether in an ICU environment). The UF volume was categorized based on the mean presented by the patients undergoing the sessions (<1500ml or >1501ml).

The dependent variables reflect the clinical complications shown during HD sessions, described in the collection instrument as yes (presented) or no (did not present): hypotension, tachycardia, drop in saturation, bradycardia, and cardiac arrest.

The collected data were entered in Epi Info® version 3.5.1, tabulated in Excel® 2007, and analyzed using the Statistical Package for the Social Sciences® version 20.0. Binominal logistic regression was used both in the bivariate analyses and in the adjusted models, by progressive adjustment by a block of variables, to evaluate the behavior of the associations between the UF volume and patient severity with clinical complications. For inclusion in the regression model, the dependent variables were selected by the epidemiological relevance in the occurrence of the investigated outcomes.

Therefore, the following adjustment variables were added: sex (male or female), age (continuous variable), the average length of sessions (calculated as mean in minutes), number of sessions, use of anticoagulants (yes or no), changes in the catheter site (yes or no) and dependent variables related to complications. A

significance level of less than 5% was adopted with a p-value, 95% confidence interval (CI), and odds ratio (OR).

This study was first authorized by the hospital and approved by the Research Ethics Committee of the university following Opinion nº 1,784,201, CAAE 60162116.0.0000.5231, on October 20th, 2016. It is part of a larger project entitled "Acute Renal Failure: from the profile of patients admitted to a University Hospital to the multidisciplinary outpatient follow-up of survivors".

RESULTS

Throughout the study, the service assisted 103 patients, 66.7% of them were males, 51.5% aged 60 years or older, 72.8% were considered critical (Table 1), 71.8% were using VAD and 66.0% were in MV. The 103 patients under study underwent a total of 519 HD sessions (minimum of one and maximum of 32 sessions per patient), most of them with an average time of more than two hours. It was verified that half of the patients had mean UF volume >1501ml (51.5%; n=53).

Table 1. Characterization of patients with acute kidney injury undergoing hemodialysis. Londrina-PR, Brazil, 2017. (n=103)

Variable	n	%
Sex		
Female	34	33.3
Male	68	66.7
Age		
≤39	22	21.8
40-59	27	26.7
60-79	38	37.6
≥80	14	13.9
Average time of sessions (minutes)		
≤120	7	6.8
121-239	55	53.4
≥240	41	49.8
Number of sessions		
1	36	35.0
2-6	42	40.8
≥7	25	24.2
Average ultrafiltration volume (ml)		
≤1500	50	48.5
≥1501	53	51.5
Use of anticoagulants		
Always	54	52.4
Notal ways	37	35.9
Never	12	11.7
Changes in the catheter site		
No	59	76.6
Yes	18	23.4
Patient severity		
No	28	27.2
Yes	75	72.8

HD was performed in patients according to the following indications: decreased urinary output (23.8%; n=124), hypervolemia (22.1%; n=115), symptomatic uremia (15.2%; n=79), hyperkalemia (3.2%; n=17), metabolic acidosis (2.3%; n=12), acute pulmonary edema (0.3%; n=2) and dialysis drug poisoning (0.1%; n=1). It should be mentioned that there was no reason for the indication of HD in 169 sessions (33.0%) (data not shown in table).

In HD sessions of 103 patients, the following complications were identified: hypotension (69.9%; n=72), tachycardia (34.9%; n=36), hypertension (20.3%; n=21), bleeding (6.7%; n=7), headache (4.8%; n=5) and nausea (4.8%; n=5). The percentage exceeds 100% due to the occurrence of more than one complication in the same patient. The higher volume of UF was not associated with the studied complications (Table 2).

Table 2. Association between ultrafiltrate volume and complications in patients with acute kidney injury submitted to hemodialysis. Londrina-PR, Brazil, 2017. (n=103)

Variable	Largest Ultrafiltrate		Smallest Ultrafiltrate		OR Ad (IC95%; p-value)
	n	%	n	%	
Hypotension					0.55 (0.15-2.06; 0.378)
Yes	36	50.7	35	49.3	1.00
No	17	53.1	15	46.9	
Tachycardia					2.38 (0.87-6.50; 0.091)
Yes	22	62.9	13	37.1	1.00
No	31	45.6	37	54.4	
Drop in O2 saturation					
Yes	1	100.0	0	-	
No	52	51.0	50	49.0	
Bradycardia					4,.10 (0.32-52.80; 0.279)
Yes	3	75.0	1	25.0	1.00
No	50	50.5	49	49.5	
CA					0.52 (0.04-6.71; 0.615)
Yes	1	33.3	2	66.7	1.00
No	52	52.0	48	48.0	0.55 (0.15-2.06; 0.378)

CA: Cardiac arrest. OR Ad: Odds ratio adjusted by sex, age, the average time of sessions, number of sessions, use of anticoagulants, and changesin the catheter site. 95% CI: 95% confidence interval. *Analysis not performed due to the low number of occurrences of the referred complication.

Critical patients with AKI had a higher chance of hypotension (p<0.001), and no statistical significance was observed for other clinical variables under study (Table 3). HD sessions were performed mainly at the bedside (69.9%), and the rest in DU.

Table 3 –Association between severity and complications in patients with acute kidney injury undergoing hemodialysis. Londrina-PR, Brazil, 2017. (n=103)

Variable	Critical		Notcritical		OR Ad (IC95%; p-value)
	N	%	N	%	
Hypotension					
Yes	66	93.0	5	7.0	20.49 (4.98-84.27; <0.001)
No	9	28.1	23	71.9	1.00
Tachycardia					
Yes	29	82.9	6	17.1	1.74 (0.50-6.03; 0.380)
No	46	67.6	22	32.4	1.00
Drop in O2 saturation					
Yes	1	100.0	0	-	*
No	74	72.5	28	27.5	
Bradycardia					
Yes	4	100.0	0	-	*
No	71	71.7	28	28.3	
CA					
Yes	3	100.0	0	-	*
No	72	72.0	28	28.0	

CA: Cardiac arrest. OR Ad: Odds ratio adjusted by sex, age, the average time of sessions, number of sessions, use of anticoagulants, and changes in the catheter site. 95%CI: 95% confidence interval. *Analysis not performed due to the low number of occurrences of the referred complication.

DISCUSSION

In this study, we analyzed the association of UF volume and severity of acute renal patients with clinical complications resulting from HD. Most patients with HD due to AKI were considered critical and/or used VAD. The population was characterized by male patients, older than 40 years, who underwent two or more HD sessions lasting more than two hours. Hypotension and tachycardia were the main complications resulting from HD. The high volume of UF was not associated with the clinical complications under study, but patients with severity had a higher chance of having hypotension.

The sociodemographic findings of this study find match other studies concerning sex and age group[5,7,14-16]. The same was observed regarding the time of sessions (more than two hours). In a

study with critical patients in the Federal District, it was observed that HD sessions lasted between three and four hours[10]. It should be considered that the length of time of the HD session may contribute to complications, especially among critical patients[17].

In the present study, we observed that hypotension and tachycardia were the most prevalent complications of HD among critical patients, with statistical significance for hypotension ($p<0.001$). Critical patients making use of VAD tend physiologically to the onset of hemodynamic changes, including hypotension. Also, the removal of solvents in HD (UF) may contribute to this result[10]. On the other hand, extended hemodialysis (HE) has been highlighted as a beneficial modality in dialysis treatment, considering its advantages concerning hemodynamic tolerability and slow and sustained solute control[18].

A Brazilian randomized clinical trial also found that arterial hypotension was the main complication of dialysis (82.6%). The group submitted to dialysis therapy with ten-hour sessions developed greater refractoriness to clinical measures of hypotension treatment, and the dialysis sessions were interrupted more frequently (30.1%, $p=0.03$)[14]. This highlights the significance of the length of time of the session for hypotension.

It is hard to determine the overload and UF volume required in critical patients and there is no consensus or uniformity in management. In a recent survey using questionnaires[19], several European professionals were approached regarding their practice on HD prescription. There was significant variability in the prescription of UF and the management of intradialytic hypotension.

The AKI and manydeaths in critical patients may make it difficult to determine since the severity of the disease can be a confounding variable, which is associated with both outcomes. However, evidence consistently points to a direct and independent causality between AKI and mortality[20]. The relationship between UF volumes, complications, and mortality has already been the object of other studies: Murugan and collaborators[21], for instance, showed an association between higher UF volumes and lower mortality overone year. However, this finding can only show that patients with higher UF had better hemodynamic response conditions. On the other hand, Hall and colleagues[22], in a retrospective study with patients undergoing continuous therapy, showed an independent association between lower fluid balance and lower mortality. In contrast, the association of volume overload and vasopressors with mortality was not kept after correction for disease severity.

Half of the population in the present study had UF1501 ml. The scientific literature highlights that volume removal by UF is a quick and effective option, providing a controlled removal rate and with a lower risk of hydro-electrolyte imbalances[11]. The UF is being used as a rescue therapy method in critical situations with resistance to diuretics[11]. The UF may also be efficient to keep the hydro-electrolyte balance, however, it may cause hemodynamic instability[11]. In this study, however, there was no statistical significance between higher UF rate and clinical complications in critical patients.

Such a fact may have varied explanations. One of them is that the medical team already tends to prescribe UF volumes adequate to the individual volume and hemodynamic situation to each patient; patients without VAD (or with low doses) could take higher UF volumes, and vice versa. Even so, nearly half of the patients still have hypotension, perhaps because of the dialysis therapy, but more probably because of the patient's own severity, as evidenced by the statistical analysis.

This investigation revealed analyses controlled by the patient, and not only by session – afact that lessens possible biases of very critical patients and with many HD sessions. One of the limitations was the temporal cutoff, which made it impossible to evaluate all the records of the patients studied. Patients who finished dialysis treatment at the beginning of the collection or those who started dialysis treatment at the end of the collection time did not have the monitoring of all complications until the end of the treatment.

Another limitation of the study is the absence of UF volumes in ml/kg/hvalues, which would be more recommended, according to a recent review[23]. There was also no control for the blood pressureat the beginning of the session, nor the concentrations of vasopressors used.

Longitudinal studies are needed to follow-up patients from hospitalization to outcome to identify the association of higher UF volume, patient severity, and clinical complications with longer hospitalization time, increased mortality, length of stay in ICUs, and other related complications. Randomized studies, in turn, may help in the determination of better UF rates and measures of hypotension prevention or treatment.

CONCLUSION

Hypotension during HD was a frequent complication, occurring in nearly half of the patients. As it was not associated with larger volumes of UF, it is concluded that, possibly, the greater severity of the patient is an explanatory factor for the onset of this complication.

ULTRAFILTRAÇÃO E GRAVIDADE DE PACIENTES RENAIS AGUDOS ASSOCIADAS COM COMPLICAÇÕES CLÍNICAS DECORRENTES DA HEMODIÁLISE

RESUMO

Objetivo: Analisar a associação entre ultrafiltração e gravidade de pacientes diagnosticados com lesão renal aguda com complicações clínicas decorrentes da hemodiálise. **Método:** Estudo transversal realizado num hospital universitário do Sul do Brasil. Foram incluídas todas as fichas diárias de sessões de hemodiálise de pacientes com lesão renal aguda submetidos à hemodiálise entre setembro e novembro de 2017. Para obtenção dos dados, elaborou-se um instrumento de coleta. Adotou-se nível de significância inferior a 5%. **Resultados:** Os 103 pacientes estudados fizeram um total de 519 sessões de hemodiálise. Prevaleceram pacientes do sexo masculino (66,7%) com 60 anos ou mais (51,5%). Cerca de metade dos pacientes apresentou volume médio de ultrafiltração ≥1501ml (51,5%). A maioria foi considerada grave (72,8%). Dentre as complicações, a mais prevalente foi a hipotensão (69,9%). A realização de um maior volume de ultrafiltração não se associou às complicações estudadas. Pacientes graves apresentaram maior chance para ocorrência de hipotensão (p<0,001 e *OR*: 33,73). **Conclusão:** Hipotensão durante a hemodiálise foi uma complicação frequente, ocorrendo em cerca de metade dos pacientes. Como não esteve associada a volumes maiores de ultrafiltração, conclui-se que, possivelmente, a maior gravidade do paciente seja um fator explicativo para o desenvolvimento dessa complicação.

Palavras-chave: Ultrafiltração. Gravidade do paciente. Lesão renal aguda. Diálise. Unidades de terapia intensiva.

ULTRAFILTRACIÓN Y GRAVEDAD DE PACIENTES RENALES AGUDOS ASOCIADASA COMPLICACIONES CLÍNICAS DERIVADAS DE LA HEMODIÁLISIS

RESUMEN

Objetivo: analizar la asociación entre ultrafiltración y gravedad de pacientes diagnosticados con lesión renal aguda con complicaciones clínicas derivadas de la hemodiálisis. **Método**: estudio transversal realizado en un hospital universitario del Sur de Brasil. Se incluyeron todas las fichas diarias de sesiones de hemodiálisis de pacientes con lesión renal aguda sometidos a hemodiálisis entre septiembre y noviembre de 2017. Para obtener los datos, se elaboró un instrumento de recolección. Se adoptó un nivel de significancia inferior al 5%. **Resultados**: los 103 pacientes estudiados realizaron un total de 519 sesiones de hemodiálisis. Prevalecieron pacientes varones (66,7%) con 60 años o más (51,5%). Cerca de la mitad de los pacientes presentó volumen medio de ultrafiltración >1501ml (51,5%). La mayoría fue considerada grave (72,8%). Entre las complicaciones, la más prevalente fue la hipotensión (69,9%). La realización de un mayor volumen de ultrafiltración no se asoció a las complicaciones estudiadas. Pacientes graves presentaron mayor predicción de ocurrencia de hipotensión (P0,001 y OR: 33,73). **Conclusión**: hipotensión durante la hemodiálisis fue una complicación frecuente, ocurriendo en aproximadamente la mitad de los pacientes. Como no estuvo asociada a volúmenes mayores de ultrafiltración, se concluye que, posiblemente, la mayor gravedad del paciente sea un factor explicativo para el desarrollo de esa complicación.

Palabras clave: Ultrafiltración. Gravedad del paciente. Lesión renal aguda. Diálisis. Unidades de cuidados intensivos.

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