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Original article

RECOVERY OF PATIENTS WITH ACUTE KIDNEY INJURY REQUIRING DIALYSIS OR NOT

Breno Guilherme Cardoso[1], Tatiane Aguiar Carneiro[2], Marcia Cristina da Silva Magro[3]

ABSTRACT: The research objective was to identify the recovery of the kidney function in patients with acute kidney injury requiring dialysis or not. Prospective and quantitative observational study, developed at an adult general intensive care unit of a public hospital in the Federal District, Brazil, between January and June 2015. The data were collected based on information from the electronic patient history. One hundred and nine patients were monitored, 19 of whom required dialysis and 10 (52.6%) were female, with a mean age of 54±19 years. The group that did not require dialysis consisted of 90 patients, predominantly male with 47 (52.2%) and a mean age of 55±21 years. Among the two groups, the outcomes in the dialysis group were a higher death rate (73.7%; p=0.009) and higher Simplified Acute Physiology Score III (83.0±10.2; p=0.0001). Although the dialysis group accumulates more severe patients, the recovery percentage of the kidney function corresponded to more than 50% of the patients in both groups.
DESCRIPTORS: Acute kidney injury; Intensive care units; Recovery of function; Nursing.

RECUPERAÇÃO DE PACIENTES COM LESÃO RENAL AGUDA DIALÍTICA E NÃO DIALÍTICA

RESUMO: O objetivo do estudo foi identificar a recuperação da função renal de pacientes com lesão renal aguda dialítica e não dialítica. Estudo observacional prospectivo e quantitativo, desenvolvido em unidade de terapia intensiva geral adulta de um hospital público do Distrito Federal, de janeiro a junho de 2015. Os dados foram coletados a partir de informações do prontuário eletrônico. Foram acompanhados 109 pacientes, desses 19 eram dialíticos, 10 (52,6%) do sexo feminino, com idade média de 54±19 anos. O grupo não dialítico constituiu-se por 90 pacientes predominantemente do sexo masculino 47 (52,2%), idade média de 55±21 anos. Entre os dois grupos, o dialítico apresentou como desfecho maior taxa de óbito (73,7%; p=0,009) e maior valor de *Simplified Acute Physiology Score III* (83,0±10,2; p=0,0001). Apesar de o grupo dialítico acumular maior gravidade, o percentual de recuperação da função renal ocorreu em mais de 50% dos pacientes em ambos os grupos.
DESCRITORES: Lesão renal aguda; Unidade de terapia intensiva; Recuperação de função fisiológica; Enfermagem.

RECUPERACIÓN DE PACIENTES CON LESIÓN RENAL AGUDA DIALÍTICA Y NO DIALÍTICA

RESUMEN: El objetivo del estudio fue identificar la recuperación de la función renal de pacientes con lesión renal aguda dialítica y no dialítica. Estudio observacional prospectivo y cuantitativo, desarrollado en unidad de terapia intensiva general adulta de un hospital público del Distrito Federal, Brasil, de enero a junio del 2015. Los datos fueron recolectados a partir de informaciones del archivo electrónico. Fueron seguidos 109 pacientes, de los cuales 19 eran dialíticos, 10 (52,6%) del sexo femenino, con promedio de 54±19 años. El grupo no dialítico fue constituido por 90 pacientes predominantemente del sexo masculino 47 (52,2%), promedio de edad 55±21 años. Entre los dos grupos, el desfecho en el dialítico fue mayor tasa de óbito (73,7%; p=0,009) y mayor valor del Simplified Acute Physiology Score III (83,0±10,2; p=0,0001). Aunque el grupo dialítico acumuló mayor gravedad, el porcentaje de recuperación de la función renal correspondió a más del 50% de los pacientes en ambos grupos.
DESCRIPTORES: Lesión renal aguda; Unidades de cuidados intensivos; Recuperación de la función; Enfermería.

[1]RN. Universidade de Brasília. Brasília, DF, Brazil.
[2]RN. Intensive Care Unit Specialist. State Health Department, Distrito Federal. Brasília, DF, Brazil.
[3]RN. Ph.D. in Nursing. Nursing Professor at Universidade de Brasília. Brasília, DF, Brazil

Corresponding author:
Marcia Cristina da Silva Magro
Universidade de Brasília
Centro Metropolitano, cj A, lote 01 - 72220-275 - Brasília, DF, Brasil.
E-mail: marciamagro@unb.br

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INTRODUCTION

Acute kidney injury (AKI) is defined as the acute reduction of the kidney function within hours or days, characterized by the decrease in the glomerular filtration rhythm and/or urinary volume as well as by disorders in the fluid, electrolyte and acid-base balance control[1]. The disease is reversible and represents one of the most common complications in the hospital environment, whose incidence varies with the patient's severity[2].

The incidence rate of AKI in hospitalized patients corresponds to 5%. At the intensive care unit (ICU), this percentage increases to between 17 and 35% and, in addition, between 49 and 70% of the patients need dialysis. Mainly in hospitals, AKI is an important complication when associated with the number of severity of the comorbidities the patients present[3-4].

The incidence of AKI is increasing, especially among hospitalized patients, due to surgical procedures, iatrogenic events and sepsis common in the ICU context. When combined with age and comorbidities, these situations make the kidneys more susceptible to injuries[5].

Thus, the early identification of AKI can represent an indicator to better guide care and support decision taking. In management and education, it can further improvements with a view to the construction of evidence-based problem-solving practices.

The AKIN (Acute Kidney Injury Network) classification adopted in this study is a tool health professionals, including nurses, use to stage the commitment degree of the kidney function.This classification offered important advances[6-7] but still depends on the patients' serum creatinine and urinary volume measures to identify the degree of kidney dysfunction[8].

AKIN defines kidney dysfunction as an increase by 0.3mg/dL or more in the baseline serum creatinine levels within an interval of at least 48 hours. According to this classification, there are three stages of commitment of the kidney function. Stage 1 corresponds to the risk of renal injury, identified by the absolute increase in serum creatinine ≥26.5µmol/L (0.3mg/dL). Stage 2 (kidney injury) is characterized by a more than twofold to threefold increase in the baseline serum creatinine levels; and in stage 3 (kidney failure), this increase is greater than three times. Stage 3 also includes those patients who need renal replacement therapy[9].

In some situations, the kidney injury is that intense that emergency dialysis treatment (hemodialysis, peritoneal dialysis or hemofiltration) is required due to the imminent risk of complications for the patient. Nevertheless, the best conduct is to prevent the need for emergency dialysis, in view of the early indication of this therapy before uremia and/or clinical, metabolic and electrolyte complications happen[1].

This scenario demands specialized assessment skills from the health professionals. Nevertheless, despite the scientific advances, no specific symptom or sign exists to identify AKI, which limits and delays the diagnosis. Although many patients recover their kidney function, they remain dialysis dependent or their kidney function is severely impaired as no early prevention measures were established[10].

Although the use of new dialysis techniques and the advanced resources available in intensive care extend the life of AKI patients, it does not bring down the mortality rates[11].

Various studies in different populations and hospital contexts signal that even "mild" forms of AKI (i.e. associated with an increase in serum creatinine by at least 0.3 mg/dL) significantly influence the mortality rate[12-13].

In that perspective, we believe that describing the factors related to AKI and the degree of recovery of ICU patients' kidney function will permit the identification of indicators that can guide and individualize the care practices for patients with this condition.

METHOD

A prospective observational study with a quantitative approach was undertaken. The study was developed at the adult general ICU of a public hospital in the Federal District between January and June 2015.

To estimate the sample size, the formula to calculate proportions was used in the software IBM Statistical Package for the Social Sciences (SPSS) Sample Power version 3.0. A percentage of 15% of AKI patients was adopted, based on the incidence of acute kidney injury found in scientific evidence[14]. An error margin of 7% was adopted. The calculation of the sample size resulted in 100 patients. Considering an 8% data loss, the sample size was calculated at 109 patients. The alpha adopted for the calculations was 95%.

In the study, patients aged 18 years or older were included, who evolved with AKI (not) requiring dialysis according to the AKIN (Acute Kidney Injury Network) classification, while patients medically diagnosed with chronic kidney failure were excluded.

The data collection strategy was supported by the completion of a structured questionnaire, including the patient's identification data, clinical history, evolution and laboratory parameters registered in the patient's electronic history.

A rate between the serum creatinine level at discharge from the ICU and the serum creatinine when hospitalized at the ICU ≤ 20% was considered as complete recovery of the kidney function, while rates > 20% but without dependence on renal replacement therapy were considered as partial recovery[15].

The database was elaborated in SPSS version 23. The results were expressed as means, standard deviation and median (25% and 75% percentiles). The Fisher or Chi-squared tests were applied to analyze the categorical variables. The Mann-Whitney test was applied to compare categorical variables. Significance was set at $p<0.05$.

Approval for the project was obtained from the Research Ethics Committee of the *Fundação de Ensino e Pesquisa em Ciências da Saúde* (FEPECS) of the State Health Department in the Federal Districtunder opinion 942.648.

RESULTS

Among the 109 patients who evolved with AKI according to the AKIN criteria, 19 required dialysis while hospitalized at the ICU.

The demographic characteristics were similar between the groups, particularly age, body mass index and race. As opposed to the dialysis group, men were predominant in the non-dialysis groups.

Systemic arterial hypertension was the predominant comorbidity, while sepsis and pneumonia stood out among the medical diagnoses in both groups. The higher death rate was the clinical outcome in the dialysis group. In that group, all patients used mechanical ventilation with positive end-expiratory pressure (PEEP) and noradrenaline as a vasoactive drug. In addition, most patients in this group presented acidosis. The Simplified Acute Physiology Score III (SAPS III)also remained high (p=0.0001).

As opposed to the dialysis group, in most patients who did not require dialysis, discharge was the clinical outcome. In both groups, substantial use was made of noradrenaline, furosemide and mechanical ventilation with PEEP, followed by frequent metabolic disorders.

The usage rates of noradrenaline and furosemide were higher in the dialysis group and this association was significant (p=0.003, p= 0.02). Acidosis and alkalosis were more frequent in this patient group (p=0.02, p=0.0002), respectively.

Most patients from the non-dialysis group were discharged from the ICU (p=0.009). The results are presented in Tables 1 and 2 below.

Table 1 – Distribution and univariate analysis of the patients in the dialysis (DG) and non-dialysis (NDG) groups according to the demographic and clinical characteristics. Federal District, Brazil,2015

Characteristics	DG n=19 (%)	NDG n=90 (%)	All n=109 (%)	P value
Age (years)	54±19	55±21	54±21	0.8*
Male sex	9 (47.4)	47 (52.2)	56 (51.4)	0.9*
Body mass index (kg/m2)	25.7±7.3	25.3±5.3	25.3±5.7	0.8*
Race				
White	2 (10.5)	16 (17.8)	18 (16.5)	0.3†
Mulatto	15 (79)	49 (54.4)	64 (58.7)	0.08†
Black	2 (10.5)	25 (27.8)	27 (24.8)	0.09†
Comorbidities				
Arterial hypertension	7 (36.8)	35 (38.9)	42 (38.5)	0.9†
Diabetes Mellitus	4 (21.1)	21 (23.3)	25 (22.9)	0.5†
Chronic obstructive pulmonary disease	5 (26.3)	16 (17.8)	21 (19.3)	0.3†
Cardiac disease	3 (15.8)	16 (17.8)	19 (17.4)	0.6†
Thyroid disease	0 (0.0)	3 (3.3)	3 (2.8)	0.6†
Cirrhosis	0 (0.0)	1 (1.1)	1 (0.9)	0.8†
Alcoholic	2 (10.5)	11 (12.2)	13 (11.9)	0.6†
Smoker	4 (21.1)	20 (22.2)	24 (22)	0.6†
Cerebrovascular accident	1 (5.3)	9 (10)	10 (9.2)	0.4†
Diagnosis				
Sepsis	10 (52.6)	40 (44.4)	50 (45.9)	0.7†
Acute respiratory failure	3 (15.8)	23 (25.6)	26 (23.9)	0.4†
Acute lung edema	0 (0.0)	5 (5.6)	5 (4.6)	0.8†
Pneumonia	8 (42.1)	38 (42.2)	46 (42.2)	0.3†
IPO of exploratory laparotomy	3 (15.8)	9 (10)	12 (11)	0.4†
Cerebrovascular accident	1 (5.3)	10 (11.1)	11 (10.1)	0.4‡

Legend: *Mann Whitney test; †Chi-squared test; ‡Fisher's exact test; IPO=immediate postoperative

Table 2 – Univariate analysis of patients in the dialysis (DG) and non-dialysis (NDG) group according to clinical variables and outcome. Federal District, Brazil, 2015 (continues)

Characteristics	DG n=19	NDG n=90	All n=109	P value
Drugs use	19 (100.0)	61 (67.8)	80 (73.4)	
Noradrenaline	19 (100.0)	56 (62.2)	75 (68.8)	0.003†
Nipride	1 (5.3)	17 (18.9)	18 (16.5)	0.1†
Furosemide	18 (94.7)	63 (70.0)	81 (74.3)	0.02‡
Altered mean blood pressure (<70 or>100)	19 (100.0)	89 (98.9)	108 (99.1)	0.8‡
Presented alkalosis	5 (26.3)	64 (71.1)	69 (63.3)	0.0002†
Presented acidosis	18 (94.7)	62 (68.9)	80 (73.4)	0.02‡
SAPS score	83.0 ± 10.2	68.3 ± 12.2	70.7 ± 13.1	0.0001*
Surgical patient	8 (42.1)	24 (26.7)	32 (29.4)	0.3†
Use mechanical ventilation	19 (100.0)	78 (86.7)	97 (89.0)	0.06†
Duration of mechanical ventilation (days)	22.4±14.8	32.4±34.2	30.5±31.5	0.4*
	16 (12–39)	22 (12–41)	20 (12–39)	
PEEP	12.3±1.6	12.6±11.7	12.6±10.5	0.03*

Outcome				
Discharge	5 (26.3)	55 (61.1)	60(55.1)	0.009†
Death	14 (73.7)	33 (36.7)	47 (43.1)	
Kidney dysfunction	19 (100.0)	86 (95.6)	105 (96.3)	0.5‡

Legend: PEEP= positive end-expiratory pressure; SAPS III = Simplified Acute Physiology Score III; ‡Fisher's exact test; *Mann Whitney test; †Chi-squared test

The commitment of the kidney function in the dialysis and non-dialysis groups is displayed in Table 3. The severity of the kidney problems was greater in the dialysis group, as 17 (89.5%) evolved to kidney failure according to the urinary volume criterion and12 (63.2%) according to the creatinine criterion. Both of these variables support the assessment of the kidney function according to the AKIN classification.

Table 3 – Kidney function staging according to AKIN ranking of dialysis patients (DG) and non-dialysis patients (NDG) during hospitalization at the Intensive Care Unit. Federal District, Brazil, 2015

DG (n=19)			NDG (n=90)		
Stage	**Creatinine Criterion**	**Urine volume criterion**	**Stage**	**Creatinine Criterion**	**Urine volume criterion**
1 (Risk)	2 (10.5)	0 (0.0)	1 (Risk)	29 (32.2)	13 (14.4)
2 (Injury)	2 (10.5)	2 (10.5)	2 (Injury)	7 (7.8)	39 (43.3)
3 (Failure)	12 (63.2)	17 (89.5)	3 (Failure)	10 (11.1)	30 (33.3)

The recovery of the kidney function was more substantial in the dialysis than in the non-dialysis group, as displayed in Table 4. It should be reminded that the recovery of the kidney function was assessed in 37 out of 109 patients, due to the death or discharge of the other patients.

Table 4 – Recovery of kidney function in dialysis patients (DG) and non-dialysis patients (NDG), distributed according to months of follow-up. Federal District, Brazil, 2015

Recovery of kidney function	**DG (n=4)**	**NDG (n=33)**
As from 1st month	1 (25.0)	14 (42.4)
As from 2nd month	2 (50.0)	1 (3.0)
As from 3rd month	0 (0.0)	2 (6.1)
Total patients who recovered the kidney function	3 (75.0)	17 (51.5)

*86 patients had no creatinine records for these periods.

DISCUSSION

AKI is predictable and can be avoidable if risk factors are identified early in the clinical context. When undiagnosed AKI is detected timely, this can certainly also lead to better disease management[16].

Scientific evidence from 477 patients diagnosed with AKI due to acute tubular necrosis, hospitalized at a teaching hospital, identified the male sex and a mean age of 65±16.2 years as common conditions in patients evolving to AKI[4]. The present findings show similar characteristics in the non-dialysis group.

On the other hand, in another study, involving 117 patients admitted to an ICU of a teaching hospital, the female sex showed a more substantial percentage, as evidenced in the dialysis group in this study.

Thus, until date, a lack of consensus persists among studies on whether the incidence rate of AKI is higher in males or females, considering that this variation tends be a function of the AKI definition assumed in the studies and the characteristics of the research population. Three distinct classifications exist today to identify and assess the kidney function: RIFLE, an acronym forrisk, injury, failure, loss, end-stage; AKIN (Acute Kidney Injury Network) and KDIGO (Kidney Disease Improving Global Outcomes[17].

Senescence or normal physiological aging pictures the age-related renal changes. The micro-anatomic structural changes of the kidney as age advances include the reduction in the number of functional glomeruli, due to the increased prevalence of nephrosclerosis (arteriosclerosis, glomerular sclerosis, tubular atrophy and interstitial fibrosis) and, to a certain extent, to the compensatory hypertrophy of the remaining nephrons[18]. In that context, advanced age represents a predisposing factor for the occurrence of AKI. A similar characteristic was identified in the patients in this study.

It is known that some risk factors and/or comorbidities can modify the probability to recover from AKI and worsen the patient's condition, among which advanced age (> 60 years), the presence of comorbidities and the late start of renal replacement theory stand out[19]. In addition, baseline serum creatinine superior to 1.2 mg/dL, previous use of non-steroid anti-inflammatory agents, presence of septic shock and systemic arterial hypertension are other factors related to the occurrence of AKI(10). Some of these factors were also present in this study.

The high mortality of AKI patients hospitalized at ICU is a reality in the current context. A range of factors predispose to AKI, causing suffering for the patient, extended hospitalization, need for renal replacement therapy and even death[20].

The development of complications like infections, sepsis, hemorrhages, surgeries and need for dialysis while hospitalized at the ICU can increase the severity of the patient and the AKI. These factors, in combination or isolation, can also predispose to greater mortality[10]. In our study, this outcome was signaled by the increase in the SAPS III, a predictive mortality score that consists of 20 variables, including an acute physiological score and assessment of the background status of patient admitted to intensive care units[21].

A study has shown that, out of 152 patients distributed between a dialysis and a non-dialysis group, all dialysis patients and 56.4% of the non-dialysis patients used invasive mechanical ventilation and that 52.6% of the dialysis patients and 25.6% of the non-dialysis patients evolved to sepsis[22]. When we compare these data with other findings[22-23], similarities were found in the clinical characteristics and mainly in the outcomes. In this study, however, these risk factors, although evidenced in both groups, always stood out in the dialysis group, with higher mortality rates.

Scientific evidence has shown that the main risk factors for AKI can also be related to cardiac illnesses (systemic arterial hypertension, congestive heart failure, hypovolemia), septic shock, systemic inflammatory response syndrome (SIRS), as well as the use of furosemide[22]. These findings were also observed in this study.

A study[22] strengthens the results of our research, verifying that dialysis and non-dialysis patients have practically the same risk factors and that, in fact, these act as indicators for better care management. Nevertheless, as patients submitted to renal replacement therapy present a potentially more severe clinical condition, they are more susceptible to invasive procedures and adverse events. In this study, the group that underwent dialysis showed a higher death rate, but we believe this fact cannot be attributed to dialysis treatment alone.

A global consensus exists today on the use of multidimensional classifications like AKIN, which was adopted in this study, to identify and stage the AKI, despite the lack of a clear and objective definition of renal recovery after the AKI event. This can delay the care actions and increase the patient's gravity[20].

In this study, the dialysis group developed metabolic acidosis. Scientific evidence ratifies severe metabolic acidosis as an isolated risk factor for mortality in dialysis patients with AKI, to the extent of

demanding early intervention for correction to improve the chances of survival[24].

In one study[23], the AKI according to AKIN, serum creatinine criterion, showed that most (69.3%) patients suffered from stage 3 AKI (kidney failure). Similarly, in this study, most dialysis patients were classified in the failure stage, not only according to serum creatinine, but also to the urine volume criterion. In the non-dialysis group, stage 2 (kidney injury), less severe, affected most of the patients.

As regards the limitations and implications for future research, the quality and difficulty to get access to electronic records were the limitations in this study. On the other hand, these findings permit the better targeting of care and make it easier to implement evidence-based problem-solving practices in the health and disease process.

CONCLUSION

AKI is a frequent complication in the ICU context, generally related to other illnesses and drugs. A substantial number of patients in both groups (dialysis and non-dialysis) evolved to renal injury or failure according to the AKIN classification.

Until date, the use of vasoactive drugs like noradrenaline, mechanical ventilation and metabolic disorders can predispose to the occurrence of AKI.

Despite the higher severity level in the dialysis group, the percentage of kidney function recovery surpassed 50% in both groups.

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