REME • Rev Min Enferm. 2017;21:e-1029
DOI: 10.5935/1415-2762.20170039

RESEARCH

IDENTIFICATION AND RECOVERY OF RENAL FUNCTION IN NON-DIALYTIC PATIENTS IN THE INTENSIVE THERAPY SCENARIO

IDENTIFICAÇÃO E RECUPERAÇÃO DA FUNÇÃO RENAL EM PACIENTES NÃO DIALÍTICOS NO CENÁRIO DE TERAPIA INTENSIVA

IDENTIFICACIÓN Y RECUPERACIÓN DE LA FUNCIÓN RENAL EN PACIENTES NO DIALÍTICOS EL ESCENARIO DE TERAPIA INTENSIVA

Tatiane Aguiar Carneiro [1]
Paula Regina de Souza Hermann [2]
Josiane Maria Oliveira de Souza [2]
Marcia Cristina da Silva Magro [2]

[1] RN. Specialist in Intensive Care. Foundation for Education and Research in Health Sciences. Brasília, DF – Brazil.
[2] RN. PhD. Professor. University of Brasília-UnB, College of Ceilândia, Nursing Course. Brasília, DF – Brazil.

Corresponding author: Marcia Cristina da Silva Magro. E-mail: marciamagro@unb.br
Submitted on: 2017/03/08 Approved on: 2017/06/07

ABSTRACT

Objectives: to determine the degree of renal function impairment in patients who progressed with non-dialytic AKI and identify the frequency of renal function recovery in the intensive care unit (ICU). **Method:** this was an observational, prospective, and quantitative study developed with 90 patients after admission to the ICU. The follow-up occurred for 15 days and data were collected from medical records. Results with $p < 0.05$ were considered significant. **Results:** the use of vasoactive drugs and mechanical ventilation was associated with the occurrence of acute renal injury ($p = 0.009$; $p = 0.001$). A total of 95.6% of patients evolved to renal dysfunction according to the Acute Kidney Injury Network (AKIN) classification. Overall, 50% of patients progressed to renal function recovery. **Conclusion:** most of the patients were identified with a lesion or renal failure, which are more severe stages according to the AKIN classification. Renal function recovery was identified in 50% of patients.

Keywords: Acute Kidney Injury; Intensive Care Units; Nursing.

RESUMO

Objetivos: *determinar o grau de comprometimento da função renal de pacientes que evoluíram com LRA não dialítica e identificar a frequência de recuperação da função renal na unidade de terapia intensiva (UTI).* ***Método:*** *estudo observacional, prospectivo e quantitativo desenvolvido com 90 pacientes após admissão na UTI. O acompanhamento ocorreu por 15 dias. Os dados foram coletados a partir dos registros do prontuário. Foram considerados significativos os resultados com p<0,05.* ***Resultados:*** *o uso de droga vasoativa e de ventilação mecânica se associou à ocorrência de lesão renal aguda (p=0,009; p= 0,001). Evoluíram com disfunção renal 95,6% dos pacientes, segundo a classificação* Acute Kidney Injury Network *(AKIN). De forma geral, 50% dos pacientes evoluíram com recuperação da função renal.* ***Conclusão:*** *a maior parte dos pacientes foi identificada com lesão ou falência renal, estágios de mais gravidade, segundo a classificação AKIN. A recuperação da função renal foi identificada em 50% dos pacientes.*

Palavras-chave: *Lesão Renal Aguda; Unidades de Terapia Intensiva; Enfermagem.*

RESUMEN

Objetivos: *Determinar el grado de compromiso de la función renal de pacientes con LRA no dialítica e identificar la frecuencia de recuperación de la función renal en la unidad de terapia intensiva (UTI).* ***Método:*** *Estudio observacional, prospectivo y cuantitativo con 90 pacientes después de la admisión a la UTI, durante quince días. Los datos fueron recogidos de los expedientes médicos de los pacientes. Se consideraron significativos los resultados con p <0,05.* ***Resultados:*** *el uso de drogas vasoactivas y de ventilación mecánica fue asociado con la causa de la lesión renal aguda (p = 0,009; p = 0,001). El 95,6% de los pacientes evolucionó a disfunción renal, según la clasificación de* Acute Kidney Injury Network *(AKIN). En general, el 50% de los pacientes evolucionó a recuperación de la función renal.* ***Conclusión:*** *La mayoría de los pacientes fue identificada con lesión o fallo renal, estadios de mayor gravedad, según la clasificación AKIN. La recuperación de la función renal fue identificada en el 50% de los pacientes.*

Palabras clave*: Lesión Renal Aguda; Unidades de Cuidados Intensivos; Enfermería.*

How to cite this article:
Carneiro TA, Hermann PRS, Souza JMO, Magro MCS. Identification and recovery of renal function in non-dialytic patients in the intensive therapy scenario. REME – Rev Min Enferm. 2017[cited _____ ___ ___];21:e-1029. Available from: _____ DOI: 10.5935/1415-2762.20170039

INTRODUCTION

Acute kidney injury (AKI) is a growing concern in intensive care units. Patients' advanced age, increased morbidity, and the complexity of treatments favor the development of AKI. Since there is no effective treatment for AKI, all efforts aimed at prevention and early detection in order to establish secondary preventive measures to prevent its progression.[1]

AKI *per se* increases the risk for both chronic kidney disease and cardiovascular complications. The hospital discharge of patients who have undergone renal aggression should be linked to preventive nephrological follow-up to minimize the burden of health care and economic costs.[2]

AKI is a syndrome characterized by the abrupt and reversible reduction of glomerular filtration rate. It results in the inability of kidneys to exert their basic functions of excretion and hydroelectrolyte balance. Renal impairment imposes imbalance on regulatory functions and is typically diagnosed by the retention of serum creatinine or reduction of urine output or even both.[3]

Although AKI is recognized as a potent predictor of long-term morbidity and mortality, there is no consensus on the rate of renal function recovery after this event. In addition, studies describe the recovery as predominantly observed in patients requiring renal replacement therapy.[4]

In AKI, the renal recovery level can substantially affect not only the mortality rate but the evolution to chronic kidney disease and occurrence of cardiovascular events in the medium and long term. Therefore, maximizing renal function recovery should be the goal of any AKI prevention and treatment strategy.[5]

Scientific evidence reinforces the need to prevent AKI as the most effective therapeutic option to modify the current scenario, even if strategies such as clinical and laboratory monitoring are fundamental for the evaluation of renal function.[6,7]

At present, the evaluation of renal function is guided by the multidimensional classification systems. These systems adopt urinary volume and serum creatinine[8] as markers of renal impairment. In the clinic, the monitoring of these markers subsidizes not only the control of complications but signals the need to implement preventive measures early.[9]

Among the classification systems, this study emphasized the *Acute Kidney Injury Network* (AKIN) as an indicator of the stages of renal impairment (Table 1).

This study is justified by alerting health professionals, especially nurses, who work in intensive care and nephrology for potential late complications in AKI survivors, stressing that the current focus should be on both AKI prevention and promotion of recovery in these patients.

In this perspective, the objectives of this study were to determine the stage of renal function impairment in patients who progressed with non-dialytic AKI and identify the frequency of renal function recovery in the intensive care unit.

Table 1 - Classification of acute kidney injury according to the Acute Kidney Injury Network (AKIN)

Stage	Serum creatinine criterion	Urinary flow criterion
1 (risk)	Increase of sCr≥0.3 mg/dL or ≥ 50% (1.5 times) of baseline value.	<0.5 mL/kg per hour in 6h
2 (renal injury)	Increase of sCr> 200 to 300% (>2x to 3x) of baseline value.	<0.5 mL/kg per hour in 12h
3*(renal failure)	Increase of sCr> 300% (>3x) of baseline value or sCr>4 mg/dL with acute increase of at least 0.5 mg/dL.	<0.3 mL/kg per hour in 24 hours or anuria per 12h.

AKI - acute kidney injury; AKIN- Acute Kidney Injury Network; sCr- Serum creatinine.*Individuals with AKI in recent treatment with renal replacement therapy are considered as stage 3.[9]

METHOD

This was an observational, prospective, and quantitative study developed from February to July of 2015 in the intensive care unit of a public hospital in the Federal District. Clinical patients who were 18 years and older without previous history of AKI were included; those with chronic renal insufficiency (glomerular filtration rate < 60 mL/min), renal transplant recipients, or those who remained hospitalized for less than seven days in the intensive care unit were excluded.

Patients who progressed with non-dialytic AKI were monitored during a 15-day period.

The estimation of the sample size (n) was based on a formula used to estimate a proportion. The variable P considered in the formula was 15% and obtained from the incidence of AKI in scientific evidence.[2] For the parameter d in the formula, an absolute proportion precision of d = 7.5% was assumed.[10] The calculated sample was of 100 patients, however, due to losses resulting from mortality (10%) and absence of records (5%), the final sample size was 90 patients.

Patients with an increase of ≥ 0.3 mg/dL or 50% over the serum creatinine baseline and/or a reduction of < 0.5 mL/kg per hour in six hours of urinary output following admission to the intensive therapy were considered with AKI.[11]

The evaluation of renal function recovery was performed gradually at the end of the first, second, and third months of hospitalization in the intensive care unit. In order to calculate the percentage of renal recovery, the ratio between serum creatinine level at the end of follow-up and the baseline serum creatinine level was adopted. Complete recovery was accepted when this ratio was ≤ 20% and partial recovery when this ratio was greater than 20% without dialysis dependence.[12]

Data collection was performed by the researcher through a structured instrument that consisted of items related to demographic, clinical identification (previous diseases, medications in use, and laboratory tests), and period of hospitalization in the intensive care unit. The information was obtained by remote access to electronic medical records available in the Health Department's *intranet* system. The calculation of the *Simplified Acute Physiology Score* 3 (SAPS

3) was based on the study by Moreno *et al.* [13] after obtaining the clinical and laboratory data of patients in the study's setting (ICU).

The study was approved by the Ethics Committee in Research of the Foundation for Education and Research in Health Sciences/State Health Department (FEPECS/SES) – Federal District, under protocol CAAE 40300714.6.0000.5553.

The data were double typed in Excel spreadsheets and exported to the *Statistical Package for Social Sciences* (SPSS) software version 23. The results were expressed as mean, standard deviation, median, and percentiles. The analysis of categorical variables was performed using the Fisher's exact test or the Chi-square test. The Mann-Whitney test was used to compare categorical and continuous variables and to compare continuous variables. Results with p value < 0.05 were considered significant.

RESULTS

The mean age of patients was 55 ± 21 years, and the body mass index was 25.3 kg/m^2. Men predominated (52.2%), and the most common comorbidity was arterial hypertension (38.9%); conversely, sepsis was diagnosed in 44.4% of the patients and 25.6% evolved with acute respiratory failure.

The vasoactive drugs were administered in the majority (74.6%) of patients. Out of all patients, 36.7% died. The use of vasoactive drugs, particularly norepinephrine, showed a significant relationship with the occurrence of renal injury (p = 0.009, and p = 0.045), respectively.

The mean of the *Simplified Acute Physiology Score* 3 (SAPS 3) was 70.7 ± 13.1. In addition, hemodynamic instability was present in 99.1% of patients. The use of invasive mechanical ventilation was associated with the occurrence of renal dysfunction (p = 0.001).

Overall, 95.6% of the patients developed renal dysfunction according to the *Acute Kidney Injury Network* (AKIN) classification. Among the criteria, urinary output was highlighted in the identification of renal dysfunction. The majority (43.3%) of cases was classified through this criterion as having renal damage; 33.3% with renal failure, which is a stage of greater severity, and 14.4% with a risk of renal injury. The creatinine criterion also stratified patients at different stages of impaired renal function; however, as shown in Table 2, the percentage affected was less expressive.

Table 2 - Staging of renal function impairment in stages according to the Acute Kidney Injury Network (AKIN) classification. Federal District, 2015

Stage classification AKIN	Criteria	
	sCr n(%)	DU n(%)
1 (risk)	29 (32.2%)	13 (14.4%)
2 (renal injury)	7 (7.8%)	39 (43.3%)
3 (renal failure)	10 (11.1%)	30 (33.3%)

sCr= serum creatinine; DU= urinary output.

Younger patients (age < 40 years) presented smaller values (40 to 60) of the *Simplified Acute Physiology Score* 3 (SAPS 3) compared to those at older ages (> 40 years). These variables were associated (p = 0.0001).

Those above 40 years old showed a statistically significant relationship with longer dependence on invasive mechanical ventilation (p = 0.02).

The lack of medical records and mortality during hospitalization made it possible to evaluate renal function recovery in 33 out of 90 patients. Overall, given the expressed values, 50% of patients evolved to the recovery of renal function and the percentage of renal function recovery was most expressive in the first month of follow-up (Figure 1).

Most patients showed renal function recovery at the ICU discharge (93%). This association was significant (p = 0.05).

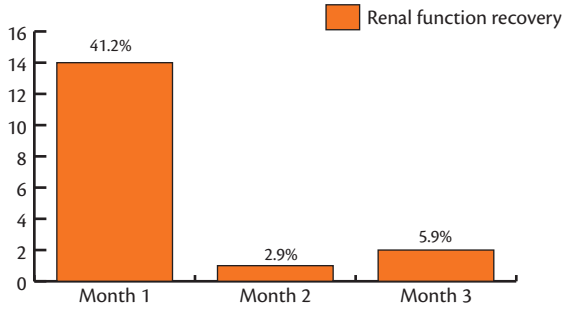

Figure 1 - Renal function recovery of non-dialytic patients hospitalized in the intensive care unit. Federal District, 2015.

DISCUSSION

The estimates show that AKI can affect approximately 20 to 200 million people in the general population. Of this total, 7 to 18% of these patients are hospitalized, including approximately 50% in the intensive care unit.[14] The present study revealed that, according to the AKIN classification, more than half of the patients admitted to the ICU were affected by AKI. Although known for decades, there is a relative lack of effective therapeutic approaches to address this major problem to date. Therefore, the modification of risk conditions seems to be an important strategy to reduce the incidence of this disease.[15]

The identification of patients at-risk, early diagnosis of AKI, and strategies to prevent and treat it have been the current major targets.[16] In the care process, incorporating measures such as the use of the *Acute Kidney Injury Network* (AKIN) classification may contribute for a systematized and preventive assistance. This study highlights the power of sensitivity, easy applicability, and the diagnostic anticipation of renal dysfunction due to this classification in the scenario of the critically ill patient.[17]

Sepsis and hemodynamic instability are the most prevalent and main etiologies of AKI.[18] Scientific evidence have shown that out of 992 patients diagnosed with sepsis and septic shock, 57.7%

developed renal damage.[19] In the study presented here, 44.4% of patients developed sepsis, and 99.1% had hemodynamic instability, which may have contributed to the high incidence of AKI.

Sepsis is a severe and dysregulated response to infection in addition to being characterized by the dysfunction of various organs. The development of AKI during sepsis increases patient morbidity and predicts mortality. This fact is associated with the increase in the length of ICU stay and therefore, consumes considerable resources in health care. AKI is a frequent and severe complication of sepsis in ICU patients as identified in our study. Above all, sepsis and septic shock account for half of the AKI cases.[20]

In addition and as indicated in our study, overweight has been highlighted as a frequent variable among AKI patients.[12] Obviously, the metabolic overload due to obesity predisposes to events that lead to complications such as renal dysfunction.[21]

SAPS is an index for mortality prediction.[22] In this study, despite its high value, the mortality rate was 36.7%. In this regard, the early identification of AKI is important to facilitate the evaluation process and prevent further kidney injury.[23]

Critically ill patients accumulate a high risk of developing AKI and consequently increased mortality. Despite the many advances in research techniques in the last 20 years and the introduction of genomic and proteomic techniques, there have been no substantial changes in the outcome of patients who develop AKI. This limited progress is related to some factors such as lack of diagnostic tests for the early detection of AKI and absence of a specific therapy in addition to renal replacement therapy. The diversity of patients who become critically ill has increased the number of AKI predictors. Individual clinical variables that predict AKI were described in groups of critically ill patients[24] as well as in those followed in our study. The highlighted predictors are: high disease severity (APACHE or SAPS), use of mechanical ventilation, old age, hypotension, oliguria, increased body mass index, history of hypertension, and atherosclerotic cardiovascular disease.[25]

Evidence indicates that the accumulation of factors (dialysis, mechanical ventilation, and use of vasoactive drugs) and comorbidities predispose to an increased severity in critically ill patients.[24] In this study, both mechanical ventilation and use of vasoactive drugs were factors associated with AKI ($p = 0.001$ and $p = 0.009$, respectively).

Urinary output, as evidenced by the AKIN classification, was revealed as the best AKI predictor in comparison to serum creatinine. The lack of sensitivity of serum creatinine represents a factor that interferes and delays the early identification of renal dysfunction.[7] Thus, the combination of urinary output and creatinine for the evaluation of renal function has currently been a common clinical practice in the hospital setting despite that oliguria is not a sensitive or specific marker; it may occur as a result of renal injury, but may also reflect an adaptive physiological response to both intracellular dehydration and hypovolemia.[16]

Nevertheless, the monitoring of urine production is a major challenge in the clinical practice because it is based on the visual readings of the amount of urine accumulated in the collector, which is often an imprecise process.[26] Ideally, renal function should be measured and monitored in real time for the early AKI diagnosis, allowing for adjustments in clinical management and control of prescribed drug doses.[16]

Although the physiological changes that occur with aging place older adults at greater risk for respiratory complications and mortality, there are many factors besides chronological age that may influence the dependence on mechanical ventilation; nevertheless in our study, the age over 40 years was significantly associated with longer time spent on mechanical ventilation.[27]

The recovery of renal function after AKI is fundamental because its repercussions extend in the long term. The percentage of renal function recovery after the diagnosis of AKI is variable among studies. In this study, it was 50%. However, scientific evidence showed that 36.7% of patients with AKI had recovered renal function at hospital discharge.[28] A higher percentage was revealed by another study that reported renal function rehabilitation in 88.2 % of survivors.[7] In the current literature, the time to evaluate renal recovery varies considerably. Recent evidence suggests that the time commonly taken to identify AKI can influence the degree of renal function impairment and predispose to mortality.[29,30] Most studies report renal function recovery at hospital discharge.

In the past, renal recovery was often defined as independence from renal replacement therapy (dialysis). More recently, failed recovery from less severe AKI has been associated with long-term adverse events.[30] Recovery may occur early after the insult that led to AKI (up to seven days) or later, during the stage of acute kidney disease (seven to 90 days). In this case, the follow up of patients with a history of renal impairment by health professionals to provide guidance on health practices is necessary even after hospital discharge.[31]

The limitations of this study are: it was developed in a single hospital scenario, the difficulty of access to medical records, and the percentage of mortality that affected some of the patients being followed up.

CONCLUSIONS

The majority of patients developed renal dysfunction according to the AKIN classification. The urinary output criterion identified a high percentage of patients with renal impairment in comparison to the creatinine criterion.

Most of the patients were identified with a lesion or renal failure, which are stages of greater severity according to the AKIN classification. Renal function recovery was identified in 50% of patients.

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