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Acute Renal Failure in COVID-19 Patients in Intensive Care at the CHU du Point G in Mali

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Abstract

Introduction: SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) causes an acute respiratory disease with interstitial and alveolar pneumonia, which can affect several organs including the kidneys [1] [2] [3]. As Mali is no stranger to this pandemic, we report our experience of the management of cases of kidney failure observed in the COVID-19 intensive care unit at the Point G University Hospital Centre (CHU). The aim of this work was to characterise acute renal failure in COVID-19 patients in intensive care, describing the management methods used and determining the vital prognosis. **Materials and Methods:** This was a retrospective descriptive study, covering an 18-month period from April 2020 to September 2021. We included all patients admitted to the COVID-19 intensive care unit on the basis of a positive RT-PCR and/or the presence of ground-glass images on thoracic computed tomography. **Results:** We selected 232 patients admitted for COVID-19. Acute Renal Failure (ARF) developed in 71 patients (30.6%). The stages of AKI according to KDIGO were Stage 1 in 28.2%, Stage 2 in 18.3% and Stage 3 in 53.5%. The mean age was 63.96 years, with a standard deviation of 16.6, and males accounted for the majority (71.8%). Organic ARF was found in 80.3% of cases. Risk factors and comorbidities for ARF included advanced age (60.6%), male sex (71.8%), hypertension (52.1%), diabetes (21.1%), invasive mechanical ventilation (71.8%) and septic shock (56.3%). Extra renal purification (haemodialysis) was used in 29.6% of patients. Admission to intensive care ranged from 7 days to 14 days in 43.7% of cases. More than half the patients (52.1%) were in critical condition on admission. Death occurred in 76.1% of patients. **Conclusion:** ARF appears to occur more frequently in patients with severe COVID-19. It is associated with a poor prognosis.

Keywords

COVID-19, Acute Renal Failure, Intensive Care Unit

1. Introduction

December 2019 is an epidemic of infectious pneumonia. Known as Coronavirus Disease-19 (COVID-19), this infectious pneumonia is caused by an emerging virus of the coronavirus family, SARS-CoV-2 [1] [2] [3]. SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) causes acute respiratory disease with interstitial and alveolar pneumonia, and can affect several organs including the kidneys, heart, digestive tract and nervous system [4].

Acute renal failure (ARF) is defined by an abrupt and reversible decrease in Glomerular Filtration Rate (GFR) [5].

The pathogenesis of ARF in COVID-19 is multifactorial, ranging from renal hypoperfusion related to mechanical ventilation, sepsis and cytokine storm, to direct toxicity of the virus on tubular cells [6].

In intensive care units, early studies estimated its prevalence at 23% (14% - 35%) [6] [7], although European data report higher prevalences of up to 50% [8] [9]. The occurrence of ARF during SARS-CoV-2 infection is strongly correlated with mortality [8] [10] [11]. European data suggest that haemodialysis is used in 13% - 28% of patients, and this organic support is associated with high mortality [12].

The use of Renal Replacement Therapy (RRT) varies from study to study, and may be indicated in 73% of patients with ARF [13]. We report our experience in the management of cases of renal failure observed in the COVID-19 intensive care unit of the Point G University Hospital Centre (CHU).

The aim of this work was to characterise acute renal failure in COVID-19 patients in intensive care by describing the management methods and determining the vital prognosis.

2. Materials and Methods

This was a retrospective descriptive study over a period of 18 months (April 2020 to September 2021). All patients hospitalised in the COVID-19 intensive care unit were included in the study. The diagnosis of SARS-CoV-2 infection was based on a positive RT-PCR and/or the presence of a ground-glass image on a chest CT scan. We included patients with at least one criterion from the KDIGO 2012 classification (**Table 1**). We did not include patients with a length of stay of less than 24 hours or patients with chronic renal failure. We collected exhaustive socio-demographic, clinical, biological, therapeutic and evolutionary data from medical records, hospitalisation registers and dialysis diaries.

- Sociodemographic data:
  - Age, sex, and time from onset of symptoms to admission to intensive care unit, length of hospital stay.

Table 1. Staging criteria for acute kidney injury (KDIGO 2012)*.

Stage	Measures acute renal failure (any of the following for each stage)		
	Increase in plasma creatinine	Decrease in diuresis	Renal replacement therapy
1	≥0.3 mg/dL (26.52 micromoles/L) or 1.5 - 1.9 times baseline	0.5 mL/kg/h for 6 - 12 h	Not indicated
2	2 - 2.9 times baseline	<0.5 mL/kg/hr for ≥12 h	Not indicated
3	≥4.0 mg/dL (353.60 micromoles/L) or ≥3 times baseline	0.3 mL/kg/hr for ≥24 hours or anuria for ≥12 hrs	Indicated

*Data from KDIGO (Kidney Disease: Improving Global Outcomes) Acute Kidney Injury Work Group: KDIGO Clinical Practice Guideline for Acute Kidney Injury. Kidney Inter Suppl. 2: 1-138, 2012.

- Clinical data:
  - Time to admission to intensive care, vital parameters (respiratory rate (cycles/min), pulsed O_2 saturation (SpO_2), heart rate (beats/min), blood pressure (mmHg), diuresis, temperature (˚C), glasgow score.
- Biological data:
  - Blood gas, C-Reactive Protein (C-RP), blood count, transaminases (ALAT, ASAT), plasma urea/creatininemia, procalcitonin, blood ionogram.
- Type of acute renal failure according to the plasma urea/creatinine ratio:

Type of ARF	Functional ARF	Organic ARF
Plasma urea/creatinine	<50 (molar expression)	>100 (molar expression)

- Therapeutic data:
  - Conditioning, respiratory assistance, anti-infective treatment, heparin therapy, correction of hypovolemia, extra renal purification, catecholamines, insulin therapy.
- Evolution:
  - Patient outcome.

The data were entered and analysed using IBM SPSS software (version 21.0). Descriptive analysis was used to describe the different variables. Data were kept anonymous.

3. Results

We have colligé 232 files of admitted patients in reanimation for COVID-19 among which the IRA is survenue at 71 patients is a frequency of 30.6%. The mean age

was 63.9 years with a standard deviation of 16.6 and the predominant sex was male (71.8%). Table 2 summarises the characteristics of the patients. The median time to admission to intensive care was 10 days. More than half the patients were at the critical stage of COVID-19 on admission. According to the urea/plasma creatinine ratio, AKI was organic in 80.3% of cases. Risk factors and comorbidities included advanced age (60.6%), male sex (71.8%), hypertension (52.1%), diabetes (21.1%), use of invasive mechanical ventilation (71.8%), and septic shock (56.3%) (Table 2). Figure 1 summarises the distribution of patients according to the KDIGO classification. Extra renal purification was performed in 29.6% of patients, with an average of 2.5 sessions ± 1.25 per patient. The characteristics of haemodialysis are shown in Table 3. Hypoglycaemia and arterial hypotension were the most frequent incidents during dialysis. The associated management measures are shown in Table 4. The mortality rate was 76.1%. Most deaths occurred in the setting of multivisceral failure.

4. Discussion

We conducted a retrospective, single-centre study. This demonstrated the few limitations of this work. The incidence of acute renal failure was 30.6%. This rate was lower than those found by some authors [8] [11], *i.e.* 76% and 46%, respectively. This could be explained by the fact that conversion enzyme levels are higher in males. According to the KDIGO classification, 53.5% of patients had Stage 3 ARF. This is confirmed in the literature, with rates ranging from 30% to 53.5% [13] [14] [15]. This rate is supported by the results of the Pepsi *et al.* This rate is supported by those of Pei *et al.* [16] in China, *i.e.* 57.1%. The mean age of the patients was 64.47 years, similar to others in the literature [13] [14] [17]. Elderly, patients are more likely to suffer from the physiological and anatomical changes associated with age, multiple medications and associated chronic diseases. In this study, the majority of patients were male (72.9%), with a sex ratio (M/F) of 2.68. This could be explained not only by genetic factors but also by the combination of risk factors and comorbidities [18].

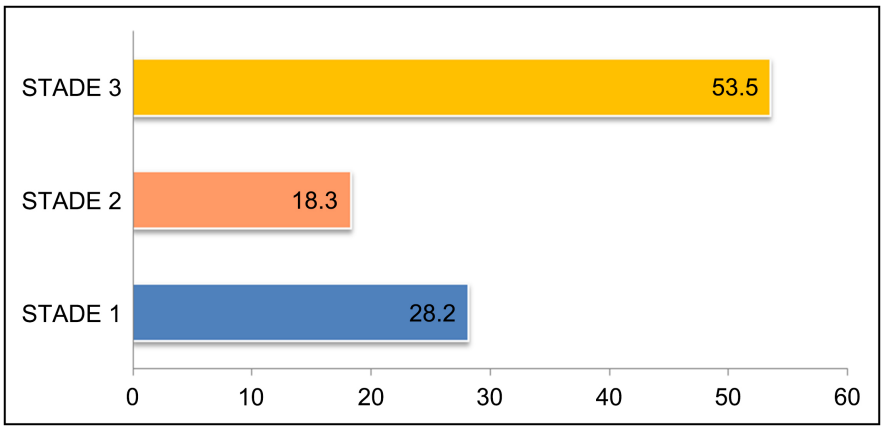

Figure 1. Classification of AKI according to KDIGO 2012. Patients suffering from ARF on COVID-19 were at Stage 3 of the KDIGO 2012 definition in 53.5% of cases.

Table 2. Patient characteristics.

Patient characteristics		Number of patients	Percentage
Age	<40 years old	7	9.9
	40 - 59 years old	11	15.5
	60 - 79 years old	38	53.5
	≥ 80 years old	15	21.1
Sex	Male	51	71.8
	Female	20	28.2
Risk factor	Age > 65	43	60.6
	Male	51	71.8
	Smoking	24	33.7
	BMI[a] > 30	4	5.6
	Mechanical ventilation	51	71.8
	Use of vasopressors	40	56.3
Comorbidities	HTA[b]	37	52.1
	Diabetes	15	21.1
	COPD[c]	3	4.2
	Stroke[d]	4	5.6
	Heart disease	3	4.2
	Asthma	1	1.4
	Cancer	1	1.4
Clinical severity	Critical	37	52.1
	Severe	31	43.7
	Moderate	3	4.2
Associated organic failure	Respiratory	67	94.4
	Circulatory	34	47.9
	Neurological	26	36.6

[a]: Body Mass Index; [b]: High blood pressure; [c]: Chronic Obstructive Pulmonary Disease; [d]: Accident cerebrovascular.

Table 3. Characteristics of dialysis.

Characteristics		Numbers			Percentage	
Indication	Metabolic acidosis (pH < 7.20)	7			9.9	
	Hyperkalemia > 6.5 mmol/l	11			15.5	
	Urea > 30 mmol/l	20			28.2	
	OAP*	3			4.2	
	Right femoral	16			76.2	
	Left femoral	4			19.0	
	Right inner chinstrap	1			4.8	
Session no.		1st-	2nd-	3rd-	4th-	5th-
Duration	1H	1	0	0	0	0
	1H30	0	0	0	0	0
	2H	16	3	1	0	0
	2H30	0	6	2	0	0
	3H	4	4	2	2	1
	3H30	0	3	1	1	0
	4H	0	0	4	1	1
UF**	0 L	2	2	0	0	0
	0.5 L	3	1	1	0	0
	1 L	10	4	4	1	0
	1.5 L	4	3	0	0	0
	2 L	0	5	1	1	1
	2.5 L	1	1	1	0	0
	3 L	1	0	3	2	1
Incident and accident	Hypoglycemia	6	2	1	0	1
	Hypotension	6	6	3	2	0
	Hypertension	1	0	0	0	0
	Hyperthermia	1	2	0	0	0
	Heart failure	0	1	0	0	0

*: Acute lung edema; **: Ultrafiltrate.

Table 4. Other management measures.

Treatment		Numbers	Percentage
Respiratory	Mask	70	98.6
	NAV*	31	43.7
	Invasive ventilation	51	71.8
Other support measures	Antibiotic therapy	71	100.0
	Anticoagulation	67	94.4
	Corticosteroid therapy	64	90.1
	Catecholamine	40	56.3
	Transfusion	15	21.1

*: Nebulisation Artificial Ventilation.

During the study, 29.6% were dialysed. This could be explained by the high rate of KDIGO Stage 3 and the delay in management. The incidence of ARF requiring intensive care EER in COVID-19 patients is high, ranging from 10.7% to 23.2% [8] [13] [14]. The indications for EER were similar to those for non-COVID-19 patients. The incidence and impact during dialysis were mainly arterial hypotension and hypoglycaemia. The literature has reported cases of dialysis filter thrombosis; we have not found any cases of filter thrombosis. All our patients requiring dialysis were on heparin.

The main risk factors and comorbidities identified appeared to be advanced age (60.6%), male sex (71.8%), mechanical ventilation (71.8%), septic shock (56.3%), hypertension (52.1%) and diabetes (21.1%). These main factors and comorbidities have also been reported in the literature [11] [13] [19].

ARF was organic in 80% of patients. This can be explained by the predominant involvement of the proximal convoluted tubule by SARS-CoV-2 [20]. The involvement of the proximal convoluted tubule could be explained by the co-expression of Angiotensin-Converting Enzyme 2 (ACE2) receptors and TMPRSS proteases (necessary for the virus to enter the host cell) [21] [22] [23].

The mortality rate in our study was 76.1%, a result similar to that reported in the literature [24] [25] [26]. In a study conducted in Ireland, mortality from ARF in COVID-19 patients admitted to the Intensive Care Unit (ICU) was greater than 75%. Our data are similar to the Irish data [25]. ARF is associated with increased in-hospital mortality [27] [28].

Several hypotheses have been put forward to explain this renal damage, including renal hypoperfusion linked to mechanical ventilation, sepsis and the cytokine storm, or direct toxicity of the virus on tubular cells [29].

Artificial ventilation is recognised as a factor in renal aggression [30]. The humoral consequences of artificial ventilation, namely activation of the renin-angiotensin-aldosterone system and inhibition of atrial-natriuretic factor,

may contribute to changes in renal perfusion [30]. This stress may be indirect, due to changes in systemic haemodynamics, or direct, independently of the reduction in cardiac output. Positive pressure ventilation may reduce venous return and/or increase right-sided ventilatory afterload, resulting in a reduction in cardiac output and renal blood flow, with redistribution to the medulla [31]. The increase in intra-abdominal pressure associated with ventilation may alter renal perfusion by increasing intra-parenchymal pressure and/or pressure in the veins [32] [33].

Although the results were positive, our study was not without its limitations in terms of its retrospective and monocentric nature, and the fact that certain examinations, such as renal biopsy, were not performed during the cold phase of the disease.

5. Conclusion

The occurrence of AKI appears to be more frequent in elderly male patients with a severe form of COVID-19 with organ failure. It is associated with a poor prognosis, hence it is important to take preventive measures in our context.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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