Scientific Research Publishing

Open Journal of Nephrology, 2022, 12, 410-425
https://www.scirp.org/journal/ojneph
ISSN Online: 2164-2869
ISSN Print: 2164-2842

COVID-19 Infection and Acute Kidney Injury: About 43 Cases Report Collected at the Nephrology Department of the Farah Polyclinic in Abidjan

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How to cite this paper: Dolaama, B., Konan, S.D., Diopoh, S.P., Moudachirou, M.A., Tona, K.G., Amekoudi, E.Y.M., Tsevi, M.C. and Yao, K.H. (2022) COVID-19 Infection and Acute Kidney Injury: About 43 Cases Report Collected at the Nephrology Department of the Farah Polyclinic in Abidjan. *Open Journal of Nephrology*, **12**, 410-425.
https://doi.org/10.4236/ojneph.2022.124042

Received: September 24, 2022
Accepted: December 4, 2022
Published: December 7, 2022

Abstract

Background: Acute kidney injury (AKI) is one of the increasingly described complications of coronavirus infection. **Objectives:** To identify factors associated with death in patients with acute kidney injury (AKI) during Coronavirus disease (COVID-19) in Abidjan, Côte d'Ivoire. **Material and Method:** This was a monocentric retrospective analytical study of all patients over 18 years of age with AKI during COVID-19 at the Farah Polyclinic in Abidjan, Côte d'Ivoire. AKI was defined and ranked according to Kidney Disease Improving Global Outcomes (KDIGO) 2012. The data were collected from the medical record and processed using RStudio. **Results:** Forty-three cases were collected. The average age was 58.5 12 years. The sex ratio (M/F) was 4.4. The main comorbidities were high blood pressure (60.4%) and diabetes (37.2%). AKI was at KDIGO stage 3 in 58%, KDIGO 2 in 21% and KDIGO 1 in 21%. The diagnosis of acute tubular necrosis was retained in 44.2% of patients followed by acute functional kidney injury in 32.6%. Hemodialysis was initiated in 48.8% of cases. The main indication of dialysis was anuria (46.6%). In total, 55.8% of patients died. Factors associated with death were KDIGO stage ($p = 0.049$), and invasive ventilation ($p < 0.001$) associated with the risk of death in univariate analysis. **Conclusion:** Mortality is high in patients with AKI during COVID-19 infection.

Keywords

Coronavirus, Acute Kidney Injury, Abidjan, 2020

1. Introduction

A new pathogen emerging since November 2019, SARS-CoV-2 (Severe Acute Respiratory Syndrome CoronaVirus-2) is a virus responsible for Coronavirus disease (COVID-19) [1]. The virus has spread to the world, including Africa. It is responsible for systemic damage, including kidney damage, resulting in high mortality [2]. Indeed, this kidney involvement is associated with the occurrence of major complications independently of comorbidities and other risk factors. The mechanisms and type of kidney involvement during infection with the new coronavirus are numerous [3].

Currently, several studies showed that the mortality rate of COVID-19 patients with acute kidney injury is high, ranging from 8% to 23% [2]. One study indicated that 6.7% of patients with SARS-CoV-2 may develop impaired kidney function, and the mortality rate for those with acute kidney injury is 91.7% [4].

In Africa, several studies were conducted on kidney disease during COVID-19 [5] [6] [7]. Few studies were conducted in Côte d'Ivoire. Hence this work, whose main objective is to determine the factors associated with death in patients with acute kidney injury during COVID-19. Specifically, it involved describing the demographic, clinical, para-clinical characteristics of patients with acute kidney injury during COVID-19, describing the evolution and prognosis of patients with acute kidney injury during COVID-19, and identifying factors associated with the death of patients with acute kidney injury during COVID-19.

2. Patients and Methods

2.1. Pattern, Framework, Population and Period of Study

This is an analytical retrospective study covering the period from March 1, 2020 to April 30, 2021. Patients were monitored monthly for 03 months. The Farah Polyclinic in Abidjan, the only center where we were able to obtain the data exploitation authorizations, served as a framework for our study.

The nephrology-dialysis service consists of 2 resident nephrologists, 1 resident nurse, 2 temporary nurses and 4 nursing assistants. The hemodialysis unit has 6 hemodialysis generators, 1 of which in the resuscitation department. Activities include clinical nephrology, conventional hemodialysis and consultations.

The source population consisted of positive COVID-19 patients seen in consultation or hospitalization for nephrological advice in the face of increased creatinine.

2.2. Inclusion and Non-Inclusion Criteria

We included patients with acute kidney injury during coronavirus disease. The

date of inclusion was the date of diagnosis of acute kidney injury.

Chronic kidney injury patients with hemodialysis and patients transferred to another hospital were not included.

2.3. Data Collection

The data were collected from patients files by the nephrologists. They were collected using a standardized survey form.

2.4. Variables Studied

The variables collected were:

- Socio-demographic data: age (years), gender;
- Clinical data: comorbidities, systolic and diastolic blood pressure (mmHg), temperature in degree Celsius, respiratory rate (per minute), pulsed oxygen saturation (%);
- Biological data: hemoglobin levels (g/dl), uremia (g/l), creatinine (mg/l), kalemia (mmol/l), CPR reactive C protein in mg/L;
- Radiological data: alveolar opacities, interstitial, pleurisy;
- Data from the positive diagnosis of Coronavirus infection;
- Type of renal involvement: based on data from the clinic;
- Patient progression: death or not, recovery of kidney function.

2.5. Operational Definition

The positive diagnosis of coronavirus infection was made on the basis of positive PCR or positive IgM serology or CT lesions in favor (areas of frosted glass, which correspond to a moderate increase in the density of the pulmonary parenchyma secondary to edema, bilateral and multifocal, rather peripheral and rather in the lower and posterior regions).

The diagnosis of acute kidney injury was made and classified according to the Kidney Diseases Improving Global Outcomes (KDIGO) 2012 [8].

High blood pressure was defined as a systolic blood pressure greater than 140 mmHg and/or a diastolic blood pressure greater than 90 mmHg.

Low blood pressure: systolic blood pressure less than 90 mmHg.

Respiratory distress was defined as a breathing rate greater than 20 cycles per minute with or without oxygen saturation of less than 90%.

Anemia was defined as hemoglobin levels below 12 g/dl in women and below 13 g/dl in men.

Hyperkalemia is defined by a kalemia greater than 5.3 mmol/l and hypokalemia by a kalemia less than 3.5 mmol/l.

Severe uremia is defined as uremia greater than 2 g/l.

2.6. Data Analysis

The data was analyzed using R Studio software version 1.4.1717. The aim was to present the means, standard deviation, minimum, maximum for quantitative variables and percentages for binary and qualitative variables.

A univariate analysis by comparison of groups according to the main judgment criterion was performed by applying the Pearson Chi-2 test for categorical variables or the exact Fischer test for continuous variables. The significance threshold was set at p-value below 0.05.

Univariate and multivariate logistic regression was performed in order to investigate the associated factors. The explanatory variables were certain socio-demographic, clinical and biological variables. Variables statistically associated with death in univariate analysis with a degree of significance p 0.20 were introduced into the initial model. Multivariate analysis estimated the odd-ratio (OR) and its 95% confidence interval for each selected variable. After obtaining the final model, interactions were sought between the various variables of the final model by including interaction terms (product of the two variables concerned) in the model and by checking their non significance. The adequacy of the model was verified based on the R^2 value.

2.7. Ethical and Administrative Considerations

The authorizations from the medical director of the Farah Polyclinic and the head of the Nephrology-Dialysis unit at the Farah Polyclinic were obtained. Anonymity was respected.

3. Results

3.1. Descriptive Analysis

A total of 43 patients met the including criteria during the study period. The majority (58%) were classified as Stage 3 according to the KDIGO classification (Figure 1). The average age was 58.5 12 years with extremes of 32 and 88 years. The most observed age group was between 60 and 70 years (32.5%). The Male/Female sex ratio was 4.4.

The comorbidities found were high blood pressure in 58.1% of cases and diabetes in 34.9% of cases.

The diagnosis of Coronavirus infection was made in 11.6% of cases with RT-PCR, 74.4% with CT lesions and 14% with positive Covid IgM serology.

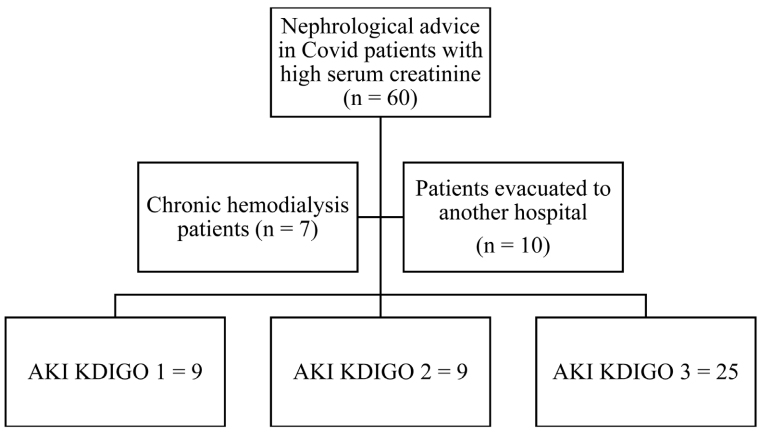

Figure 1. Patients flow chart.

Only 1 patient had low blood pressure and 6 (14%) had grade 1 or 2 high blood pressure. Respiratory distress was present in 60.5% of patients and fever 16.3% of patients. The mean hemoglobin level was 10.8 g/dl with extremes of 5.2 and 16.3 g/dl. The average CRP was 30.81 mg/l. All patients had a CRP greater than 6 mg/l of which 4 (9.3%) had a CRP < 30 mg/l, 8 (18.6%) between 30 - 60 mg/l and 27 (62.8%) a CRP 60 mg/l. Uremia and creatinine were averaging 1.9 g/L (extremes of 0.4 g/L and 4.8 g/L) and 78.7 mg/L (extremes of 15 mg/L and 240 mg/L), respectively. The mean kalemia was 4.6 mmol/l (extremes of 2 mmol/l and 6.9 mmol/l).

For the pleuropulmonary lesions on CT, they were represented by pleurisy, alveolar pneumonia and interstitial pneumonia respectively in 46.5%, 69.8% and 97.7%. The type of renal involvement was dominated by acute tubular necrosis in 44.2% of cases followed by acute functional kidney injury in 32.6% of cases. It was undetermined in 23.3%.

The treatments received were antibiotics (93%), corticosteroids (65.1%), anticoagulants (65.1%), vasoactive amines (34.9%), non-invasive ventilation (9.3%), invasive ventilation (44.2%) and hemodialysis (48.8%). Indications of hemodialysis were dominated by anuria (35%) and hyperkalemia (35%), followed by severe uremia (25%) and PAO (5%).

There is a statistically significant difference by KDIGO stage in gender (p = 0.01), kidney involvement type (p = 0.001), hemodialysis treatment (p = 0.006) and kidney function evolution (p = 0.02) (**Table 1**). In terms of gender, there were more women in the KDIGO 2 stage (55.6%), whereas men predominated in the KDIGO 1 (100%) and KDIGO 3 stages (84%). In terms of type of kidney involvement, the majority of KDIGO 1 patients (55.6%) had functional kidney injury; stage 2 was also dominated by functional kidney injury in 44.4% of cases; however, stage 3 had a high proportion of acute tubular necrosis (68%). Sixty-eight (68%) of KDIGO 3 patients had been hemodialysis (**Table 1**). Stages 1 and 3 had the highest proportion of deaths, respectively 77.8% and 60%, in contrast to stage 2, which had a higher proportion (44.4%) of kidney function recovery (**Table 1**).

3.2. Factors Associated with the Risk of Death

In univariate analysis, age (p = 0.0109), respiratory distress (p = 0.01), KDIGO stage (p = 0.049), vasoactive amines (p = 0.0068) and invasive ventilation (p < 0.001) were associated with the risk of death (**Table 2**). In multivariate analysis, KDIGO stage 2 (OR = 0.14 [CI = 0 - 0.1]; p = 0.0148), KDIGO Stage 3 (OR = 0.7; 95% CI = 0 - 0.1; p = 0.0492) were protector factor associated to death. Invasive ventilation (OR = 22.5; 95% CI = 8.7 - 207.7; p = 0.0120) was associated with the risk of death (**Table 2**). Survival was better in KDIGO 2 patients but the difference was not significant (p = 0.082) (**Figure 2**). According to Kaplan Meyer curve, the probability of survival was better when the patient had not benefited from invasive ventilation (p = 0.0007) (**Figure 3**).

Table 1. Patients general characteristics.

Characteristics	Total (N = 43)	KDIGO 1 (n = 9)	KDIGO 2 (n = 9)	KDIGO 3 (n = 25)	p-value
Age					0.9116
<60 years	79% (34/43)	55.6% (5/9)	66.7% (6/9)	52% (13/25)	
≥60 years	21% (9/43)	44.4% (4/9)	33.3% (3/9)	48% (12/25)	
Gender					0.01403
Male	79% (34/43)	100% (9//9)	44.4% (4/9)	84% (21/25)	
Female	21% (9/43)	0	55.6% (5/9)	16% (4/25)	
Comorbidities					
Hypertension	58% (25/43)	77.8% (7/9)	44.4% (4/9)	56% (14/25)	0.4014
Diabetes	34.9% (15/43)	44.4% (4/9)	55.6% (5/9)	24% (6/25)	
Heart diseases	14% (6/43)	33.3% (3/9)	0	12 (3/25)	0.143
Clinical signs					
Hypotension	2.3% (1/43)	0	11,1% (1/9)	0	0.4186
Fever	16.3% (7/43)	22.2% (2/9)	0	20% (5/25)	0.5102
Respiratory distress	60.5% (26/43)	66.7% (6/9)	33.3% (3/9)	68% (17/25)	0.7039
Biological signs					
Hemoglobin < 12 g/dl	37.2% (16/43)	55.6% (5/9)	33.3% (3/9)	32% (8/25)	0.4717
Hyperkalemia	27.9% (12/43)	11.1% (1/9)	22.2% (2/9)	36% (9/25)	0.3357
Uremia (g/l)					0.1875
<2	51.2% (22/43)	22.2% (2/9)	55.6% (5/9)	60% (15/25)	
≥2	48.8% (21/43)	77.8% (7/9)	44.4% (4/9)	40% (10/25)	
CT lesions					
Interstitial	51.2% (22/43)	44.4% (4/9)	44.4% (4/9)	56% (14/25)	
Alveolar	18.6% (8/43)	0	22.2% (2/9)	24% (6/25)	0.5941
Pleurisy	46.5% (20/43)	44.4% (4/9)	33.3% (3/9)	52% (13/25)	0.7667
Type of kidney involvement					0.00124
ATN	44.2% (19/43)	0	22.2% (2/9)	68% (17/25)	
FKI	32.6% (14/43)	55.6% (5/9)	44.4% (4/9)	20% (5/25)	
Not determined	23.3% (10/43)	44.4% (4/9)	33.3% (3/9)	12% (3/25)	
Duration of the disease					0.4306
<7 days	14% (6/43)	22.2% (2/9)	0	16% (4/25)	
≥7 days	86% (37/43)	77.8% (7/9)	100% (9/9)	84% (21/25)	
Treatment					
Antibiotics	93% (40/43)	100% (9/9)	100% (9/9)	88% (22/25)	0.5624
Anticoagulants	65.1% (28/43)	55.6% (5/9)	44.4% (4/9)	76% (19/25)	0.1872
Corticosteroids	65.1% (28/43)	44.4% (4/9)	77.8% (7/9)	68% (17/25)	
Vasoactive amines	34.9% (15/43)	55.6% (5/9)	11.1% (1/9)	36% (9/25)	0.1501

Continued

Invasive ventilation	44.2% (19/43)	33.3% (3/9)	33.3% (3/9)	52% (13/25)	0.3454
Hemodialysis	48.8% (21/43)	11.1% (1/9)	33.3% (3/9)	68% (17/25)	0.00685
Evolution					0.02758
Death	55.8% (24/43)	77.8% (7/9)	22.2% (2/9)	60% (15/25)	
Chronic	16.3% (7/43)	22.2% (2/9)	33.3% (3/9)	8% (2/25)	
Recovery	27.9% (12/43)	0	44.4 (%4/9)	32% (8/25)	

ATN: Acute Tubular Necrosis, FKI: Functional Kidney Injury.

Table 2. Factors associated with the risk of death.

Variables	n	Death	Univariate analysis	p-value	Multivariate model	p-value
Age (ans)				0.0109*		0.0666
<60	22	36.4% (8/22)			-	
≥60	21	76.2% (16/21)	5.6 [1.56 - 22.9]		2.8 [1.14 - 19.3]	
Gender				0.4431		
Female	9	44.4% (4/9)	-		-	
Male	34	58.8% (20/34)	1.7 [0.4 - 8.3]		-	
Comorbidities						
Hypertension	25	56% (14/25)	1.0 [0.3 - 3.4]	0.9		
Diabetes	15	46.7% (7/15)	0.5 [0.1 - 2]	0.3787		
Clinical signs						
Hypotension	1	0	-	0.4418		
Fever	7	85.7% (6/7)	6.8 [1 - 137]	0.09		
Respiratory distress	26	73.1% (19/26)	19 [2.7 - 39]	0.01*	1.36 [1.5 - 3.8]	0.7917
Biological signs						
Haemoglobin < 12 g/dl	16	62.5% (10/16)	1.5 [0.4 - 5.7]	0.4978		
Hyperkalemia	12	75% (9/12)	3 [0.7 - 15.7]	0.1517		
Uremia (g/l)				0.4332		
<2	22	50% (11/22)	-			
≥2	21	61.9% (13/21)	1.6 [0.4 - 5.6]	0.4332		
CRP (mg/l)						
<30	4	¼ (25%)	-			
[30 - 60[	8	3/8 (37.5%)	1.8 [0.1 - 46.2]	0.6670		
≥60	27	19/27 (70.4%)	7.1 [0.7 - 156.8]	0.1102		
CT lesions						
Interstitial	42	57.1% (24/42)	+	0.9944		
Alveolar	30	63.3% (19/30)	2.8 [0.7 - 11.2]	0.1375		
Pleurisy	20	55% (11/20)	0.9 [0.3 - 3.1]	0.9202		

Continued

KDIGO stage				0.04964		
1	9	77.8% (7/9)	-		-	
2	9	22.2% (2/9)	0.08 [0 - 0.6]		0.14 [0 - 0.1]	0.0148*
3	25	60% (15/25)	0.4 [1.1 - 2.2]		0.7 [0 - 0.1]	0.0492*
Type of kidney involvement				0.5374		
FKI	14	42.8% (6/14)	-			
NTA	10	60% (6/10)	2.2 [0.6 - 9.8]			
Not determined	19	63.2% (12/19)	2 [0.3 - 11.1]			
Duration of the disease				0.5953		
<7 days	6	66.7% (4/6)	-			
≥7 days	37	54.1% (20/37)	0.6 [0.1 - 3.4]			
Treatment						
Antibiotics	40	52.5% (21/40)	-	0.2425		
Anticoagulants	28	60.7% (17/28)	1.7 [0.4 - 6]	0.3787		
Corticosteroids	28	53.6% (15/28)	0.7 [0.2 - 2.7]	0.6861		
Vasoactive amines	15	86.7% (13/15)	10 [2.2 - 72.7]	0.0068*	0.6 [0.2 - 3.9]	0.2975
Invasive ventilation	19	89.5% (17/19)	20 [4.4 - 154.7]	<0.001*	22.5 [8.7 - 207.7]	0.0120*
Hemodialysis	21	52.4% (11/21)	0.7 [0.2 - 2.5]	0.6581		

ATN: Acute Tubular Necrosis; FKI: Functional Kidney Injury.

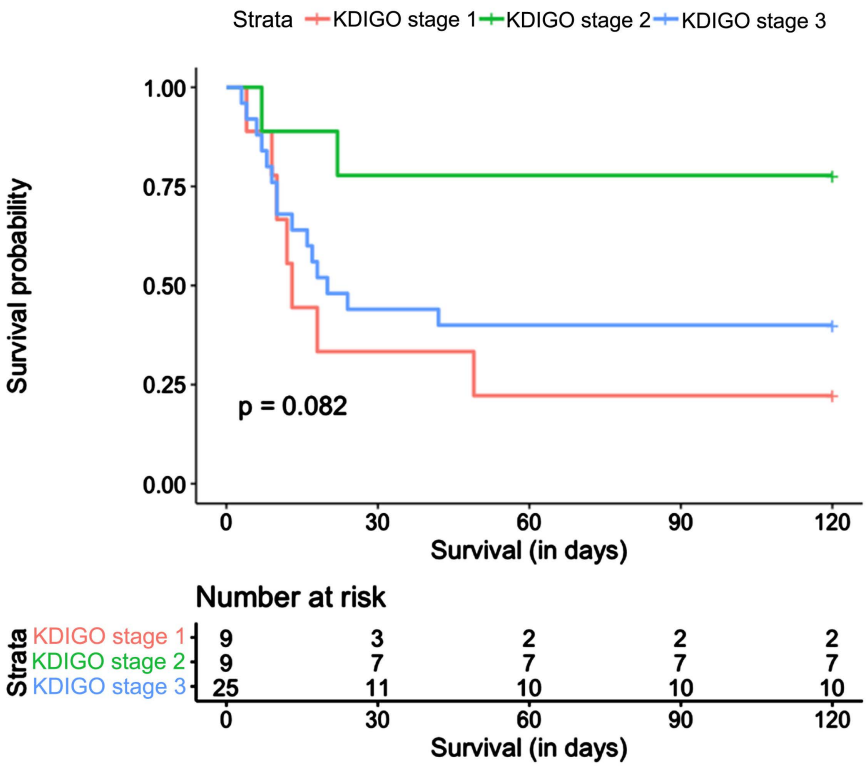

Figure 2. Kaplan-Meier model survival curve according to KDIGO stage.

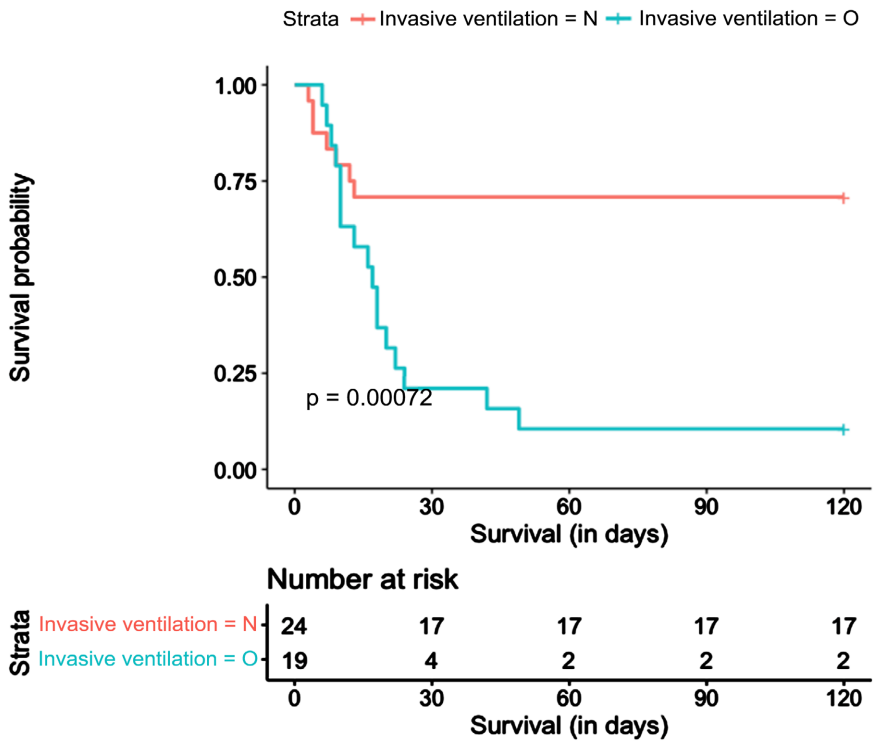

Figure 3. Kaplan Meier model survival curve according to invasive ventilation.

4. Discussion

We report 43 cases of AKI on Covid 19 infection. In Ghana, Afriyie-Mensah and al. found 36.4% of ARF [9] in a population of 22 patients infected with covid 19 and not having pre-existing kidney injury. Ketfi found 10.7% hypercreatinemia (serum creatinine greater than 14 mg/l) in Algeria [10] in a population of 86 patients. Arrocha had reported 37.8% of AKI in a population of 82 patients in Bolivia [11]. All of these single-center studies reported less than 100 cases of AKI during COVID-19 with different methodologies.

The average age in our series was 58 years. Gupta [12] and Chan [13] in the USA reported an average age of 62 and 71 in 2 different series. Ibrahim [14] had found an average age of 65 years and Rubin [15] had found 61 years in Bordeaux (France). The age group most represented in Gupta in the United States was over 80. At Afriyie-Mensah in Ghana, 63.6% were at least 60 years old. Gutiérrez in Spain [16] found that those over 65 represented 91.8% of the population. There is a clear predominance of the elderly.

The male/female sex ratio was 4 in Bordeaux (Rubin and *et al.*) [15], 2 in Nigeria (Ibrahim and *et al.*) [14], 9.4 in India (Sampathkumar and *et al.*) [17], and 2.5 in the USA in Gupta's series. Male predominance was also reported in our study. Male gender is already identified as a factor associated with the occurrence of an AKI during Covid [18] [19]. One hypothesis was the overexpression of ACE2 in male subjects [20]. Androgenic hormones would also play a role in increasing the expression of ACE2 [21].

High blood pressure was a comorbidity present in 60.4% of patients. The pre-

valence of hypertension was 71.7% in the USA [12], 16.7% in Nigeria [14] and 59% in India [17]. Gutierrez reported that 57.9% of his population had hypertension. The prevalence of hypertension was superimposed on ours except in the Nigerian study. There is probably an underestimation of high blood pressure cases in Nigeria where data were collected at interrogation in patients hospitalized in Intensive Care. Hypertension was identified as a risk factor for AKI during Covid [22]. Nevertheless, Hypertension is often accompanied by many factors [22].

Diabetes was a variable proportion in the studies. It was 37.2% in our series against 52.1% in Gupta in the USA [12] and Gutierrez 26.7%. It was comparable to that of Hirsch (43.3%) [23] and Chan (31%) [13]. There is strong expression of ACE2 in the kidneys of diabetic subjects [24].

Afriyie-Mensah and Arrocha found a clear predominance of respiratory distress with 90.9% and 98.7% respectively. This is superimposed on our results. The vast majority of lung damage is caused by COVID [25].

The mean hemoglobin was 10.8 g/dl and 12.3 g/dl in the Chan series [13]. Anemia was present in 53.5% of our patients compared to 16% in Ibrahim [14]. Anemia was present in 50.6% of patients in the Marques and al. series in Portugal. These results are superimposed on ours (74.4%). Anemia, common during Covid, is aggravated by the onset of kidney injury [26].

CRP levels were variable: 175 mg/L in Gupta [12] and 12.7 mg/L in Chan [13]. This is much lower than our result, related to the delay in management. CRP increases as the infection progresses [27]. It is a factor in the severity of Covid infection [28]. Inflammatory syndrome with high CRP was consistent in all our patients as in Marques (92.1%). COVID-19 is responsible for a significant inflammatory syndrome; inflammatory syndrome is also a prognostic factor.

The proportion of stage 3 patients in Arrocha in Bolivia [11] was 24.8% and 30% in Rubin [15] respectively, which is less than 58% in our series.

ATN accounted for 60.7% of patients. On renal biopsies performed, ATN lesions coexisted with several other lesions and were present in 70.6% of patients [29]. In another series, Sharma found 100% ATN lesions [30]. The predominance of ATN is related to the physio-pathology, which associates in a large proportion an effective hypovolemia, a rhabdomyolysis [31].

The majority of our patients (93%) were on antibiotics. Although no treatment showed efficacy, there is overuse of antibiotics without formal evidence of bacterial infection. This cannot be without negative effects.

Hemodialysis was initiated in 48.8% of patients. In the other series, it represented respectively 6.6% for Gupta [12], 29% for Chan [13] and 40% for Arrocha [11]. Gupta had patients with single-organ failure, with intensive care management early. On the other hand, Chan and Arrocha had a population distribution superimposed on ours. The indications of dialysis had not been specified in the series. In ours, it was dominated by anuria (46.6%).

Invasive ventilation was used in 79.1% of patients in Gupta, 68.2% of patients in Arrocha. In contrast, Afriyie-Mensah had 4.5% of patients with mechanical ventilation and Kanay had 16.4% of patients. Gupta and Arrocha had more se-

vere patients with at least two-organ failure in intensive care. The study populations of Afriyie-Mensah and Kanay were low (28 and 22 patients respectively), which may be a selection bias. In addition, they were carried out in Africa where invasive ventilation in public hospitals is limited [32].

In Gupta, 6.6% had received therapeutic-dose anticoagulants. In contrast, we found a higher proportion of patients who received anticoagulant therapy. Coagulopathy described during COVID-19 infection motivated the use of anticoagulants. In addition, the majority of patients had high D-dimers motivating the prescription of anticoagulants before imaging to rule out venous thromboembolic disease.

The proportion of patients on vasoactive amines was 34.9%. This is superimposed on the result of Gutiérrez (46.1%) in Spain [16]. COVID-19 is responsible for a sepsis that can develop into a state of shock requiring the use of vasoactive amines [33].

Corticosteroids were used in 65.1% of patients. Afriyie-Mensah and Gutiérrez reported a percentage of corticosteroid use of 72.7% and 48.6%, respectively. The inflammation described in COVID-19 motivated the use of corticosteroids and was proposed by the WHO in severe patients [34] [35].

Death occurred in 55.8% of our patients. The percentage of deaths was 63.3% for Gupta [12], 46.4% for Hirsch [23], 50% for Chan [13] and Arrocha [11], respectively. However, it was high (90.3%) in Ibrahim [14] and low (21%) in Rubin [15]. There was a high mortality rate.

Hirsch and *et al.* [23] found that there was a statistically significant difference between age, male gender, race, Latino ethnicity, type of insurance, comorbidities (hypertension, diabetes), treatments used (antihypertensives, mechanical ventilation, inotropes, vasoactive amines), duration of hospitalization and KDIGO stage in univariate analysis. We did not find the same results, probably because of methodological limitations and missing data.

In our work, age over 60 years was associated with the risk of death in univariate analysis but not confirmed in multivariate analysis, probably due to the small number of our study population. Kolhe also found that age over 65 [36] was associated with a high risk of death. On the other hand, in his study, heart failure, respiratory failure and history of cancer were risk factors for death in patients with AKI during COVID-19. High age is known as a factor fragility and poor prognosis of COVID-19 [17].

Cheng found that elevated proteinuria and hematuria were factors associated with the risk of death in COVID-19 patients with AKI [1]. In Spain, systemic inflammatory response syndrome (OR = 2.4) and the occurrence of acute respiratory distress syndrome (OR = 2.8) were associated with the occurrence of death in COVID-19 patients with AKI [16].

In a study in Spain, artificial ventilation (OR = 5.9) and corticosteroid therapy (OR = 1.7) were associated with the onset of death in COVID-19 patients with AKI [16]. This was a study of 794 COVID-19 patients with AKI. We also found

that invasive ventilation was associated with a high risk of death. Invasive ventilation has been identified as a death factor in COVID-19 patients [37]. Casas-Aparicio [38] in Mexico differed by KDIGO stage in symptoms such as rhinorrhea ($p < 0.02$), cough ($p < 0.02$), obesity ($p = 0.04$), mechanical ventilation ($p = 0.01$) and albuminemia ($p = 0.02$). Mortality was more common in KDIGO 3 (79.3%) and KDIGO 2 (68.7%) patients compared to KDIGO 1 (25%) with $p = 0.004$. Alfano in Italy [39] found no association between the KDIGO stage and the risk of death. In contrast, Xiao [40] in China found that the KDIGO stage was associated with the risk of dying with more deaths in stages 2 and 3 (64.3% of deaths versus 7.3% of deaths in stage 1). Blood [41] in China as well, in an ICU study, found that stage 3 was associated with the risk of death in patients with ARF during Covid (OR = 5.33 CI = 1.15 - 24.65, $p < 0.01$). The difference between our results and those of the literature could be explained by the lack of diuresis in our study and the small study population. It is accepted that KDIGO stage 3 is a factor of death during insufficiencies. It is recognized that stage KDIGO 3 is a factor of death during acute renal failure, regardless of cause [8].

5. Limitations of the Study

The absence of some information in patient records related to the retrospective nature of our study influenced our comments.

Our work took place in a private institution not specialized in nephrology. Creatinine was not always dosed at intake. In addition, the diuresis data were missing. The diagnosis of COVID-19 infection was based on imaging or positive IgM serology or positive PCR. The diagnosis of kidney injury was based on evolutionary arguments. No renal biopsy was performed.

The conclusions of our study are therefore difficult to generalize, because they are based on a single center and on a small number of cases.

6. Conclusions

Mortality is high in COVID-19 patients with acute kidney injury. The factors associated with this are the advanced age of fragile patients and the severity of clinical signs justifying invasive ventilation. This raises the problem of systematic screening of patients in order to initiate early management, before the onset of respiratory distress.

What is already known on this topic: The coronavirus is responsible of kidney failure.

What this study adds: Prognosis and factor associated to death in Cote d'Ivoire.

Acknowledgements

Our thanks to the director of the Farah Polyclinic in Abidjan.

Contribution of the Authors

Dolaama Badomta collected data, performed data analysis and wrote the manu-

script.

Konan Serge Didier and Diopoh Sery Patrick brought relevant criticism for the drafting of the research protocol, corrected the manuscript.

Moudachirou Mohamed Alex drafted the research protocol and participated in the data collection.

Tona Komlan Georges was involved in the data capture and editing of the descriptive analysis.

Amekoudi Eyram Yoan Makafui and Tsevi Mawufemo Claude reread the manuscript in order to bring relevant criticism concerning the method, the bibliographic review.

Yao Kouamé Hubert was involved in drafting the protocol, writing the results, correcting the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Ethical Considerations

The authorizations of the medical director of the Farah Polyclinic and the head of the Nephrology-Dialysis unit at the Farah Polyclinic have been taken. Patient anonymity was respected.

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