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Outcome of Hospitalized Pneumonia Patients with and without COVID-19: A Retrospective Cohort Study

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Abstract

COVID-19 pneumonia and community-acquired pneumonia (CAP) have been associated with morbidity and mortality. The aim of this study was to evaluate the outcome of hospitalized patients with COVID-19 pneumonia versus CAP in terms of mortality. This was a retrospective cohort study conducted between pre-COVID-19 era (May 2019–November 2019) and COVID-19 era (May 2020–November 2020). The study included all adult patients with COVID-19 pneumonia (Group 1) and adult patients with CAP but are COVID-19 negative (Group 2). A total of 106 patients were included in the study, of which 56 were in the COVID-19 pneumonia group and 50 in the CAP group. Patients who developed acute kidney injury (AKI) were 60.7% (n = 34) in Group 1 and 48% (n = 24) in Group 2. Mortality occurred in 37.5% (n = 21) patients in Group 1 and 12.0% (n = 6) in Group 2 (P = 0.003). A total of 52 patients required admission to intensive care unit (ICU), of which 44.6% (n = 25) were in Group 1 and 54.0% (n = 27) in Group 2. Of the 58 patients who developed AKI, 3 (8.8%) patients in Group 1 passed away compared to none in Group 2. Moreover, 58.8% patients (n = 20) in Group 1 and 70.8% patients (n = 17) in Group 2 required ICU admission. Mortality rate in the ICU was 80.0% (n = 16) and 35.3% (n = 6) in Groups 1 and 2, respectively (P = 0.006). The overall mortality rate was higher in case of COVID-19 patients than those with CAP. In case of patients with AKI, mortality rate in the ICU was significantly higher in COVID-19 pneumonia patients compared to CAP patients.

Keywords: acute kidney injury; COVID-19; mortality; pneumonia

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Introduction

Novel coronavirus disease (COVID-19) is a newly discovered contagious disease caused by severe acute respiratory syndrome (SARS)-coronavirus (CoV)-2 with clinical manifestations ranging from asymptomatic presentation to pneumonia, acute respiratory distress syndrome, and respiratory failure. Moreover, it can affect multiple organs such as the kidney, heart, digestive tract, blood, and nervous system (1). The disease has resulted in number of hospitalizations and intensive care unit (ICU) admissions (2). Morbidity and mortality from COVID-19 have been mainly attributed to respiratory failure and acute respiratory distress syndrome, often in the setting of multiorgan failure. The case fatality rate varies by country, ranging between 0.8% and 14.2% (3).

Community-acquired pneumonia (CAP) is also a common cause of hospital admission. It is associated with significant morbidity and mortality (4, 5). The overall 30-day mortality ranges between 6% and 15% in hospitalized patients (5–7).

Moreover, acute kidney injury (AKI) was reported to occur in approximately 22% of hospitalizations (8). It often occurs as a complication of CAP, and is present in a significantly high proportion of ICU patients (25%) (9, 10). Furthermore, the kidney may serve as a target for organ injury in COVID-19 because angiotensin-converting enzyme 2, the binding site for SARS-CoV-2, is highly expressed in proximal tubule cells (11, 12). Postmortem biopsy series have demonstrated marked renal tubular injury (13). The incidence of AKI among COVID-19 patients was reported to be as high as 36%, and in-hospital mortality of 35–54% in AKI patients (14, 15).

Here, the primary aim of this study was to evaluate in terms of mortality the outcome of patients with COVID-19 pneumonia versus CAP who were admitted to our institute. The secondary aim was to assess the effect of AKI as a contributing factor for ICU admission and mortality in these patients.

Materials and Methods

This was a retrospective cohort study conducted at Makassed General Hospital (MGH), Beirut, Lebanon, between pre-COVID-19 era (May 2019–November 2019) and COVID-19 era (May 2020–November 2020). MGH is a 200-bed university hospital with an occupancy rate of 70–80%. The study included all adult patients with COVID-19 pneumonia (Group 1) and with CAP but were COVID-19 negative (Group 2) during the study period. Exclusion criteria were patients with infections other than pneumonia and patients on chronic hemodialysis.

Following the approval of the Institutional Review Board, the following data were collected from patients' medical records: age, gender, comorbidities (cardiovascular disease, respiratory disease, diabetes mellitus, acute renal failure, chronic kidney disease, and malignancy), ICU or floor admission, clinical stability of the patient, whether on vasopressors or not, and mortality. The severity of underlying disease was assessed with sequential organ failure assessment (SOFA) score.

Statistical analysis

The Statistical Package for Social Sciences (SPSS, version 24) was used for data analysis. Bivariate analysis was carried out using the Chi-square test or Fisher's exact test (as appropriate) for comparing categorical variables. Categorical variables were presented as number and percentage. Continuous variables were compared using the Student's *t*-test. These variables were presented as mean values and standard deviation. $P < 0.05$ indicated statistical significance.

Results

A total of 106 patients were included in the study, of which 56 were in the COVID-19 pneumonia group (Group 1) and 50 in the CAP group (Group 2). The mean age of the patients in Group 1 was 72.66 ± 7.99 years, and 73.60 ± 9.67 years for those who were in Group 2. In Group 1, 64.3% (n = 36) were males and 35.7% (n = 20) were females whereas in Group 2, 56% (n = 28) were males and 44% (n = 22) were females. Around 35% of the patients in Group 1 were smokers compared to 52.0% in Group 2. The most common COVID-19 stage for those in Group 1 was the severe stage (50.0% [n = 28]), followed by moderate stage (39.3% [n = 22]), and mild stage (10.7% [n = 6]) (Table 1).

Table 1: Patients' demographics.

Demographics		Group 1 (COVID-19 pneumonia) (n = 56)	Group 2 (CAP) (n = 50)	P-value
Age	Years	72.66 ± 7.99	73.60 ± 9.67	0.59
Gender	Male	36 (64.3%)	28 (56.0%)	0.38
	Female	20 (35.7%)	22 (44.0%)	
COVID-19 stage	Mild	6 (10.7%)	-	-
	Moderate	22 (39.3%)	-	
	Severe	28 (50.0%)	-	
Smoking		20 (35.7%)	26 (52.0%)	0.09

CAP: community-acquired pneumonia

The most common morbidity was hypertension with 73.2% (n = 41) patients in Group 1 and 76% (n = 38) in Group 2. Other comorbidities varied; for instance, patients having diabetes mellitus were 42.9% (n = 24) in Group 1 and 48% (n = 24) in Group 2. Around 33% of the patients in Group 1 had chronic obstructive pulmonary disease (COPD) compared to 44% in Group 2. The percentage of those who had heart failure in Group 2 (62.0% [n = 31]) was higher than those who had heart failure in Group 1 (21.4% [n = 12]) (P < 0.0001). The least comorbidity percentage was observed in cerebrovascular events with 3.6% (n = 2) and 18.0% (n = 9) for Groups 1 and 2, respectively (P = 0.02). Patients who had chronic kidney disease (CKD) were 17.9% (n = 10) in Group 1 and 10% (n = 5) in Group 2, with both mainly having stage 3B: 80.0% (n = 8) and 60.0% (n = 3) in Groups 1 and 2, respectively (Table 2).

Concerning patients' complications, none of the patients in Group 2 suffered from acute respiratory distress syndrome (ARDS), while 23.2% (n=13) of the patients in group 1 developed ARDS (P < 0.0001). The rate of bacterial infection was significantly higher in Group 2, since all patients had bacterial infection compared to 62.5% (n = 35) of the patients in Group 1 (P < 0.0001). The least type of complication was thromboembolic events with 8.9% (n = 5) and 6.0% (n = 3) in Groups 1 and 2, respectively. Proportion of patients who developed AKI in the disease process was 60.7% (n = 34) and 48.0% (n = 24) for Groups 1 and 2, respectively. The mean glomerular filtration rate (GFR) of the patients who developed AKI on day 1–7 was 26.81 ± 14.85 mL/min for Group 1 and 22.25 ± 11.73 mL/min for Group 2, and for those who developed AKI on days 8–15, the mean GFR for Group 1 was 29.43 ± 19.78 mL/min and 30.25 ± 12.34 mL/min for Group 2. The mean GFR at the time of discharge for Group 1 was 55.64 ± 15.69 mL/min and 50.47 ± 12.17 mL/min for Group 2. Proportion of those who had recovered kidney function was 41.2% (n = 14) in Group 1 and 45.8% (n = 11) in Group 2. A total of 23.2% (n = 13) in the first group and 16.0% (n = 8) in the second group required dialysis (Table 3).

All 56 patients in Group 1 had steroids in their treatment plan whereas only 24 (48.0%) in Group 2 were prescribed steroids (P < 0.0001). None of Group 2 patients were prescribed antiviral drugs but 35.7% (n = 20) of those in Group 1 required antiviral medications (P < 0.0001). The use of convalescent plasma was higher in Group 1 with 14.3% (n = 8) compared to none in Group 2 (P = 0.006). The use of nephrotoxic drugs was higher in Group 1 (19.6%) compared to Group 2 (4.0%) (P = 0.01) (Table 4).

Some of the patients who were admitted to the hospital required ICU admission or a long hospital stay whereas others passed away. A total of 52 patients required ICU admission, of which 44.6% (n = 25) were in Group 1 and 54.0% (n = 27) were in Group 2. The mean length of hospital stay for Group 1 patients was 14.86 ± 15.65 days and for those in Group 2 was 17.38 ± 14.66 days. Mortality rate was

Table 2: Patients' clinical characteristics.

Comorbidities	Group 1 (COVID-19 pneumonia) (n = 56)	Group 2 (CAP) (n = 50)	P-value
COPD	19 (33.9%)	22 (44.0%)	0.29
Hypertension	41 (73.2%)	38 (76.0%)	0.74
Diabetes	24 (42.9%)	24 (48.0%)	0.60
Coronary artery disease	20 (35.7%)	23 (46.0%)	0.28
Cerebrovascular accident	2 (3.6%)	9 (18.0%)	0.02
Heart failure	12 (21.4%)	31 (62.0%)	<0.0001
Malignancy	5 (8.9%)	6 (12.0%)	0.61
Chronic kidney disease (CKD)	10 (17.9%)	5 (10.0%)	0.25
CKD stage 1	1 (10.0%)	2 (40.0%)	0.34
CKD stage 3A	1 (10.0%)	0 (0.0%)	
CKD stage 3B	8 (80.0%)	3 (60.0%)	
SOFA score (mean ± SD)	4.59 ± 3.11	4.12 ± 3.31	0.45

COPD: chronic obstructive pulmonary disease; CAP: community-acquired pneumonia; SOFA: sequential organ failure assessment.

Table 3: Patients' complications.

Complications	Group 1 (COVID-19 pneumonia) (n = 56)	Group 2 (CAP) (n = 50)	P-value
ARDS	13 (23.2%)	0 (0.0%)	<0.0001
Bacterial infection	35 (62.5%)	50 (100.0%)	<0.0001
Septic shock	19 (33.9%)	15 (30.0%)	0.67
Thromboembolic events	5 (8.9%)	3 (6.0%)	0.72
Acute kidney injury (AKI)	34 (60.7%)	24 (48.0%)	0.19
GFR on day 1–7	26.81 ± 14.85	22.25 ± 11.73	0.26
GFR on day 8–14	29.43 ± 19.78	30.25 ± 12.34	0.94
GFR at discharge	55.64 ± 15.69	50.47 ± 12.17	0.33
Recovered kidney function	14 (41.2%)	11 (45.8%)	0.72
Dialysis	13 (23.2%)	8 (16.0%)	0.35

CAP: community-acquired pneumonia; ARDS: acute respiratory distress syndrome; GFR: glomerular filtration rate.

Table 4: Patients' treatment.

Treatment	Group 1 (COVID-19 pneumonia) (n = 56)	Group 2 (CAP) (n = 50)	P-value
Steroids	56 (100.0%)	24 (48.0%)	<0.0001
Antiviral drugs	20 (35.7%)	0 (0.0%)	<0.0001
Antibiotics	35 (62.5%)	50 (100.0%)	<0.0001
Anticoagulation	39 (69.6%)	9 (18.0%)	<0.0001
Convalescent plasma	8 (14.3%)	0 (0.0%)	0.006
Nephrotoxic drugs	11 (19.6%)	2 (4.0%)	0.01

CAP: community-acquired pneumonia.

significantly higher in Group 1 compared to Group 2 (37.5% [n = 21] vs. 12% [n = 6], respectively, P = 0.003) (Table 5).

Regarding AKI and mortality, of the 58 patients who developed AKI, 3 (8.8%) in Group 1 passed away compared to none of the patients in Group 2. Moreover, 58.8% (n = 20) in Group 1 and 70.8% (n = 17) in Group 2 required ICU admission. Of the patients admitted to ICU having AKI, 55% (n = 11) required dialysis in Group 1 and 41.2% (n = 7) required dialysis in Group 2. Mortality rates in the ICU were 80.0% (n = 16) and 35.3% (n = 6) in Groups 1 and 2, respectively (P = 0.006) (Table 6).

Discussion

The major result of this study was that the overall mortality rate was significantly higher in COVID-19 pneumonia patients (37.5% [n = 21]) than those with CAP (12% [n = 6]). In addition, for the patients with AKI, mortality rate in the ICU was significantly higher in COVID-19 pneumonia patients (80.0% [n = 16]) compared to CAP patients (35.3% [n = 6]).

SARS-CoV-2 infection is associated with respiratory tract illness that could lead to pneumonia and may progress to grievous acute respiratory distress syndrome (16). COVID-19 pneumonia presents symptoms similar to that of CAP (16). Both COVID-19 and CAP cause significant morbidity. They have demonstrated high rates of hospital admissions, ICU requirement as well as mortality (2, 17–19).

In the present study, the mean age of patients in the two groups was around 73 years. Comorbidities were present in most of the patients, with hypertension being the most common one, followed by diabetes and coronary heart

Table 5: Patients' outcome.

Outcome	Group 1 (COVID-19 pneumonia) (n = 56)	Group 2 (CAP) (n = 50)	P-value
ICU admission	25 (44.6%)	27 (54.0%)	0.34
Length of hospital stay (days)	14.86 ± 15.65	17.38 ± 14.66	0.40
Mortality	21 (37.5%)	6 (12.0%)	0.003

CAP: community-acquired pneumonia.

Table 6: Patients with acute kidney injury and rates of mortality and ICU admission.

Outcome	Group 1 (COVID-19 pneumonia) (n = 34)	Group 2 (CAP) (n = 24)	P-value
Mortality	3 (8.8%)	0 (0.0%)	0.26
No ICU admission	11 (32.4%)	7 (29.2%)	0.80
ICU admission	20 (58.8%)	17 (70.8%)	0.35
Dialysis	11 (55.0%)	7 (41.2%)	0.40
Mortality in ICU	16 (80.0%)	6 (35.3%)	0.006

CAP: community-acquired pneumonia.

disease. These results were similar to those reported by Zhou et al. (2), who examined the clinical course of hospitalized patients with COVID-19, and to Tian et al. (16), who compared the clinical characteristics of patients having COVID-19 and CAP. Several studies reported that age and presence of comorbidities were risk factors for mortality in patients with COVID-19 and CAP (1, 18, 19).

Furthermore, acute heart failure was reported to be a possible consequence of COVID-19, associated with a high incidence in mortality (20). Tomasoni et al. found that around 33% of patients with previous heart failure had an acute heart failure decompensation during COVID-19 hospitalization (21). However, acute heart failure not only develops as a decompensation of chronic heart failure but it can also occur as a new-onset heart failure (22).

As for cerebrovascular disease, approximately one-third of stroke patients suffer from pneumonia (23). Some studies have established an association between a history of cerebrovascular disease and increased severity and mortality of COVID-19 (24, 25). In addition, studies established that acute cerebrovascular disease could result from COVID-19 (26, 27). Nannoni et al. reported in their systematic review and meta-analysis that 1.4% of COVID-19 patients suffered from acute cerebrovascular disease (28).

Regarding complications, AKI was one of the most observed complications in this study (60.7% in COVID-19 Group 1 vs. 48.0% in CAP Group 2). AKI frequently occurs among COVID-19 patients (14, 29, 30). The incidence of AKI in COVID-19 patients ranges between 3% and 39%, which is lower than the rate encountered in this study (2, 8, 14, 15, 29, 30). The difference could be explained by variations in disease severity and the binding to angiotensin converting enzyme by the virus. Angiotensin is expressed in several tissues of the body, including the kidneys. It is also related to the damage of the podocytes by macrophage activation and cytokine storm, resulting in micro-coagulation and angiopathy (30). On the other hand, the incidence of AKI in patients with CAP was reported as 34% (31). In our study, AKI occurred in almost half of the patients with CAP. Murugan et al. explained that the context of AKI in pneumonia is related to the baseline characteristics of patients' higher concentrations of inflammatory, coagulation, and fibrinolysis markers (31).

Moreover, our study demonstrated that there was no statistically significant difference in the rate of ICU admission between COVID-19 pneumonia and CAP patients (44.6% and 54%, respectively). In their meta-analysis, Abate et al. reported that the rate of ICU admission for COVID-19 patients was 32% (32). Similarly, the rate of ICU admission for CAP patients was 33% (33). Tian et al. concluded that there were more frequent ICU admissions in patients with COVID-19 pneumonia compared to CAP patients (36% and 15%, respectively) (16). On the other hand, the overall mortality rates in our study were significantly higher in

COVID-19 pneumonia patients compared to CAP patients (37.5% vs. 12%). In-hospital and 30-day mortality for CAP patients ranged between 4% and 18% (19), while that for COVID-19 it was between 0.8% and 14.2% (3). Tian et al. reported that 30-day mortality was more than double in patients with COVID-19 pneumonia than in CAP patients (12% vs. 5%) (16). This could be attributed to the higher rate of ARDS in patients with COVID-19-associated pneumonia (16), since pathology and autopsy studies concluded that the main pathological findings of COVID-19 pneumonia are hyaline membrane formation and diffused alveolar disease, which are the pathological basis of ARDS and mortality (34, 35).

Concerning AKI and its association with mortality, 3 (8.8%) COVID-19 patients who developed AKI died compared to none of the CAP patients. Other studies reported higher rates of mortality among COVID-19 patients with AKI. For instance, Hirsch et al. (14) encountered 35% mortality rate, while Raina et al. (15) demonstrated a mortality rate of 54%. On the other hand, Akram et al. reported that 30-day mortality among patients with CAP was 8.7% (36). Furthermore, in the present study, 58.8% (n = 20) of COVID-19 patients with AKI and 70.8% (n = 17) of CAP patients with AKI required ICU admission. From those who were admitted to ICU having AKI, mortality rates in the ICU were 80.0% (n = 16) and 35.3% (n = 6) for COVID-19 and CAP patients, respectively. Hirsch et al. (14) reported a similar rate of ICU admission among COVID-19 patients with AKI (53.2%) whereas Chen et al. (9) found that around 43% of CAP patients with AKI required ICU admission. Mohamed et al. concluded that mortality rate among COVID-19 patients with AKI admitted to ICU was 50% (37).

Although this study established a real-life experience of a country with limited resources, yet it had a limitation of being a single-center retrospective study. Multicenter prospective studies are required to distinguish COVID-19-associated pneumonia from CAP.

Conclusion

In conclusion, COVID-19 and CAP are associated with several comorbidities and complications. AKI and ICU admission are common among patients with COVID-19 pneumonia. The overall mortality rates were higher in COVID-19 patients than those with CAP. In addition, for patients with AKI, mortality rate in ICU was significantly higher in COVID-19 pneumonia patients compared to CAP patients.

Conflict of interest

None.

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