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Article

A Comparative Analysis of Ventilator Mechanics and Outcomes in COVID-19 vs. Non-COVID ARDS Patients in the Emergency Department: A Cohort Study

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Abstract: Background & Aim: Mechanical ventilatory support is frequently required in patients with acute respiratory distress syndrome (ARDS). However, early differences in ventilatory mechanics and severity scoring between COVID-19 and Non-COVID ARDS remain uncertain. This study aimed to compare respiratory parameters and clinical scores in COVID-19 and Non-COVID ARDS patients managed in the emergency department (ED) and to evaluate their association with in-hospital mortality. **Methods:** This prospective cohort study included adult patients diagnosed with ARDS (PaO₂/FiO₂ <300 mmHg) who received mechanical ventilatory support in the ED. Initial respiratory parameters and clinical severity scores (SOFA, APACHE II, PSI) were recorded within the first 30 minutes. Patients were categorized into COVID-19 and Non-COVID groups, and outcomes were compared between survivors and non-survivors. **Results:** A total of 70 patients were included: 32 (45.7%) in the COVID-19 group and 38 (54.3%) in the Non-COVID group. Plateau pressure was significantly higher in the COVID-19 group (30.0 vs. 21.0 cmH₂O, p = 0.01), while static compliance was lower without statistical significance. No ventilatory parameter predicted mortality. Among clinical scores, SOFA was significantly higher in both COVID-19 patients and non-survivors. Additionally, APACHE II score was significantly higher in non-survivors within the COVID-19 group, suggesting its potential prognostic value. PSI did not show a significant difference. **Conclusion:** While COVID-19 patients had higher plateau pressures than Non-COVID patients, early respiratory mechanics were not associated with mortality. SOFA scores differed between groups without a significant association with outcome. Notably, APACHE II was the only scoring system that significantly predicted mortality within the COVID-19 group, suggesting its potential usefulness in early risk assessment.

Keywords: acute respiratory distress syndrome; COVID-19; respiratory mechanics; mechanical ventilation; emergency service; hospital; severity of illness index

1. Introduction

Mechanical ventilation (MV) is a cornerstone of supportive care in patients with acute respiratory failure and acute respiratory distress syndrome (ARDS) [1]. The COVID-19 pandemic has significantly increased the demand for MV, with a substantial proportion of patients progressing to severe hypoxemia and requiring invasive support [2]. While COVID-19-associated ARDS shares some clinical features with classical ARDS, accumulating evidence suggests that it may represent a distinct phenotype with different respiratory mechanics. These differences include preserved lung

compliance despite severe hypoxemia, altered plateau pressures, and unique responses to positive end-expiratory pressure (PEEP). These variations have raised important questions about the applicability of standard ARDS ventilatory strategies to COVID-19 patients [3]. Recent physiologic investigations, such as the matched-cohort study by Grieco et al., have demonstrated that although COVID-19 patients may present with slightly higher compliance and ventilatory ratio, the overall mechanical behavior and recruitability remain largely comparable to ARDS from other causes, especially in early phases of mechanical ventilation [4].

In the emergency department (ED), where many patients receive initial ventilatory support, understanding the physiological differences between COVID-19 and non-COVID-19 ARDS is crucial for guiding early ventilator settings and improving outcomes. However, most comparative studies on ventilatory mechanics have been conducted in ICU populations, with limited data from the ED setting [5]. Moreover, the impact of ventilator parameters—such as tidal volume, driving pressure, and compliance—on clinical outcomes, particularly mortality, remains understudied in COVID-19 versus non-COVID-19 patients during the initial resuscitation phase.

This study aims to compare the mechanical ventilation profiles and associated mortality of COVID-19-positive and -negative patients who required invasive ventilation in the emergency department, thereby contributing real-world evidence to inform early ventilatory management in acute care.

2. Materials and Methods

2.1. Study Design and Setting

This prospective cohort study was conducted between March 1, 2022, and March 1, 2023, in the emergency department (ED) and the affiliated pandemic intensive care unit (ICU) of a tertiary academic hospital. The ICU was structurally and administratively affiliated with the emergency department and primarily managed by emergency medicine specialists to ensure consistent ventilatory management. Patients who met inclusion criteria were followed throughout their hospital stay, and the primary outcome was defined as 30-day in-hospital mortality. Ethical approval was obtained from the local Non-Interventional Clinical Research Ethics Committee (Approval No: 2022/02-08, Date: 09.02.2022).

2.2. Patient Selection

Adult patients (≥ 18 years) who received mechanical ventilatory support in the emergency department with a preliminary diagnosis of COVID-19-associated acute respiratory distress syndrome (ARDS) were eligible for inclusion. ARDS was defined according to the Berlin criteria as a $\text{PaO}_2/\text{FiO}_2$ (P/F) ratio below 300 mmHg at the time of respiratory support initiation. Patients were subsequently followed in the emergency department and its affiliated pandemic intensive care unit (ICU). Patients with no international travel history, no known exposure, and two consecutive negative PCR tests on alternate days were classified as the non-COVID group (Figure 1).

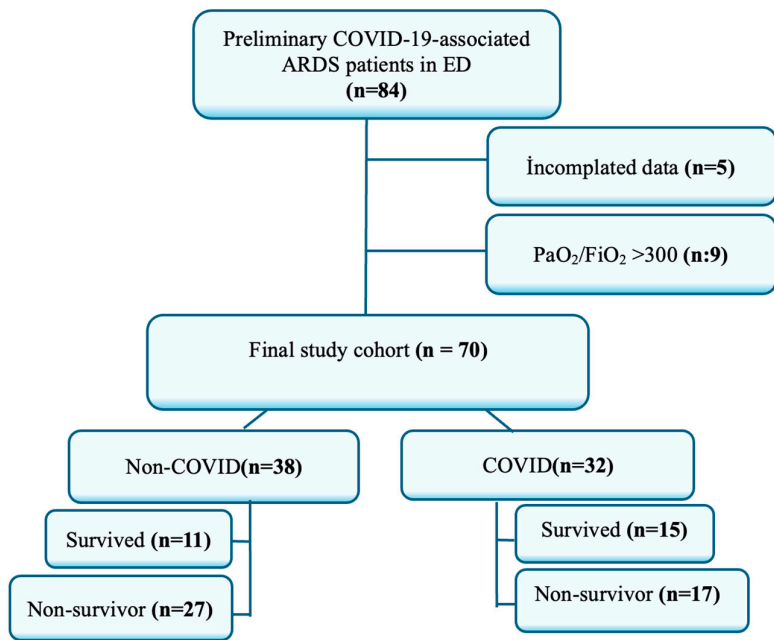


Figure 1. Flow Chart of Participant.

2.3. Data Collection

Patient data were collected, reviewed, and verified by an emergency medicine specialist. These included baseline demographic characteristics (age, sex, and comorbidities) as well as clinical severity scores: Sequential Organ Failure Assessment (SOFA), Acute Physiology and Chronic Health Evaluation II (APACHE II), and Pneumonia Severity Index (PSI). Ventilator parameters were recorded within the first 30 minutes of mechanical ventilatory support. These included static compliance (Crs), elastance, airway resistance, driving pressure (ΔP_{rs}), PaO₂/FiO₂ ratio, peak inspiratory pressure (Ppeak), plateau pressure (Pplat), tidal volume (TV), and positive end-expiratory pressure (PEEP). All data were obtained using the Biyovent R ventilator (PN: 6515-7315-0003, Aselsan, production date: 08/2020).

2.4. Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test. Continuous variables were expressed as medians with interquartile ranges (IQR) or means with standard deviations (SD), depending on data distribution. Categorical variables were reported as frequencies and percentages. Comparisons between the COVID and Non-COVID groups were performed using the Mann–Whitney U test for non-normally distributed continuous variables and the Student’s t-test for normally distributed ones. Categorical variables were compared using the chi-square test. A p-value of <0.05 was considered statistically significant.

3. Results

3.1. Patient Demographics and Comorbidities

Baseline demographic characteristics and comorbidities did not differ significantly between the COVID-19 and Non-COVID groups. The median age was 77.5 years (IQR: 61.3–86.0) in the COVID-19 group and 74.5 years (IQR: 66.5–82.5) in the Non-COVID group (p = 0.65). The proportion of male patients was similar (59.4% vs. 57.9%, p = 0.90). Although most comorbidities were evenly

distributed, congestive heart failure was more common in the Non-COVID group, with a borderline significance (63.2% vs. 40.6%, $p = 0.06$; Table 1).

Table 1. Baseline Characteristics of Study Groups.

Demographic Characteristics and Comorbidities	Non-COVID (n=38)	COVID-19 (n=32)	p-value
Age (Median, IQR 25-75)	74.5 (66.5–82.5)	77.5 (61.3–86.0)	0.65
Male Gender n, (%)	22 (57.9%)	19 (59.4%)	0.90
CHF n, (%)	24 (63.2%)	13 (40.6%)	0.06
MAP (mmHg)	81.7(69.3-93.2)	73.3(63.3-97.5)	0.77
CKD/AKI n, (%)	11 (28.9%)	8 (25.0%)	0.71
CVD n, (%)	7 (18.4%)	3 (9.7%)	0.61
DM n, (%)	19 (50.0%)	15 (46.9%)	0.79
CAD n, (%)	14 (36.8%)	9 (28.1%)	0.43
COPD n, (%)	13 (34.2%)	17 (53.1%)	0.11
Neuropsychiatric Disorders n, (%)	5 (13.2%)	5 (15.7%)	1.00
Malignancy n, (%)	6 (15.8%)	3 (9.4%)	0.49

Chi-square test and Fisher’s exact test were used for statistical analysis. Abbreviations: CHF:Congestive Heart Failure; CKD: Chronic Kidney Disease; AKI:Acute Kidney Injury; CVD:Cerebrovascular Disease; DM:Diabetes Mellitu; CAD:Coronary Artery Disease; COPD: Chronic Obstructive Pulmonary Disease; MAP:Mean Arterial Pressure.

3.2. Laboratory Parameters

Laboratory parameters were largely comparable between the COVID-19 and Non-COVID groups. There were no statistically significant differences in white blood cell count, hemoglobin, creatinine, or C-reactive protein (CRP) levels. Platelet count was higher in the COVID-19 group, showing a borderline trend toward significance ($219 \times 10^3/\mu\text{L}$ vs. $186 \times 10^3/\mu\text{L}$, $p = 0.06$; Table 2).

Table 2. Comparison of Laboratory Parameters by Group.

Parameter	Non-COVID (Median, IQR 25–75)	COVID-19 (Median, IQR 25–75)	p-value
WBC ($\times 10^3/\mu\text{L}$)	11.2 (8.15–17.8)	12.0 (8.22–18.5)	0.39
Hemoglobin (Hgb, g/dL)	12.7 (11.0–14.1)	13.3 (10.0–14.1)	0.86
Hematocrit (Hct, %)	39.2 (34.4–43.9)	38.2 (31.9–44.1)	0.49
Platelet Count (Plt, $\times 10^3/\mu\text{L}$)	186 (155–265)	219 (193–321)	0.06
Urea (mg/dL)	82.0 (42.3–114)	62.0 (44.3–102)	0.63
BUN (mg/dL)	38.5 (18.8–52.8)	38.0 (18.8–57.0)	0.86
Creatinine (mg/dL)	1.33 (0.95–1.53)	1.25 (0.98–1.71)	0.68
Sodium (mmol/L)	139 (137–142)	139 (136–143)	0.99
Potassium (mmol/L)	4.55 (3.92–5.07)	4.30 (3.88–4.90)	0.55
Glucose (mg/dL)	161 (123–221)	150 (119–232)	0.80
AST (IU/L)	27.5 (18.0–67.3)	35.0 (20.0–81.3)	0.42
ALT (IU/L)	21.5 (15.3–38.3)	23.0 (17.8–44.5)	0.36
CRP (mg/dL)	70.5 (17.3–148)	106 (39.8–176)	0.36

Abbreviations: WBC: White blood cell count; Plt: Platelet count; Hgb: Hemoglobin level; Hct: Hematocrit level; BUN: Blood Urea Nitrogen; AST: Aspartate Transaminase; ALT: Alanine Transaminase; CRP: C-reactive Protein.

3.3. Mechanical Ventilator Parameters and Mortality

Among the ventilatory parameters, plateau pressure was significantly higher in the COVID-19 group compared to the Non-COVID group (30.0 vs. 21.0 cm H₂O, $p = 0.01$). Static compliance was lower in the COVID-19 group, but the difference was not statistically significant ($p = 0.16$). Other

parameters—including driving pressure, elastance, resistance, tidal volume, and PEEP—showed no significant differences between the groups (Table 3).

Table 3. Comparison of Ventilator Parameters by Group.

Parameter	Non-COVID (Median, IQR 25–75)	COVID-19 (Median, IQR 25–75)	p-value
Compliance (Crs, mL/cm H ₂ O)	34.0 (26.75–46.50)	26.0 (17.8–39.0)	0.16
Elastance (cm H ₂ O/mL/kg)	28.5 (19.2–33.5)	37.0 (24.0–48.0)	0.18
Resistance (cm H ₂ O/L/s)	14.0 (11.5–16.5)	19.5 (12.7–29.5)	0.10
Tidal Volume (mL)	422.5 (401.5–435.0)	400 (400–450)	0.50
PEEP (cm H ₂ O)	5 (5–7)	6 (5–10)	0.10
Pmax (cm H ₂ O)	35 (30–35)	35 (30.5–37.0)	0.13
Pplat (cm H ₂ O)	21 (17–26.5)	30 (23.25–36.50)	0.01*
ΔPrs (cm H ₂ O)	13.50 (8.25–19.75)	18 (11.5–23.75)	0.30

PEEP: Positive End-Expiratory Pressure; Pmax: Maximum Pressure; Pplat: Plateau Pressure; ΔPrs: Driving Pressure.

Ventilator parameters were compared between survivors and non-survivors. Although non-survivors had lower static compliance (24.5 vs. 29.0 mL/cm H₂O), the difference was not statistically significant (p = 0.56). Other variables—including plateau pressure, driving pressure, PEEP, and tidal volume—also showed no significant association with mortality (Table 4).

Table 4. Comparison of Ventilator Parameters by Mortality Status.

Parameter	Survivors (Median, IQR 25–75)	Non-Survivors (Median, IQR 25–75)	p-value
Compliance (Crs, mL/cm H ₂ O)	29.0 (22.25–37.50)	24.5 (22.0–38.25)	0.56
Elastance (cm H ₂ O/mL/kg)	29.5 (22.75–39.5)	28.0 (24.0–31.5)	0.61
Resistance (cm H ₂ O/L/s)	15.0 (13.25–20.0)	16.0 (13.25–19.75)	0.80
Tidal Volume (mL)	410 (400–432.0)	422.50 (400–450)	0.58
PEEP (cm H ₂ O)	7.5 (5–8.5)	5 (5–7)	0.09
Pmax (cm H ₂ O)	35 (30–35.5)	35 (30–35)	0.60
Pplat (cm H ₂ O)	24 (19.75–31.25)	27 (19.25–30.75)	0.75
ΔPrs (cm H ₂ O)	20.50 (8.75–24.25)	18 (13.25–25.50)	0.97

PEEP: Positive End-Expiratory Pressure; Pmax: Maximum Pressure; Pplat: Plateau Pressure; ΔPrs: Driving Pressure.

3.4. Clinical Scoring Systems

Among clinical scoring systems, the SOFA score was significantly higher in the COVID-19 group compared to the Non-COVID group (3.5 vs. 3.0, p = 0.02). APACHE II and PSI scores did not show significant differences between groups. Mortality rates were 71.1% in the Non-COVID group and 53.1% in the COVID-19 group, but this difference was not statistically significant, indicating similar outcomes between the groups (p = 0.12; Table 5).

Table 5. Comparison of Clinical Scores and Outcomes by Group.

Parameter	Non-COVID	COVID-19	p-value
APACHE-2 (± SD)	25.3±7.20	27.4±8.75	0.27
PSI (IQR 25-75)	116 (96–144)	137.5 (93–147.2)	0.34
SOFA (IQR 25-75)	3 (3–3)	3.5 (3.0–4.0)	0.02
P/F ratio	136(105-166)	98.4(63.8-168)	0.02
Mortality	Survivors	11 (28.9%)	0.12
	Non-Survivors	27 (71.1%)	

APACHE-2: Acute Physiology and Chronic Health Evaluation-2 Score; SOFA: Sequential Organ Failure Assessment Score; PSI: Pneumonia Severity Index.; P/F: PaO₂/FiO₂.

In the COVID-19 group, non-survivors had significantly higher APACHE II scores compared to survivors (30.7 vs. 23.7, $p = 0.02$). PSI and SOFA scores were also higher in non-survivors, but these differences did not reach statistical significance. Similarly, the P/F ratio tended to be lower in non-survivors, without a significant difference (Table 6).

Table 6. Comparison of Clinical Scores by Mortality in COVID-19 Patients.

Parameter	Survivors (n:15)	Non-Survivors (n:17)	p-value
APACHE-2 ($\pm$ SD)	23.67 $\pm$ 8.60	30.71 $\pm$ 7.66	0.02
PSI (IQR 25-75)	119 (79.5-143)	142 (125-151)	0.11
SOFA (IQR 25-75)	3 (3-4)	4 (3-4)	0.88
P/F ratio IQR 25-75	102 (85.5-177)	81.4(57.4-165)	0.27

APACHE-2: Acute Physiology and Chronic Health Evaluation-2 Score; SOFA: Sequential Organ Failure Assessment Score; PSI: Pneumonia Severity Index.; P/F: PaO₂/FiO₂.

4. Discussion

Acute respiratory distress syndrome (ARDS) remains a major challenge in the management of critically ill patients, and the emergence of COVID-19 has added further complexity to its clinical presentation and ventilatory management. Although COVID-19-associated ARDS shares many features with classical ARDS, ongoing debate persists regarding whether it represents a distinct physiological entity requiring tailored ventilatory strategies [4]. In this context, our study aimed to explore the early respiratory mechanics and outcomes of patients with COVID-19 and non-COVID-19 ARDS in the emergency department setting. By focusing on real-world data from the initial phase of invasive ventilation, our findings offer insights into the practical similarities and potential differences between these patient populations.

Demographic characteristics and comorbidity profiles appeared largely comparable between COVID-19 and non-COVID-19 ARDS patients in our cohort. Similarly, Bain et al. reported comparable age but noted a higher BMI in COVID-19 cases [5]. In contrast, Brault et al. observed older age and more frequent obesity and diabetes among COVID-19 patients, while immunosuppression was more common in the non-COVID group [6]. Variability in these findings may be attributed to differences in regional populations and study periods.

Our study identified significantly higher plateau pressures and a trend toward lower static compliance in COVID-19-associated ARDS patients compared to non-COVID-19 patients, despite similar driving pressures. This observation is consistent with prior findings from Vandembunder et al., who reported reduced static compliance in moderate-to-severe COVID-19 ARDS but found no association between compliance and 28-day ventilator independence or survival [7]. Similarly, Azizi et al. demonstrated that COVID-19 patients were ventilated with higher mechanical power, but the relationship between mechanical power and mortality was not modified by COVID-19 status [8]. In contrast, Boscolo et al. found that both low static compliance (<48 mL/cmH₂O) and higher driving pressures were associated with increased ICU mortality in COVID-19 ARDS [9]. These varying findings may be due to differences in ventilation timing, disease phase, or setting (ICU vs. ED). Taken together, the observed mechanical disparities in our ED cohort suggest that while early respiratory mechanics may differ by etiology, their prognostic value remains uncertain, especially in the emergency care context.

The observed differences in respiratory mechanics, such as reduced compliance and elevated plateau pressures in COVID-19 ARDS, may be partly explained by the unique pathophysiologic features of the disease, including endothelial injury, diffuse alveolar damage, and microvascular thrombosis, as described by Ball et al. [10].

In our cohort, early ventilatory parameters like static compliance, plateau pressure, and driving pressure didn't significantly predict mortality. Similar findings were reported by Li Bassi et al., who found respiratory compliance within 48 hours of intubation wasn't predictive of ICU mortality but associated with earlier discharge [11]. Pan et al. observed poor lung recruitability in most COVID-19

ARDS patients despite elevated driving pressures and low compliance, suggesting standard mechanical indices may not reflect lung physiology or treatment response [12]. Rovas et al. further supported this dissociation by showing microvascular dysfunction and endothelial glycocalyx degradation, not gross ventilator mechanics, underlie clinical deterioration in critical illness [13]. These studies and our findings suggest early ventilator mechanics alone may have limited prognostic value for mortality, especially in heterogeneous ARDS populations, and emphasize the importance of integrating microcirculatory and systemic factors into outcome prediction.

Although our findings suggest that early ventilator parameters such as compliance, plateau pressure, and driving pressure were not predictive of mortality, literature reports on this association remain mixed. For example, Martínez et al. found no link between initial static compliance and 28-day mortality in COVID-19 ARDS, aligning with our results [14]. Similarly, Maamar et al. reported that despite physiological differences between COVID-19 and influenza-associated ARDS, mortality rates were comparable [15]. In contrast, Gutiérrez et al. identified elevated driving pressure and ventilatory ratio as predictors of mortality in COVID-19 patients, particularly beyond the early phase [16]. These varying outcomes reflect the heterogeneity of ARDS and emphasize the importance of contextualizing ventilatory parameters within broader clinical trajectories.

The relationship between respiratory system compliance and mortality in ARDS remains complex and incompletely defined across studies. Panwar et al., analyzing pre-COVID ARDS cohorts, reported that lower compliance was independently associated with increased mortality, though with no clear threshold [17]. Conversely, our study did not find early static compliance or other mechanical parameters to be predictive of mortality. This is consistent with findings by Li Bassi et al., who noted that baseline mechanical parameters, including PEEP and driving pressure, did not show consistent associations with 28-day mortality when examined alongside time-dependent clinical variables [18]. Adding further nuance, Puah et al. found that patients with initially high compliance who later experienced a marked decline were more likely to die, suggesting that dynamic changes, rather than isolated early values, may carry prognostic significance [19]. From a pathophysiological perspective, Mohanty et al. emphasized that microthrombi, endothelial injury, and diffuse alveolar damage seen in autopsies of COVID-19 patients might explain why mechanical indices alone fall short in predicting outcomes [20]. Together, these findings highlight that while ventilatory mechanics remain clinically relevant, their isolated early values may be insufficient for prognostication in ARDS, especially in the context of evolving lung pathology and systemic involvement.

In our study, the SOFA score was significantly higher in COVID-19 patients compared to Non-COVID patients, although no scoring system effectively differentiated survivors from non-survivors when all patients were considered together. This groupwise difference in SOFA aligns partially with previous findings by Citu et al., who demonstrated that higher SOFA scores were significantly associated with mortality in COVID-19 patients [21]. While PSI did not significantly vary between outcome groups in our cohort, a study by Chen et al. suggested that both PSI and APACHE II could predict mortality in COVID-19 pneumonia [22]. Supporting our subgroup analysis, Mehryar et al. reported that APACHE II scores were significantly higher in deceased COVID-19 patients, highlighting its potential role as a prognostic tool in this population [23]. Together, these findings suggest that among commonly used clinical scores, APACHE II may offer better prognostic value in COVID-19-related ARDS, particularly during early emergency department management.

Several studies have investigated the prognostic value of severity scoring systems in COVID-19-related critical illness. In our cohort, APACHE II scores were significantly higher in non-survivors within the COVID-19 group, supporting the findings of Onuk et al., who also reported a trend toward higher APACHE II values in deceased patients, although not statistically significant in their sample [24]. Mohammad et al. found that both APACHE II and SOFA scores were significantly elevated in non-survivors, with SOFA showing a stronger discriminatory performance [25]. Similarly, Yang et al. demonstrated that a SOFA score ≥ 5 was highly predictive of mortality, with an AUC of 0.995, suggesting strong prognostic accuracy in severe COVID-19 [26]. In contrast, our findings highlight

that while SOFA scores were higher in COVID-19 patients compared to Non-COVID patients, only APACHE II was able to distinguish survivors from non-survivors within the COVID-19 group, suggesting that its utility may be more pronounced in early emergency department settings where rapid risk stratification is critical.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, it was conducted at a single academic center, which may limit the generalizability of the results to other settings with different patient populations and resource availability. Second, ventilator parameters and clinical scores were recorded at a single time point—within the first 30 minutes of mechanical ventilation—during the emergency department phase, potentially missing dynamic changes in respiratory mechanics or severity scores that could occur in the subsequent ICU course. Third, although patients were managed with standardized ventilators, individual clinician-driven adjustments may have introduced variability in settings such as tidal volume or PEEP. Fourth, the relatively small sample size, especially when stratified by PCR status and survival outcomes, may have limited the statistical power to detect subtle differences in some parameters. Lastly, we did not evaluate long-term outcomes beyond in-hospital mortality, nor did we incorporate biomarkers of inflammation or endothelial dysfunction, which may provide additional prognostic insight.

5. Conclusions

In this cohort of ARDS patients who received mechanical ventilatory support in the emergency department, COVID-19 cases exhibited significantly higher plateau pressures compared to Non-COVID cases. However, early ventilatory parameters were not associated with in-hospital mortality. Among clinical severity scores, SOFA was higher in the COVID-19 group, while APACHE II was significantly elevated in non-survivors within the COVID-19 subgroup, suggesting its potential role in early prognostic assessment for these patients.

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Informed Consent Statement: Informed consent is not applicable, as this study was based on a medical record review and no individual information appears.

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Conflicts of Interest: The authors declare no conflicts of interest.

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