Prognostic value of transthoracic echocardiography and BNP as a biomarker of cardiac dysfunction in COVID-19 and non COVID-19 pneumonia patients admitted to intensive care units.

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Abstract:

Background:

One of the main reasons for hospitalization is community-acquired pneumonia (CAP), and about 10% of hospitalized CAP patients need ICU admission which also causes high rates of morbidity, mortality , and medical expenses. The most important aspects of managing CAP patients are risk classification and prognosis prediction, which enable the choice of the best care environment, including outpatient therapy, hospital ward admission, or the critical care unit.

Aim: To determine the incidence of right ventricular dysfunction in the setting of CAP patients admitted to ICU and evaluate the predictive value of NT-ProBNP and echocardiographic characteristics, such as left and right ventricular performance, in such patients.

Methods: Ninety adult patients with community-acquired pneumonia as a primary or secondary diagnosis who were admitted to the El Sheikh Zayed Specialized Hospital and Imbaba General Hospital's critical care units were included in this prospective observational cross-sectional study. Patients were classified into 2 categories COVID -19 non COVID-19 pneumonia patients , On admission , each patient's NT ProBNP level was measured and transthoracic echocardiography was done within 48 hours of admission and follow up echocardiography was done after one week.

Results: ninety patients (42%) females and (57%) males were studied ,categorized into 2 groups (COVID-19 and non COVID-19), each group included forty five patients , which was further divided into two subgroups (RV impaired group and RV non impaired group . Among 90 patients with severe CAP , 31 patients (34%) suffered RV impairment 18 patients had non COVID pneumonia and 13 patients had COVID CAP. when comparing patients with RV impairment in both groups we found although higher portion of patients were identified as having RV dysfunction by TAPSE < 1.7 in non COVID group (40%) versus (28%) in the COVID group , it was not of statistical significance. There was significant difference regarding FAC that was higher in non COVID-19 patients with RV impairment than COVID-19 patients with RV impairment . Using multivariate logistic regression showed that TV max, RVSP and FAC were the most significant predictors of mortality. Our study revealed that NT-pro-BNP was significantly higher in COVID patients with RV impairment in comparison to non COVID-19 patients . NT-pro-BNP carried 100 % sensitivity and 80 % specificity for prediction of mortality with cut off value 1159.

Conclusion Based on our findings, we came to the conclusion that RV dysfunction might have carried worse prognosis and higher risk of mortality in community acquired pneumonia However, despite deteriorated RV measurement values, this was not statistically significant which could be explained by limited sample population. NT- ProBNP could be a reliable parameter for mortality prediction .

Keywords: Transthoracic echocardiography, BNP, cardiac dysfunction, community acquired pneumonia, intensive care units.

Introduction: Community-acquired pneumonia (CAP) is one of the main causes of hospitalization and increased comorbidities and death (1). The most important aspects of managing CAP patients are risk classification and prognosis prediction, which enable the choice of the best care environment, either be an intensive care unit , a hospital ward, or outpatient treatment . Numerous severity assessment scoring systems contributed in objective classification of patients into the different risk categories including the CURB-65 (confusion, urea nitrogen, respiratory rate, blood pressure, age ≥65 years), and the pneumonia severity index (PSI), have been created to forecast death and complex hospitalizations (CH) as well as to gauge the severity of pneumonia (2).

Myocardial injury of both ventricles is often linked to sepsis and septic shock (3). Several processes, such as myocardial and systemic inflammation, increased sympathetic tone, SARS-Co-V-2 direct cardiac involvement, thrombosis (including micro- and macro-thrombosis) that interferes with ventilation-perfusion matching, atelectasis and hypoxia from shunting (4), and hypoxic pulmonary vasoconstriction that raises right ventricular (RV) afterload, are some of the ways that COVID-19 affects the right ventricle. This can lead to thrombotic events and sequelae, arrhythmias, myocardial damage, acute coronary syndromes, cardiogenic shock, and acute cor-pulmonale (5).

Hospitalized COVID-19 patients' transthoracic echocardiograms showed right cardiac abnormalities, including increased PAP (6), dilatation (7), and ventricular dysfunction (7). In patients with severe COVID-19 pneumonia, RV dysfunction (RVD) was linked to a higher mortality rate than in non-RVD patients(8).

PATIENTS AND METHODS

Ninety adult patients who were admitted to El Sheikh Zayed Specialized Hospital's and Imbaba General Hospital's critical care units between May 2021 and February 2022 with a main diagnosis of community-acquired pneumonia or a contributing factor were the subjects of this prospective observational cross-sectional study. Either as a main diagnosis or as a component of a diagnosis, community-acquired pneumonia was identified in every patient. 50% of the patients (45 patients) had COVID 19 pneumonia confirmed by positive reverse-transcriptase polymerase chain reaction test for coronavirus , while the other 50% (45 patients) had CAP that was not attributed to COVID-19.

Inclusion criteria:

CAP is a primary diagnosis or part of a primary diagnosis in patients admitted to the intensive care unit (ICU) who are at least eighteen years old. Chest radiography was done to confirm the diagnosis , and patients had been assessed to require mechanical respiratory support or is deemed unstable and in need for critical care admission.

Pneumonia was diagnosed as new infiltrates on chest radiograms and two out of six clinical signs of pneumonia: Leukocytosis ≥ 10 x109 / l or leukopenia ≤ 4 x109 / l, cough, sputum production, temperature > 38 °C or < 35.8 °C, respiratory auscultation indicates consolidation, and more than 10% rods were considered .

The Chinese National Health Commission's recommendations for diagnosing and treating COVID-19 (trial sixth edition), which were released on February 18, 2020, were taken into consideration when diagnosing the severe and critically ill COVID-19 patients that were part of this investigation. In this study, the following criteria were used to identify cases: respiratory rate >30/min, oxygen saturation ≤ 93% ; need for mechanical ventilatory support due to respiratory insufficiency; shock; respiratory failure in addition to other organ failure requiring manegment in intensive care unit;; PaO2/FiO2 ratio ≤ 300; individuals whose lung imaging shows more than 50% lesion progression in 24 to 48 hours (9).

Exclusion criteria*:*

- Patients who are younger than eighteen.
- Individuals suffering from chronic chest conditions.
- Patients with poor acoustic echocardiographic window .
- Patients who have a known right ventricular dysfunction or tricuspid valve lesion.
- Congestive heart failure patients.

Ethical Considerations:

This work was approved by Cairo University's Faculty of Medicine Ethics Committee. All participants were fully informed of the study's goals and procedures before to recruitment, and they were requested to offer written consent, or their legal representative if they were unable to give it on their own.

The following procedures were performed on the study's participants:

1. **Detailed History:** comprehensive history that contained sociodemographic details, special habbits of medical importance, past history of other medical diseases and current medications
2. **2. Physical assessment:** General examination and vital signs including blood pressure measurement, assessment of the pulse, respiratory rate and temperature.
3. **3. Laboratory work up:** such as CBC, INR, liver and renal function, D dimer, CRP, ferritin, procalcitonin, ABG, and microbiological culture, were methodically documented.

4. **4. Pro-BNP** was assessed in all CAP patients upon admission to the intensive care unit.

5. **5. The severity of COVID-19 and the diagnosis of pneumonia** were determined using the chest computed tomography score and X-ray chest. Each of the five lobes that made up each lung was evaluated separately. The following anomalies were deemed significant for the disease: reticulation, nodule, consolidation, ground-glass opacity, bronchial wall thickening, lymph node enlargement, pleural effusion, pericardial effusion, interlobular septal thickening, interlobular septal thickening, linear opacities, and subpleural curvilinear line. A CT score ranging from 0 to 5 may be assigned to each lobe based on the extent of its impairment: The scores are as follows: One denotes less than 5% involvement, two denotes 5% to 25% involvement, and zero denotes no involvement. Three denotes a level of involvement between 26% and 49%, four between 50% and 75%, and five over 75%.

6. **6. The severity of CAP** was evaluated using the SMART-COP score, the SOFA, APACHE-II, CURB-65, and pneumonia severity index scores.

7. Within 48 hours after admission, a thorough transthoracic echocardiogram was performed utilizing the SonoScape M22 with probe 2P1 and the GE Versana with probe 4C-RS.

8. In our study, patients underwent a follow-up echocardiogram one week later.

Echocardiographic examination:

- ***Evaluation of echocardiography with a focus on RV evaluation***

  Transthoracic echocardiography was conducted on all patients utilizing the SonoScape M22 with a 2P1 PHASED ARRAY transducer (1-6 MHz) and the GE Versana Active with a 4C-RS probe, with patients positioned in the left lateral and supine position (for ventilated patients). Standard views , M-mode and 2D colour Doppler echocardiography were employed. M-mode echocardiographic measurements were obtained based on the standards of the American Society of Echocardiography . Left ventricle internal dimensions and Left ventricular ejection fraction (LVEF) was calculated using the M mode .

- Right ventricular assessment for dimensions was done in both the parasternal long axis view and the A4C view. Right ventricular function is evaluated using the fractional area of change (FAC), peak tricuspid regurgitant (TR) velocity by continuous wave Doppler, S' velocity by pulsed wave tissue Doppler, where the cursor was placed on the lateral tricuspid annulus or in the middle of the basal segment of the RV's free wall and the M mode of the tricuspid annular plane systolic excursion (TAPSE).

- RV systolic dysfunction denoted as TAPSE < 17 mm or S′ velocity < 9.5 cm/sec. by TDI . RV dilatation occurs when the RV mid-diameter exceeds 3.5 mm.

Pro-BNP analysis:

We employed the ELISA immunoassay method, which enables quantitative in vitro measurement of human NT pro-BNP levels.

Outcome of the Study:

Primary outcome was patients' right ventricular dysfunction while parameters for secondary outcomes included length of ICU stays and mortality .

Statistical Methods and Data Analysis

The statistical program SPSS (Statistical Package for the Social Sciences) version 24 was used to code and enter the data. The Spearman correlation coefficient, ROC curve, and Mann-Whitney test were employed.

Results: : ninety patients (42%) females and (57%) males were studied ,categorized into 2 groups (COVID-19 and non COVID-19), each group included forty five patients , which was further divided into two subgroups (RV impaired group and RV non impaired group . Among 90 patients with severe CAP , 31 patients (34%) suffered RV impairment 18 non COVID patients(40%) and 13 COVID CAP patients (28%).

Comparing patients with RV impairment in both groups , our study revealed:

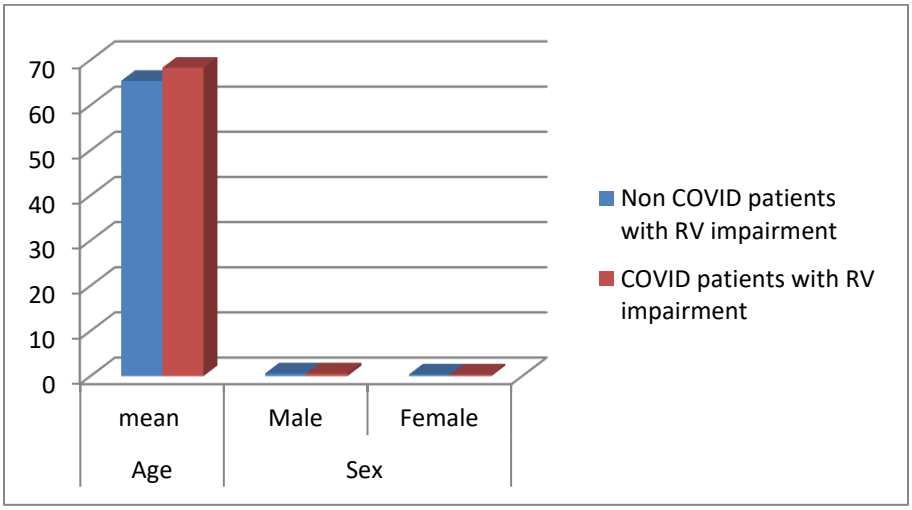

Figure 1: Age and sex in RV impaired COVID-19 patients and non COVID-19 pneumonia patients.

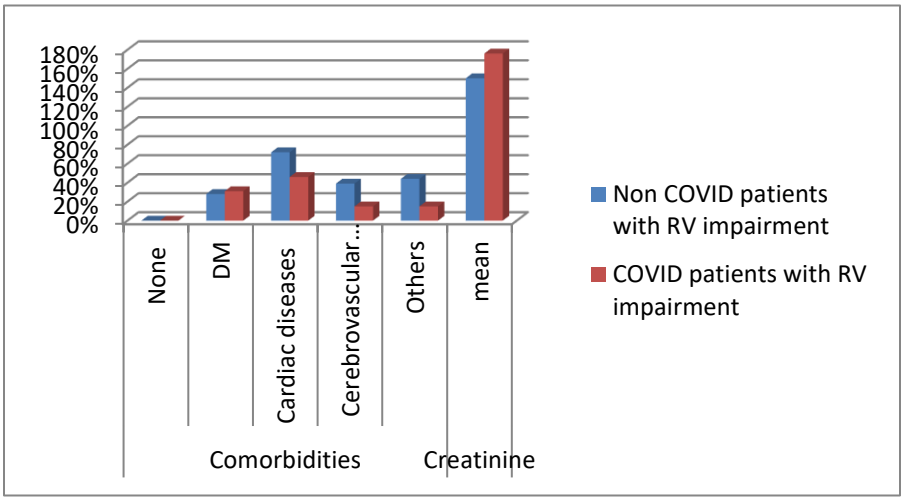

Figure 2: Comorbidities and creatinine in RV impaired COVID-19 patients and non COVID-19 pneumonia patients.

Figures (1) and (2) reveal that there was no discernible difference in the demographic data between patients with RV impairment whether suffered COVID or not..

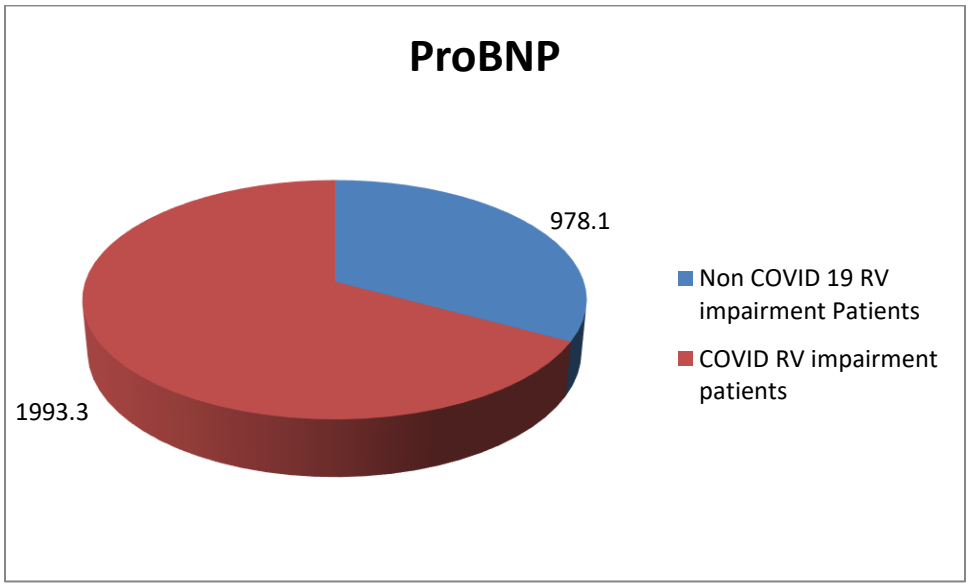

Figure (3): Pro-BNP at admission among non COVID and COVID patients with RV impairment.

Figure (3) demonstrates significant difference regarding ProBNP that was higher in COVID-19 patients with RV impairment than non COVID -19 patients with RV impairment.

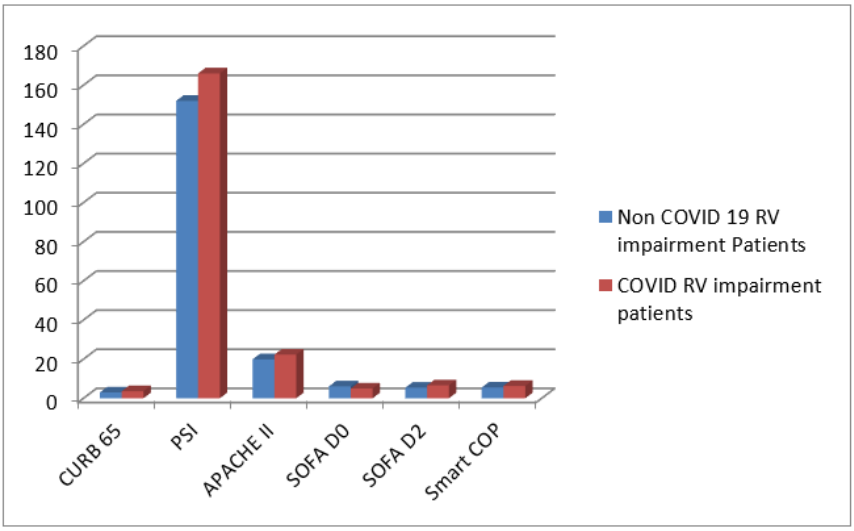

Figure 4: RV impaired patients severity scores for both COVID-19 and non-COVID-19 patients upon admission.

Figure (4) shows that among the different severity scores , CURB 65 was significantly higher in COVID-19 patients with RV impairment than in non-COVID-19 pneumonia patients with RV impairment, while other scores did not differentiate significantly

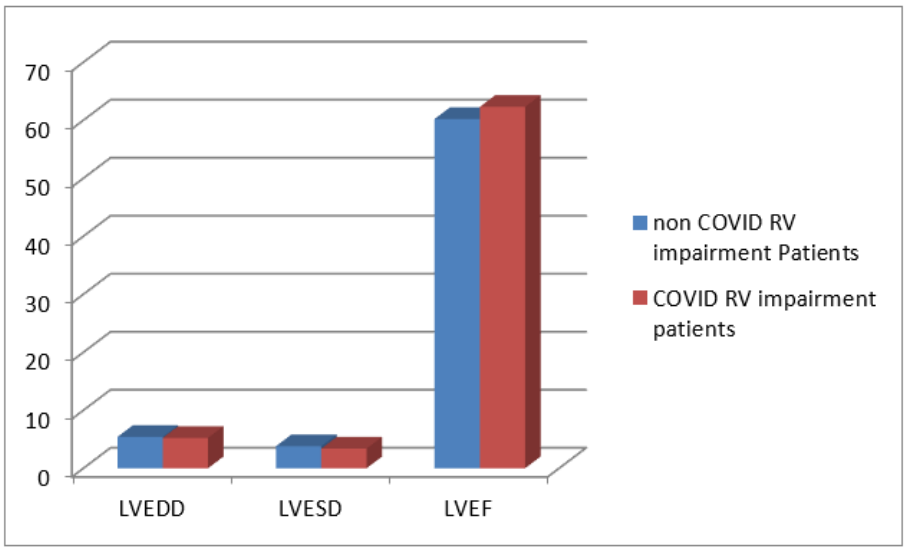

Figure 5: LV echocardiographic parameters in both non-COVID-19 and COVID-19 patients with RV impairment on admission

Figure (5) demonstrated that COVID-19 and non-COVID-19 patients with RV dysfunction did not significantly differ in LVEDD, LVESD, or LVEF at admission.

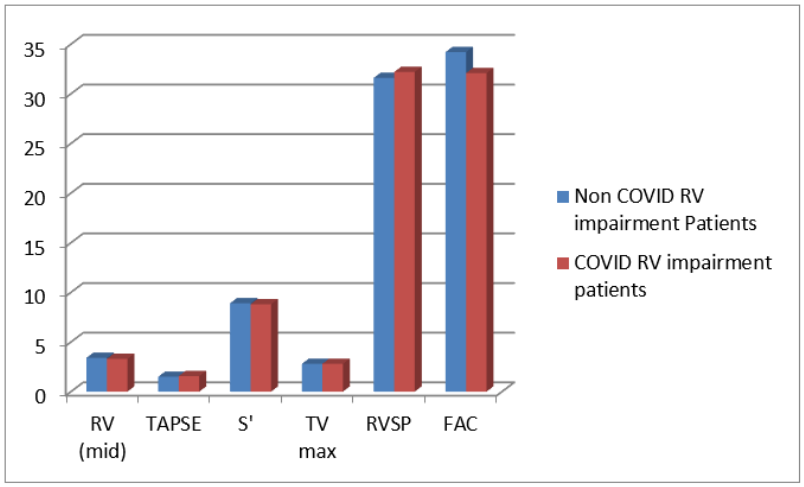

Figure 6: RV echocardiographic parameters on admission for COVID-19 and non-COVID-19 patients with RV impairment.

Figure (6) showed that patients with RV impairment in either groups of COVID-19 or non COVID-19 had no significant differences in TV max, RVSP, FAC, TAPSE, S', and RV.

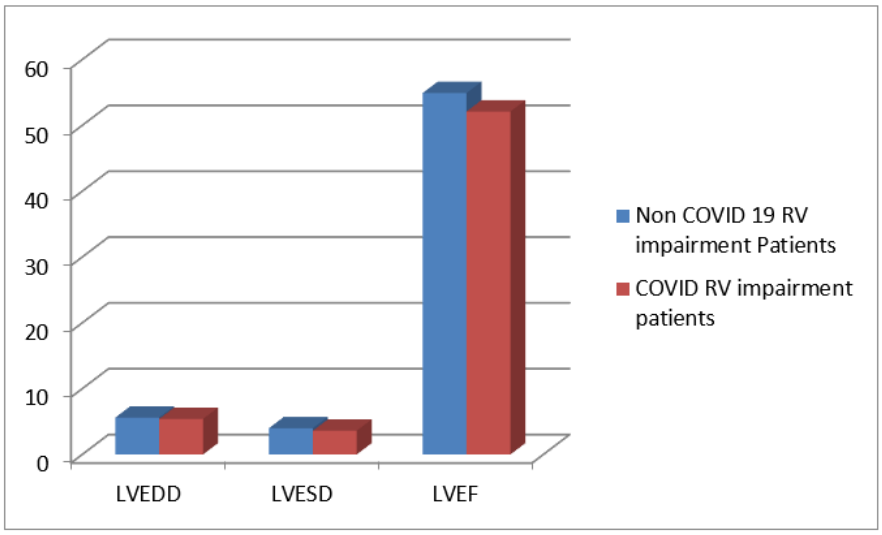

Figure 7: Follow up LV echocardiographic parameters in both non-COVID-19 and COVID-19 patients with RV impairment.

Figure (7) demonstrated that, in terms of LVEDD, LVESD, and LVEF at follow-up, there was no discernible difference between COVID-19 and non-COVID 19 individuals with RV impairment.

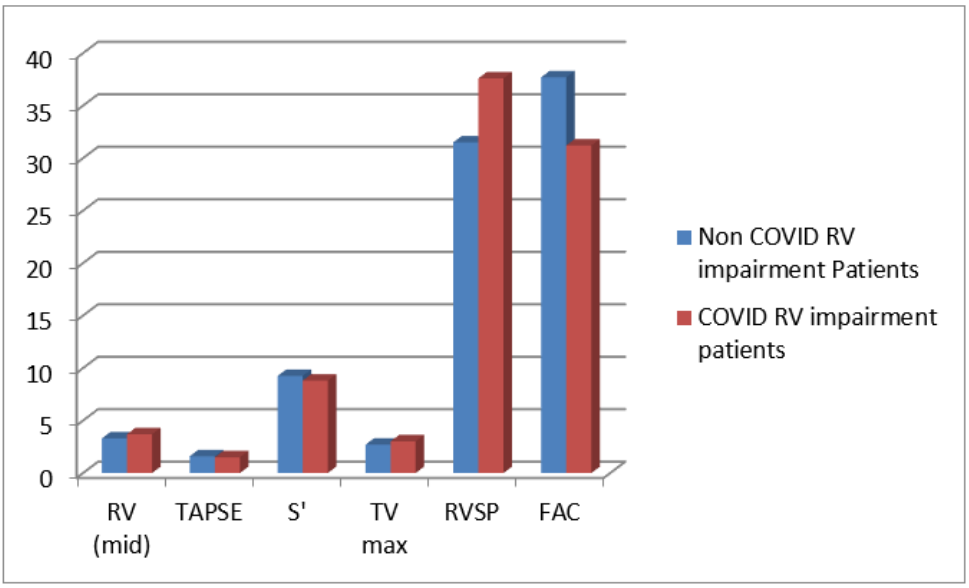

Figure 8: Follow up RV echocardiographic parameters for COVID-19 and non-COVID-19 patients with RV impairment.

Figure (8) illustrates that RV (mid), TAPSE, S', TV max, and RVSP during follow-up did not significantly differ between non-COVID-19 and COVID-19 patients with RV impairment , however The FAC of non-COVID-19 patients with RV impairment was higher than that of COVID-19 patients with RV impairment, indicating a significant difference in FAC

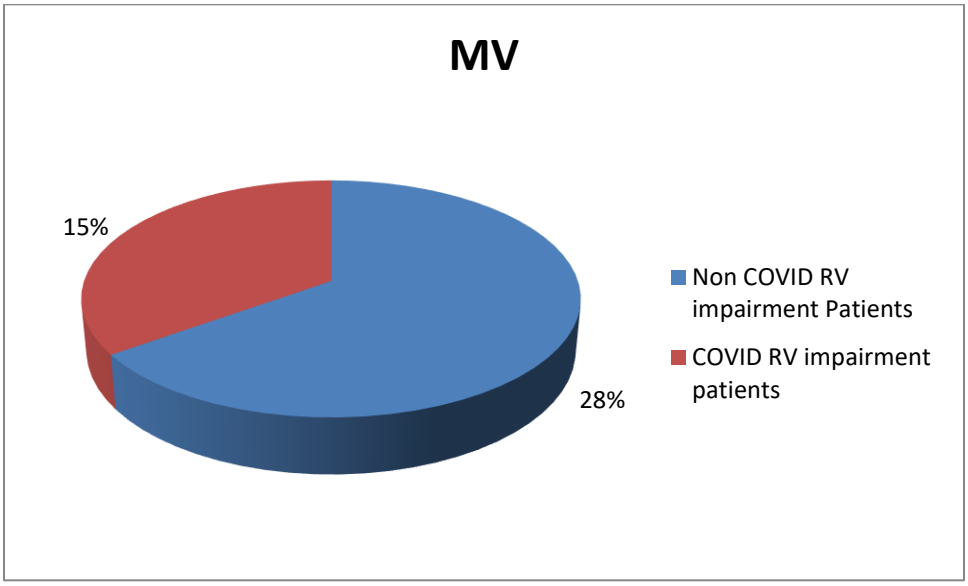

Figure 9: MV among non COVID-19 and COVID-19 patients with RV impairment.

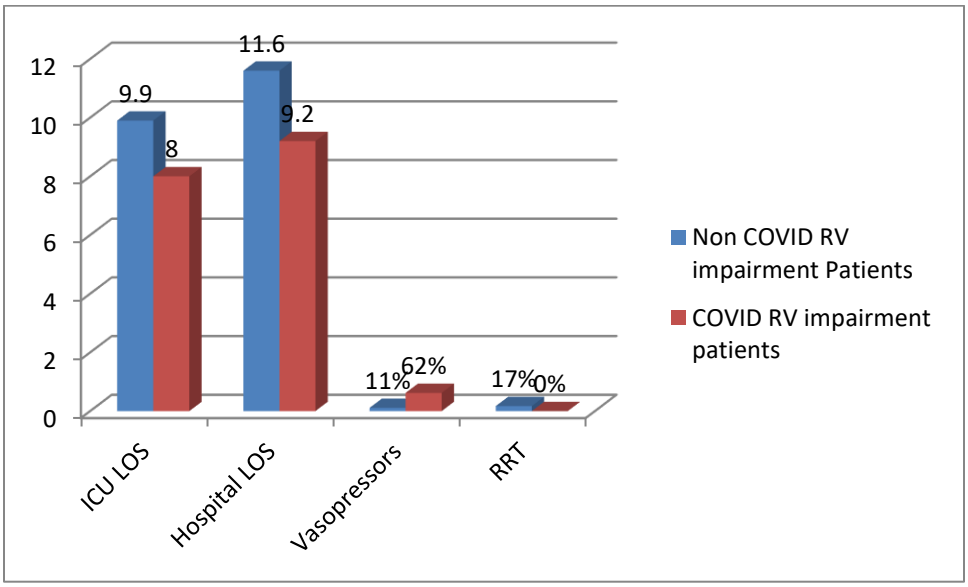

Figure 10: ICU, hospital LOS, Vasopressors and RRT in COVID-19 patients with RV impairment vs non-COVID-19 patients.

Figures (9) and (10) showed no significant difference in MV duration , ICU LOS, or hospital LOS and RRT between COVID-19 and non-COVID-19 patients with RV impairment while there was significant difference regarding the need for vasopressors that was higher in COVID-19 than non COVID-19 patients with RV impairment.

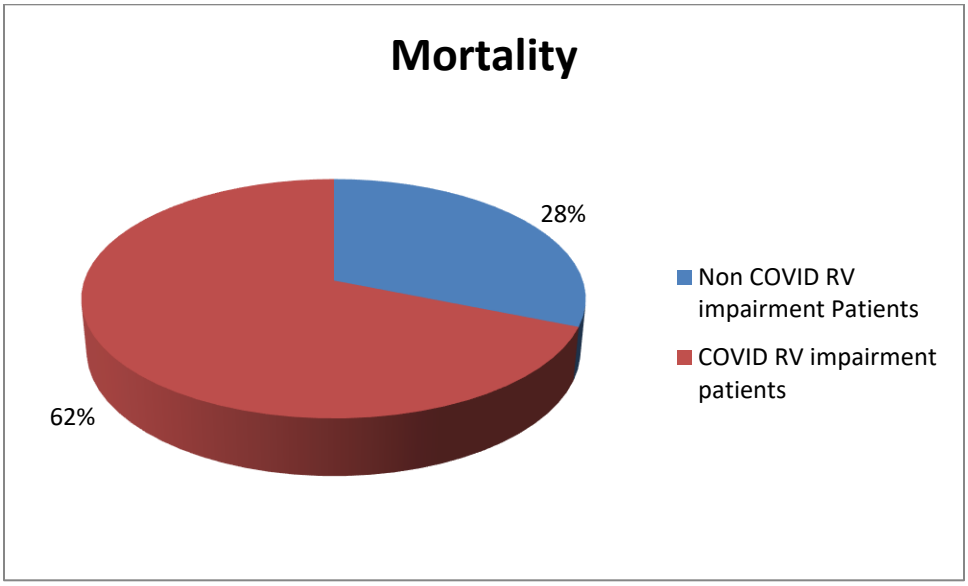

Figure 11: Mortality rate among non COVID-19 and COVID-19 patients with RV impairment.

Figure 11 showed that mortality rate was higher in COVID-19 patients with RV impairment than non COVID-19 patients with RV impairment but it did not reach significant difference.

Table (1): ROC curve of NT-proBNP and severity scores to predict the mortality.

	AUC	P value	Cut off	Sensitivity	Specificity
ProBNP	0.97	<0.001*	1159	100%	80%
CURB 65	0.76	0.01*	3.5	61%	90%
PSI	0.72	0.03*	142	84%	60%
APACHE II	0.72	0.03*	17.5	78%	50%
SOFA D0	0.64	0.18	3.5	92%	45%
SOFA D2	0.81	0.003*	5.5	84%	82%
Smart COP	0.7	0.05	6.5	61%	79%

ProBNP, CURB 65, PSI, APACHE II, SOFA at day 2 can be used as predictors of mortality with sensitivity 100%, 61%, 84%, 78%84% respectively and specificity 80%, 90%, 60%, 50% and 82% respectively (Table 1).

Table (2): ROC curve of RV function to predict the mortality.

	AUC	P value	Cut off	Sensitivity	Specificity
RV (mid)	0.56	0.54	2.85	61%	45%
TAPSE	0.34	0.15	1.45	76%	44%
S'	0.68	0.003*	7.9	78%	53%
TV max	0.59	0.37	2.6	76%	66%
RVSP	0.62	0.24	29.5	75%	63%
FAC	0.24	0.01*	30.1	77%	60%

S' and FAC can be used as predictors of mortality with sensitivity 78% and 77% respectively and specificity 53% and 60% respectively (Table 2).

Table (3): Logistic regression between mortality and other parameters

	P value	Odd ratio	95% CI
LVEF	0.95	0.99	0.96-1.03
RV (mid)	0.92	0.95	0.35-2.5
TAPSE	0.14	0.22	0.03-1.65
S'	0.64	0.92	0.67-1.2
TV max	0.03*	0.02	0.01-0.53
RVSP	0.03*	1.7	1.03-2.8
FAC	0.04*	0.93	0.87-0.99

Using logistic regression analysis, TV max, RVSP and FAC were the most significant predictors of mortality (Table 3).

Table (4): Pearson correlation between NT-proBNP and other parameters

Parameter	P value

CURB 65	0.001*
PSI	0.04*
APACHE II	0.04*
SOFA D0	0.92
SOFA D2	0.001*
Smart COP	0.56
LVED	0.56
LVES	0.91
LVEF	0.58
RV (mid)	0.78
TAPSE	0.34
S'	0.24
TV max	0.01*
RVSP	0.001*
FAC	0.06

Table (4) showed that there was significant positive correlation between NT-proBNP and CURB 65, PSI, APACHE II, SOFA at day 2, TV max and RVSP

Table (5): Kaplan Maier showing mortality rate among all RV impaired patients.

	Estimated mean length of ICU stay per day	Number of deaths	Number of survivals	P value
RV impaired Non COVID (TAPSE<1.7) (N=18)	19.2	5 (28%)	13 (72%)	0.11
RV impaired COVID (TAPSE<1.7) (N=13)	10.6	8 (53%)	5 (47%)	

Table (5) shows the estimated mean time between ICU admission for non COVID-19 patients with RV impairment and death was 19.2 days compared to 10.6 days for COVID-19 patients with RV impairment, this means that chance of survival is more for non COVID-19 patients with RV impairment, but it did not reach significant difference. Deaths rate among COVID-19 patients with RV impairment was (53%) compared to (28%) among non COVID-19 patients with RV impairment.

Discussion:

Pneumonia acquired in the community (CAP), which also has high rates of morbidity, mortality, and medical costs, is one of the primary causes of hospitalization by **Waterer and Bennett** (1). Our study's objective was to evaluate echocardiographic characteristics, such as left and right ventricular performance, in adult patients admitted to intensive care units due to severe community-acquired pneumonia (CAP) and assess the prognostic value of this echocardiographic parameter and NT- Pro BNP among those patients.

Our research demonstrated no significant difference in severity scores between individuals with RV dysfunction who suffered COVID-19 CAP and those who did not, with the exception of CURB 65.

In line with our findings, **Van Blydenstein and associates.** (10). When he evaluated 48 patients with severe and critically ill COVID-19 in face of 24 patients with non-COVID-19 CAP, he demonstrated that there was no discernible variation in severity scores between the groups as both groups had similar severity of ARDS scores, which may be caused by the small sample sizes. According to a Turkish study 268 that only included patients who were seriously ill, the APACHE II was approatching by **Asar et al.** (11) and the groups with and without COVID-19 ARDS had similar SOFA scores by García-Cruz et al. (7) **and Shafiabadi et al.** (8), respectively.

According to **Evrard et al.** (12), Comparing patients with ARDS associated with SARS-CoV-2 with those with ARDS unrelated to SARS-CoV-2 , the later group needed vasopressor medication more frequently and had a higher SOFA score. This conclusion contradicts our findings and is possibly as a result of low prevalence of initial bacterial infections among his patients .

our results showed That NT-Pro BNP levels in COVID-19 and non-COVID-19 patients with RV impairment differed significantly, with a p-value of 0.001 for COVID patients being higher.

In contrast to our research, **Jirak et al.** (13) compared critically ill COVID-19 patients admitted to intensive care with CAP patients of other etiologies apart from COVID-19. he observed that non-COVID-19 had higher levels of cardiac biomarkers (hs-Tn, CKMB, and NT-pro-BNP), with a P value of 0.001, reflecting a higher burden of CI in non-COVID-19.

We found no significant difference in left ventricle internal dimensions assessed between COVID-19 and non-COVID-19 patients with RV dysfunction at admission or follow-up in line with **Evrard** et al. (12). Additionally, they noted indexed LVEF (52% vs 54.5%), volume of indexed LVED (44 against 43 ml/m2) and indexed LVES (20 versus 20 ml/m2).

We demonstrated that, on admission there was no discernible difference in RV, TAPSE, S', TV max, RVSP, and FAC between those with RV impairment who had COVID-19 and those who did not.

Consistent with our findings, **Van Blydenstein et al**. (10) showed that regardless the presence of complication or not in COVID-19 patients , they did not significantly differ in their echocardiographic results.

Comparing COVID-19 and non COVID-19 patients with RV impairment on follow up echocardiography, we noted that although the two groups' RVFACs differed significantly, being much more affected in COVID-19 group, TAPSE, S', TV max, RVSP, and RV (mid diameter) did not significantly change .

Contrary to our findings, **Evrard et al**. (12) stated that although the maximum tricuspid S velocity was not statistically lower ARDS unrelated to SARS-CoV-2 patients than in patients with ARDS due to SARS-CoV-2, RVFAC and TAPSE were. These values were maintained in SARS-CoV-2-associated ARDS patients , and could be attributed to the effect of positive pressure ventilation on the RV as all of his patients were on

mechanical ventilation. Acute cor-pulmonale (ACP) and SARS-COV-2-related ARDS were also more common in this group than in the other groups. Increased RV afterload results in the development of ACP , leading to paradoxical interventricular septal motion, prolonged RV contraction, and RV-LV pressure imbalance. It has been previously proposed that a decrease in RV radial shortening is caused by a rise in RV afterload. Remarkably, in patients with pulmonary hypertension, transverse wall motion (also known as RV radial shortening), as measured by RVFAC, was a more accurate indicator of RVEF than longitudinal wall motion, as measured by TAPSE. It has also been demonstrated that the ventricular mechanical pattern is impacted by RV volume overload conditions. RV contraction is greatly affected by the interventricular septum, RV shortening occurs in both the radial and antero-posterior axes as a result of shortening of septal circumferential myocardial fibres after LV contraction. RV radial and anteroposterior shortening may be lessened when there is paradoxical septal motion because the septum cannot contract effectively.

Although duration of mechanical ventilation, ICU length of stay, and hospital length of stay were longer in non-COVID-19 patients, we demonstrated that there was no statisticaly discernible difference between COVID-19 and non-COVID-19 patients with RV impairment which we attributed to the higher mortality rates in COVID-19 patients during the initial days of admission.

Asar et al. (11) found no discernible difference between the COVID-19 and non-COVID-19 pneumonia groups in terms of length of stay in the intensive care unit and duration of invasive mechanical ventilation, which is consistent with our findings.

We showed that although mortality rate was higher in COVID-19 patients with RV impairment than non COVID-19 patients with RV impairment (62% versus 28%, p value 0.07) but it did not reach statistically significant difference. In contrary **van Blydenstein et al. (10)** showed that the COVID-19 group had a substantially greater actual mortality even though their SAPS II score and expected mortality were lower, on contrary to the non-COVID-19 CAP group . Compared to non-COVID-19 CAP , the COVID-19 mortality rate was higher (27%) versus (12%) for non COVID group. The increased mortality seen notwithstanding the projected mortality is likely due to the progression of COVID-19 from admission (when measurements were taken) to a multi-system thrombo-inflammatory disease resulting in multi-organ dysfunction. It is also possible to hypothesise that early RVD in COVID-19 patients indicates a worse prognosis than later RVD.

Our ROC analysis of different severity scores for prediction of mortality showed that CURB 65, PSI, APACHE II, SOFA at day 2 can be used as predictors of mortality with

AUC 0.76, 0.72, 0.72, 0.81 also sensitivity 61%, 84%, 78%, 84% respectively and specificity 90%, 60%, 50% and 82% respectively. Similarly **Ito et al., (14)** showed the AUCs of CURB-65 and PSI in predicting 30-day mortality were 0.755 and 0.767 in Japan .

Also our ROC analysis of proBNP in prediction of mortality showed that NT-proBNP can be used as sensitive marker for predicting mortality with high sensitivity and specificity with p value <0.001. This came in line with **Benmachiche et al. (15)** who showed that, irrespective of their clinical features, patients with elevated proBNP are more likely to experience longer length of stay and in-hospital mortality.

Also, **Mohamad et al.** ***(16)*** reported in his study which was to ascertain the prevalence and prognostic significance of right ventricular (RV) dysfunction in COVID-19 patients admitted to the intensive care unit, a highly significant correlation between mortality and elevated proBNP levels (p value <0.001)..

Based on our findings, it is likely that NT-proBNP levels could be used to predict in-hospital mortality in patients with a wider range of pathologies.

We found that LVEDD, LVESD and LVEF had poor sensitivity and specificity and cannot be used as predictors of mortality, however S' and FAC can be used as predictors of mortality with p value of sensitivity 78% and 77% respectively and specificity 53% and 60% respectively.

In agreement with our results, **Diaz-Arocutipa et al. (17)** in his systematic review and meta-analysis found that in patients with COVID-19, RV dysfunction was independently linked to a nearly three-fold increase in mortality; a 1% drop in FAC or a 1 mm drop in TAPSE was significantly linked to a higher mortality rate.

Mohamad et al. ***(16)*** Additionally, he grouped the patients in his study into groups of severely ill COVID-19 survivors and non-survivors. He observed a highly significant correlation between fatality and a lower FAC % ($p < 0.001$).

According to **Moody's et al.** (18), a greater percentage of subjects (28 percent vs. 21 percent) had overall reduced RV function (defined by FAC < 35%) than had reduced longitudinal RV function (defined by TAPSE < 17 mm). In all groups, the highest mortality rate was linked to impaired longitudinal RV function as measured by FAC.

Using logistic regression analysis, we found that FAC, TV max, RVSP were the most significant echocardiographic parameters for prediction of mortality.

In agreement with our study, **Moody et al. (18)** demonstrated that, in multivariable Cox regression analysis, impaired RV systolic function was the only factor that was

independently linked to all-cause mortality, surpassing the effects of adjusting for sex, diabetes mellitus, hypertension, chronic lung disease, and malignacy. Also he showed that after a median follow up of 31 days (interquartile range:14-42 days), 66 (40%) COVID-19 patients had died, and of those, 30 (52%) had reduced RV function.

Furthermore , **Zhang et al. (19)** demonstrated that standard RV function characteristics, such as RVFAC, TAPSE and S′, 2D RVFWLS, and 3D RVEF, were examined using ROC in order to predict patient mortality. Only RVFAC, 2D RVFWLS, and 3D RVEF were linked to mortality, according to the ROC analysis with optimal cutoff value for RVFAC 42.7% (AUC, 0.79, P < 0.001; sensitivity, 72%; specificity, 78%). This is consistent with our ROC analysis, which showed that S' and FAC could be used to predict mortality with p values of 0.003 and 0.01, and AUCs of 0.68 and 0.24 respectively.

We showed that there was significant positive correlation between BNP and CURB 65, PSI, APACHE II, SOFA at day 2, TV max and RVSP.

Using Kaplan-Meier analysis we showed that in non COVID-19 patients the estimated mean time for ICU stay in patients with RV impairment was 19.2 days and deaths number of 5 , deaths rate (28%). While in COVID-19 patients the estimated mean time for ICU stay in patients with RV impairment was 10.6 days and deaths number of 8 , deaths rate (62%) which means higher incidence of mortality in patients with RV dysfunction.

In line with our study **, Moody et al. (18)** showed that RV dysfunction was present in 58 (35%) patients, and it was associated with increased mortality on Kaplan-Meier analysis.

Conclusion:

Based on our findings, we deduced that RV dysfunction was associated with an increased risk of death in community-acquired pneumonia. This may be a type II error due to the small sample size, even if the RV parameters deteriorated, this was not statistically significant. With a reasonable degree of accuracy, ProBNP could forecast mortality in CAP.

This study requires additional research to corroborate its conclusions .

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