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Correlation between pulmonary computed tomography severity scores and clinical outcomes in COVID-19 patients: A study from a tertiary hospital in Bangladesh

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Abstract

Introduction: The global outbreak of coronavirus disease 2019 (COVID-19), caused by the novel severe acute respiratory syndrome coronavirus 2, has posed unprecedented challenges to healthcare systems worldwide. Pulmonary computed tomography (CT) severity scoring offers a semi-quantitative approach to evaluate the extent of lung involvement, which may correlate with clinical outcomes. This study aims to assess the correlation between pulmonary CT severity scores (CTSSs) and clinical outcomes in COVID-19 patients admitted to a tertiary hospital in Bangladesh.

Materials and Methods: This observational study was conducted at the Radiology Department of a tertiary hospital in Bangladesh from January to December 2021, including 90 reverse transcription polymerase chain reaction –confirmed COVID-19 patients who underwent chest CT within 5 days of admission. Adults aged ≥18 years with complete clinical and imaging data were included. Data were analyzed using the Statistical Packages for the Social Sciences 26.0.

Results: Patients with severe CTSS had a markedly increased need for oxygen therapy (93.1%), intensive care unit (ICU) admission (72.4%), and mechanical ventilation (58.6%), and showed higher mortality (37.9%) compared to those with mild or moderate scores. A CTSS cut-off of ≥18 effectively predicted mortality with high sensitivity (86.7%) and specificity (86.2%). Significant correlations were also observed between CTSS and inflammatory markers (C-reactive protein, ferritin, D-dimer) and lower oxygen saturation at admission.

Conclusion: This study demonstrates a significant correlation between pulmonary CTSSs and clinical outcomes in COVID-19 patients admitted to a tertiary hospital in Bangladesh. Higher CTSSs were strongly associated with increased need for oxygen therapy, ICU admission, mechanical ventilation, prolonged hospital stay, and mortality.

Keywords: Clinical outcomes, coronavirus disease 2019, computed tomography severity score, pulmonary computed tomography

Introduction

The coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2, has posed an unprecedented global health crisis since its emergence in late 2019. With over 770 million confirmed cases and more than 7 million deaths globally as of

2024, the disease has strained healthcare systems, particularly in resource-limited settings, such as Bangladesh.[1] While most patients experience mild-to-moderate symptoms, a significant proportion progresses to severe respiratory complications, including acute respiratory distress syndrome, multi-organ failure, and death.[2,3] This clinical heterogeneity has necessitated the development and validation of prognostic tools to stratify risk and guide clinical management. Chest computed tomography (CT) imaging has emerged as a valuable diagnostic and prognostic modality in COVID-19, particularly when reverse transcription polymerase chain reaction (RT-PCR) testing is delayed or inconclusive.[4,5] High-resolution CT offers detailed visualization of pulmonary involvement, often revealing ground-glass opacities, consolidations, and crazy paving patterns that correlate with disease severity.[6] Consequently, various semi-quantitative CT severity scoring systems have been developed to assess the extent of lung involvement and predict patient outcomes.[7] The CT severity score (CTSS), which typically ranges from 0 to 25 or 0 to 40 depending on the scoring protocol, quantifies the degree of pulmonary involvement across different lobes.[8] Several studies from China, Europe, and the Middle East have demonstrated a strong correlation between CTSS and clinical parameters, including oxygen saturation, inflammatory markers, intensive care unit (ICU) admission, need for mechanical ventilation, and mortality.[9-11] For instance, Francone *et al*. observed that a CTSS >18 was significantly associated with poor clinical outcomes and higher mortality.[12] Similarly, a study in India found that CTSS had good predictive value for adverse outcomes, particularly when combined with clinical indicators, such as comorbidities and age.[13] In Bangladesh, the role of CT imaging during the COVID-19 pandemic has been increasingly recognized due to challenges in testing capacity, especially in the early phases of the outbreak. However, limited data exist regarding the prognostic utility of CTSS in Bangladeshi patients.[14] Given the country's high population density and relatively fragile healthcare infrastructure, it is crucial to identify reliable and easily accessible tools for risk stratification and early intervention. The heterogeneity in clinical outcomes among COVID-19 patients in Bangladesh may be influenced by several factors, including delayed hospital presentation, limited ICU capacity, and high prevalence of comorbidities, such as diabetes, hypertension, and chronic kidney disease.[15] Therefore, evaluating the relationship between CTSS and clinical outcomes, such as duration of hospitalization, ICU admission, need for oxygen or mechanical ventilation, and mortality could enhance triage decisions and optimize resource allocation in tertiary care settings.[16] Previous studies have highlighted that higher CTSS is associated with elevated levels of inflammatory markers, such as C-reactive protein (CRP), ferritin, and D-dimer, suggesting that CT findings may reflect underlying systemic inflammation and hypercoagulability. In addition, a combined assessment of CTSS with laboratory and clinical parameters has been shown to improve prognostic accuracy.[17] However, discrepancies in scoring protocols and thresholds across institutions necessitate context-specific validation, especially in low- and middle-income countries. This study aims to assess the correlation between pulmonary CTSSs and clinical outcomes in COVID-19 patients admitted to a tertiary hospital in Bangladesh.

Materials and Methods

This hospital-based observational study was conducted in the Department of Radiology, in collaboration with the Department of Medicine, at a tertiary care hospital in Bangladesh from January 2021 to December 2021. A total of 90 RT-PCR–confirmed COVID-19 patients who underwent high-resolution chest CT within 5 days of admission were included. Inclusion criteria were patients aged ≥18 years, with confirmed COVID-19 and available CT scans and clinical data. Exclusion criteria included patients with pre-existing chronic lung diseases, poor-quality CT images, or incomplete clinical records. CTSSs were calculated based on the extent of lobar involvement (range 0–25). Clinical outcomes, including the need

for oxygen therapy, ICU admission, mechanical ventilation, hospital stay duration, and mortality, were recorded. Data were analyzed using Statistical Packages for the Social Sciences version 26.0. Descriptive statistics were used for demographic and clinical variables, and Pearson's correlation coefficient was applied to assess relationships between CTSS and continuous variables, while Chi-square and used to evaluate associations and predictive accuracy. A $P < 0.05$ was considered statistically significant.

Results

Among the 90 patients enrolled, the majority were male (64.4%) with a mean age of 56.2 years. Most patients (78.9%) had at least one comorbidity, with hypertension and diabetes being the most common [Table 1].

CT severity scoring categorized most patients into the moderate range (47.8%), followed by severe (32.2%) and mild (20%). This reflects a high burden of pulmonary involvement in hospitalized patients [Table 2].

A significant relationship was observed between increasing CTSSs and worse clinical outcomes, including longer hospitalization, ICU need, mechanical ventilation, and higher mortality [Table 3].

CTSS was positively correlated with inflammatory biomarkers, such as CRP, D-dimer, and ferritin. Oxygen saturation decreased significantly with increasing CTSS, supporting its predictive value [Table 4].

A CT score ≥18 was associated with high sensitivity (84.6%) and specificity (82.3%), suggesting it is a strong prognostic tool [Table 5].

Table 1: Demographic and clinical profile of COVID-19 patients at a tertiary hospital in Bangladesh (*n*=90)

Parameter	Frequency (%)/Mean±SD
Age (years)	56.2±13.7
Sex	
Male	58 (64.4)
Female	32 (35.6)
Comorbidities	
Hypertension	42 (46.7)
Diabetes mellitus	39 (43.3)
Ischemic heart disease	22 (24.4)
Chronic kidney disease	12 (13.3)
No comorbidity	19 (21.1)

COVID-19: Coronavirus Disease 2019; SD: Standard deviation

Table 2: Distribution of pulmonary CT severity scores in COVID-19 patients (*n*=90)

CT severity score category	Score range	Number of patients (%)
Mild	0–7	18 (20.0)
Moderate	8–17	43 (47.8)
Severe	18–25	29 (32.2)

COVID-19: Coronavirus disease 2019, CT: Computed tomography

Discussion

This study aimed to evaluate the correlation between pulmonary CTSSs and clinical outcomes among hospitalized COVID-19 patients in a tertiary care setting in Bangladesh. Our findings demonstrate that higher CTSS values were significantly associated with adverse clinical outcomes, including increased need for oxygen supplementation, ICU admission, mechanical ventilation, longer hospital stay, and mortality. These results are consistent with previous studies that have reported the prognostic value of chest CT imaging in assessing disease severity and predicting outcomes in COVID-19 patients. In our cohort of 90 patients, the majority had moderate-to-severe CTSS (47.8% and 32.2%, respectively). This is similar to findings by Francone *et al*., who reported that over 70% of hospitalized COVID-19 patients in Italy presented with moderate-to-severe CT involvement, with CTSS showing strong predictive capacity for clinical deterioration.[12] Similarly, a study by Yang *et al*. in Wuhan demonstrated that patients with higher CTSS were significantly more likely to require ICU care and had higher

Table 3: Correlation between CT severity score and clinical outcomes in COVID-19 patients (n=90)

Outcome	Mild (*n*=18) (%)	Moderate (*n*=43) (%)	Severe (*n*=29) (%)	*P*-value
Oxygen therapy required	4 (22.2)	25 (58.1)	29 (100.0)	<0.001
ICU admission	0 (0.0)	8 (18.6)	21 (72.4)	<0.001
Mechanical ventilation required	0 (0.0)	3 (7.0)	17 (58.6)	<0.001
Duration of hospital stay (days)	6.1±2.4	9.7±3.5	14.3±4.1	<0.001
Mortality	0 (0.0)	2 (4.7)	11 (37.9)	<0.001

COVID-19: Coronavirus disease 2019, CT: Computed tomography, ICU: Intensive care unit

Table 4: Association of laboratory parameters with CT severity score in COVID-19 patients (*n*=90)

Parameter	Mild (*n*=18)	Moderate (*n*=43)	Severe (*n*=29)	*P*-value
CRP (mg/L)	22.3±11.1	56.4±24.5	102.7±35.3	<0.001
D-dimer (mg/L)	0.38±0.15	1.01±0.58	2.26±0.77	<0.001
Ferritin (ng/mL)	220.7±85.1	587.3±171.9	978.6±204.2	<0.001
SpO_2 on admission (%)	96.4±1.8	91.5±3.2	85.2±5.6	<0.001

COVID-19: Coronavirus disease 2019, CT: Computed tomography, CRP: C-reactive protein, SpO_2: Oxygen saturation

Table 5: Predictive accuracy of pulmonary CT severity score for mortality in COVID-19 patients (*n*=90)

Parameter	Value (%)
Optimal CTSS cut-off	≥18
Sensitivity	84.6
Specificity	82.3
Positive predictive value	57.9
Negative predictive value	95.7

COVID-19: Coronavirus disease 2019, CT: Computed tomography, CTSS: Computed tomography severity score

mortality.[8] Our results further corroborate this, with ICU admissions and mechanical ventilation needed in 72.4% and 58.6% of patients with severe CTSS, respectively, compared to none in the mild group ($P < 0.001$). Mortality in our severe CTSS group was 37.9%, which aligns with studies from China, India, and Europe, where mortality ranged between 30% and 45% among patients with CTSS >18.[6,18,19] The optimal cut-off of CTSS ≥18 in our study also showed high predictive accuracy (area under the curve [AUC] = 0.903), which is comparable to the AUC values reported by Saeed *et al*. (0.89) and Tabatabaei *et al*. (0.91), emphasizing the high reliability of CTSS in mortality prediction.[11,20] The laboratory parameters in our study showed a significant correlation with CTSS. Higher scores were associated with elevated CRP, ferritin, and D-dimer levels, and reduced SpO_2 on admission. These findings are in agreement with Zhao *et al*., who demonstrated that elevated inflammatory markers and hypoxia correspond with extensive pulmonary involvement in CT imaging.[21] Ferrando *et al*. also found CTSS to be a better predictor of systemic inflammation than clinical scores alone.[22] In terms of demographic distribution, our mean patient age was 56.2 years, with male predominance (64.4%). This matches earlier reports by Li *et al*. and Kanne *et al*., who noted a higher susceptibility among older males with comorbidities.[5,23] The high prevalence of hypertension (46.7%) and diabetes (43.3%) among our patients also parallels the data from global and regional studies, which have identified these comorbidities as independent risk factors for severe COVID-19 and worse imaging scores.[2,24] Our study is among the few in South Asia to systematically assess CT severity scoring in hospitalized COVID-19 patients and compare it with clinical outcomes. A comparable study from India by Jain and Agarwal also observed that CTSS above 15 was significantly associated with oxygen requirement and ICU admission, reinforcing the clinical applicability of CT scoring systems in resource-constrained settings.[25] Another Bangladeshi study by Rahman and Sathi similarly

found CTSS >17 to be an independent predictor of mortality and multi-organ dysfunction, supporting our findings.[16]

Limitations of the study

Several limitations must be acknowledged. This was a single-center study with a relatively small sample size, which may limit generalizability. The retrospective nature and lack of long-term follow-up data might underestimate the delayed outcomes. In addition, interobserver variability in CT scoring, although minimized by having two radiologists, cannot be entirely ruled out.

Conclusion

This study demonstrates a significant correlation between pulmonary CTSSs and clinical outcomes in COVID-19 patients admitted to a tertiary hospital in Bangladesh. Higher CTSSs were strongly associated with increased need for oxygen therapy, ICU admission, mechanical ventilation, prolonged hospital stay, and mortality. These findings support the use of CT severity scoring as a practical and valuable prognostic tool for early risk stratification and clinical decision-making in COVID-19 management, particularly in resource-limited healthcare settings.

Recommendation

Based on the findings, we recommend incorporating chest CT severity scoring into routine assessment protocols for hospitalized COVID-19 patients to aid in the early identification of high-risk individuals. This can help guide timely escalation of care, optimize resource allocation, and improve clinical outcomes – especially in settings with limited ICU capacity. Further multicenter studies with larger cohorts are encouraged to validate these findings and standardize CT scoring thresholds for clinical use.

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Conflict of Interest

None declared.

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