IM - COMMENTARY

CT score in COVID-19-related pneumonia, the radiologist, and the internist. Trying to unmask who is "the good", who is "the bad" and who is "the ugly"

Giulia Crisci[1] · Valeria Valente[1] · Andrea Salzano[2] · Antonio Cittadini[1] · Alberto Maria Marra[1,3,4]

"You may run the risks, my friend, but I do the cutting"

Clint Eastwood (Blondie) to Eli Wallach (Tuco the ugly)
"The good, the bad and the ugly", Sergio Leone, 1966.

After the first cases of the coronavirus disease 2019 (COVID-19) [1], caused by the diffusion of the severe acute respiratory syndrome-corona virus-2 (Sars-CoV-2) [2], the rapid increase of cases provoked a dramatic global health threat, with millions of people at risk worldwide. Although coronavirus disease has multiorgan involvement with various extrapulmonary manifestations [3, 4], pneumonia is the most frequent severe manifestation of the disease with fever, dry cough, shortness of breath, and fatigue up to acute distress respiratory syndrome (ARDS) and death [5].

Computed tomography (CT) of the chest can be considered as a cornerstone for COVID-19 diagnosis; specifically, there are typical radiologic features, as bilateral distribution ground-glass opacities, consolidation in a peripheral distribution, interlobular septal thickening, and crazy-paving pattern [6]. Therefore, chest CT can be used to objectively quantify the extent of lung opacities at a greater extent than chest radiography. Moreover, it is also helpful for COVID-19 classification and staging, and monitoring eventual disease progression.

In the present issue of the Internal and Emergency Medicine journal, Luo et al. proposed a novel score based on the severity of lung involvement assessed by admission CT scan and evaluated its association with clinical outcomes in COVID-19 patients [7]. A retrospective multi-center cohort of 496 patients from 24 COVID-19 hospitals in the Jiangsu province in China was analyzed. Patients were divided into four groups using a quantitative evaluation with CT scoring system depending on the percentage of pulmonary opacity (described as ground-glass opacities or consolidation area) relative to the entire lung on CT images. As a result, the authors showed that CT pulmonary score was independently associated with demographic/clinic characteristics (e.g., age, single onset, fever, and cough) and blood biomarkers (e.g., peripheral capillary oxygen saturation, lymphocyte count, platelet count, albumin level, C-reactive protein (CRP) level and fibrinogen level on admission). In addition, a higher chest CT score was an independent predictor of disease severity, and associated with intensive care unit admission, respiratory failure, and a more prolonged hospital stay when compared with patients with a lower score.

The topic is of great interest, and the present study, detached from previous ones, confirmed that chest CT findings in coronavirus disease 2019 quantified with pulmonary opacity score were strongly correlated with morbidity and clinical outcomes in COVID-19 patients. The current study represents a model of quantitative evaluation using scoring system, offering a simple and easily reproducible quantitative parameter of the extent pulmonary parenchymal involvement. As a strength of the present report, the cohort is larger than most of the previously published studies, and authors included also asymptomatic/mildly symptomatic patients, that usually have been excluded from other reports.

However, there are many issues that deserved further investigations. For instance, among most common and severe complications of COVID-19 due to

✉ Alberto Maria Marra
alberto_marra@hotmail.it; albertomaria.marra@unina.it

1   Department of Translational Medical Sciences and Interdisciplinary Research Centre in Biomedical Materials (C.R.I.B.), University Federico II of Naples, Via Pansini 5, 80131 Naples, Italy

2   IRCCS SDN, Diagnostic and Nuclear Research Institute, Naples, Italy

3   Centre for Pulmonary Hypertension, Thoraxklinik at Heidelberg University Hospital, Heidelberg, Germany

4   Translational Lung Research Center Heidelberg (TLRC), Member of the German Center for Lung Research (DZL), Heidelberg, Germany

Table 1 Key studies dwelling upon CT-derived score in hospitalized patients with COVID-19

Author, year of publication (references)	Study design	Patients age women (%)	Score CT scan	Results
Wang et al. [15]	Retrospective study	$N = 161$ 45 ± 12 y 44.7% w	0: no involvement (0%) 1: mild (1–49%) 2: moderate (50–75%) 3: severe (> 75%) Range 0–3 Global score 0–15	CT visual severity score was the factor with the highest odds [odds ratio 5.86 (95% CI 1.70–20.23)] for predicting in-hospital complications, allowed guide early intervention
Hu et al. [16]	Retrospective study	$N = 73$ 67 ± 12 y 26% w	0: 0% 1: 1–25% 2: 26–50% 3: 51–75% 4: 76–100% Range 0–4 Global score 0–20	Highest CT score was correlated to mortality and moderate positive score with inflammatory parameters
Francone et al. [17]	Single-center retrospective analysis	$N = 130$ 63.2 ± 15.8 y 35.4% w	0: 0% 1: < 5% 2: 5–25% 3: 26–50% 4: 51–75% 5: > 75 Range 0–5 Global score 0–25	CT score is highly correlated with laboratory findings and disease severity
Zhao et al. [18]	Retrospective study	$N = 101$ 44.44 ± 12.32 y 49% w	0:0% 1: < 25% 2: 25–49% 3: 50–74% 4: > = 75% Range 0–4 Global score 0–24	Score CT scan corresponding with gravity of clinical status
Aalinezhad et al. [19]	Cross sectional study	$N = 270$ 60.72 ± 16.74 y	0:0%; 1: < 50%; 2: > 50% Range 0–2 Global score 0–40	Hypoxia was inverse correlated with CT severity score
Guillo et al. [20]	Retrospective study	$N = 214$ 59 ± 19 y 44.3% w	0–10% 11–25% 26–50% 51–75% 76–100%	CT score > 25% was associated with intubation and death
Luo et al. [7]	Multi-center cohort study	$N = 496$ 45.10 ± 17.13 y 45.6% w	< = 5% 6–20% 21–40% > 41%	Patients with high pulmonary opacity score (> = 41%) had a high risk of poor prognosis

multiple pathologic processes, there is pulmonary embolism that was not available in the study analysis. Indeed, according to a recently published retrospective charts analysis, almost 20% of patients admitted for ARDS due to COVID-19 presented concomitant pulmonary embolism [8]. Furthermore, mortality is not included in the analysis, with authors claiming that a considerable number of deaths have been avoided, because of the use of a self-reported

program, which encompasses an early recognition of high-risk and critically ill patients, early intervention guided by intensivists, clinical experts-guided hierarchical management strategy, and adequate material and human resources [9]. Although very intriguing, such a low survival rate is highly surprising, considering that COVID-19 related mortality accounts from 26 to 61% according to different reports [2, 5]. Moreover, it is quite surprising that in the present study a limited number of comorbidities were reported in the study population considering that COVID-19 patients usually present a high rate of comorbidities which in turn have a remarkable impact on clinical outcomes [3]. Finally, there was no relationship between CT severity score and crucial laboratory parameters recurrently used during COVID-19 pandemic such as transferrin, lactate dehydrogenase, troponin, and inflammation related factors of leucocytes, neutrophils, and IL-2R [10].

Several studies have been published so far aimed in providing clinicians a diagnostic and prognostic score of pulmonary involvement in COVID-19 pneumonia, as shown in Table 1. This spread of CT scan derived scores, stems from the motivated need to synthesize imaging findings and to consequently drive a quick clinical-therapeutic decision-making in hospitalized patients. However, the latter should not be based only on these tools and must always be interpreted in the light of the whole clinical picture. For instance, it is well-known that in COVID-19 pneumonia there is a mismatch between the degree of lung morphological involvement and the patient's symptoms, a phenomenon also known as "happy hypoxia" [11–13].

In this regard, a recent editorial published on *Nature Medicine*, referring to the "*Choosing Wisely*" campaign, stressed how there are still no data available to justify the use of CT scan and derived scores to guide management of patients with COVID-19 pneumonia [14] and a systematic use of this diagnostic technique without and underlying valid clinical indication should be avoided.

Therefore, similarly to what 'the blondie' stated to 'Tuco the ugly' in Sergio Leone's masterpiece 'The good, the bad, and the ugly', although imaging support is absolutely needed and useful, the radiology may run all the risks, but who must always make the final cuttings is the internist.

Declarations

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