AUCTORES
Globalize your Research

Clinical Research and Clinical Trials

Alireza Almasi Nokiani*

Open Access

Short communication

Making the best use of CT Quantification Scores in Management of COVID-19 Patients

Alireza Almasi Nokiani

Department of Radiology, Firoozabadi Hospital, Iran University of Medical Sciences, Tehran, Iran.

Corresponding Author: Alireza Almasi Nokiani, Department of Radiology, Firoozabadi Hospital, Iran University of Medical Sciences, Tehran, Iran.

Received date: March 14, 2022; **Accepted date:** April 05, 2022; **Published date:** April 14, 2022

Citation: Alireza Almassi Nokiani. (2022) Making the best use of CT Quantification Scores in Management of COVID-19 Patients. *Clinical Research and Clinical Trials*. 5(5); DOI: 10.31579/2693-4779/091

Because of the primary involvement of the respiratory system, chest computed tomography (CT) is strongly recommended in suspected COVID-19 cases, for both initial evaluation and follow-up [1]. At least seven scoring systems using chest CT have been proposed to quantify lung involvement in COVID-19 which are summarized in table 1 [1-10] and we use the term CT severity score (CTSS) to refer to them with numbers 1-7 to refer to a specific scoring system.

CTSSs	Segmentation	Severity Score for each segment	Maximum Score
CTSS1 [2,3]	Three zones in each lung are divided by carina and lower pulmonary vein	1-4 according to percentage of involvement (<25, 25-49, 50-74, >75)	24
CTSS2 [4]	The same zonal concept as CTSS1 with additional division of each zone into anterior and posterior regions divided by midpoint of diaphragm antero-posteriorly	1-4 according to percentage of involvement (<25, 25-49, 50-74, >75)	48
CTSS3 [5,6]	Five anatomic lobes of the lungs	1-4 according to percentage of involvement (<25, 25-49, 50-74, >75)	20
CTSS4 [7,8]	Five anatomic lobes of the lungs	1-5 according to percentage of involvement (>5, 5-25, 25-49, 50-74, >75)	25
CTSS5 [current authors]	Five anatomic lobes of the lungs with additional consideration of the lingula as a separate lobe	1-5 according to percentage of involvement (>5, 5-25, 25-49, 50-74, >75)	30
CTSS6 [9]	Five anatomic lobes of the lungs	1-4 according to the diameter of the largest lesion in each lobe (<1cm, 1-3cm, >3cm up to 50% of the lobe, >50% of a lobe	20
CTSS7 [10]	18 anatomic segments of the lung with an additional division of apico-posterior segment of the left upper lobe into apical and posterior divisions and anteromedial segment of the left lower lobe into anterior and medial segments	No involvement=0 <50% involvement=1 ≥50% involvement=2	40

Table 1: Seven proposed COVID-19 CT severity score systems

Clinical severity of the disease has been judged more or less as is presented in table 2 [11] in most studies [1-10, 13-15]. A more simplified classification which may be used is: mild= no hospital admission, moderate= hospital admission, severe= intensive care unit (ICU) admission, critical= intubation or death [12]. Many attempts to correlate clinical severity of the disease at presentation (for triage) or disease outcome (for prognostication) with CTSSs have been published [1-10, 12-15]. Initial reports on performance of these scoring systems in triage showed promising results in small groups of less severely affected patients; with area under the curve (AUC) up to 0.918 for receiver operator characteristic (ROC) curve to diagnose severe/critical disease [6,10]. Later studies showed less impressive figures with AUC for ROC

curves up to 0.7 for diagnosis of severe/critical disease (for triage) and up to 0.77 for prediction of severe/critical disease at the most severe period of disease (for prognostication) and up to 0.79 for prediction of critical disease (intubation or death) [12-15]. Another issue about CT disease quantification in COVID-19 patients is interrater reliability. Good interrater reliability is achievable in all scoring systems [6,10,13].

Measured Indicator/Severity [a]	Mild	Moderate	Severe	Critical
Respiratory Rate	≥24	≥30	-	-
SPO_2	≥93	93>SPO_2≥90	89>SPO_2≥85	<85 [b]
Respiratory Distress	None	None	Mild to moderate	Severe [c]
Blood Pressure	-	-	-	<90/60

Table 2: Clinical severity of COVID19

a: presence of any of the severity indicators of the more severe group places the patient in the more severe group
b: despite high-flow O_2 administration
c: nasal flaring, air hunger, intercostal retraction, subcostal retraction

We have reported a comparative study on the performance of these 7 different CTSS systems. The study had aimed to determine the value of CTSS in making decisions about the intensity of the treatment of respiratory failure (triage) and predicting the risk of development of severe/critical disease in the course of COVID-19 in correlation with selected clinical parameters (prognostication). We observed little difference in performance between the 7 scoring systems (ROC curve AUCs for triage = 0.67-0.7 and AUCs for prognostication = 0.76-0.79) and all of them showed good interrater reliability so that intraclass correlation coefficient (ICC) was 0.77-0.84 [13].

The scoring systems with more numerous segmentations in the lung parenchyma showed better interrater reliability [13]. *Therefore, it is wise to use CTSS2, CTSS7, or CTSS5 if a later follow-up by CT is contemplated or if the scores are going to be used in an analytical study.*

There are many comorbidities which may aggravate COVID-19, for example, hypertension, obesity, diabetes, active cancer, chemotherapy, solid organ transplant, chronic kidney disease and immunosuppressive therapy [16]. Most of these comorbidities including hypertension result in disturbances in immune system [16] which may present as more extensive inflammation leading to higher scores on CT images. Regarding CT severity quantification, two other comorbidities are of special importance: heart failure and preexisting lung disease, because they may lead to more severe disease and higher mortality rate without increasing the extent of COVID-19 lung involvement on CT. Considering the whole patients population heart failure is a major risk factor for in-hospital mortality [17-18] with odds ratio of 3.46 reported in a systematic review [16]. Preexisting respiratory disease has also a major impact on the COVID-19 mortality with a reported adjusted odds ratio of 1.36 in a study [19]. *Consequently, it is a good practice to place patients with heart failure or preexisting significant pulmonary disease in the high-risk group without any judgment upon their CTSS.*

Last but not least is that CTSS is most accurate in COVID-19 patients' triage in those ≥65 years old and is of limited value in the lower age groups as we have shown in another study by excellent AUC for ROC curve of up to 0.83 (for CTSS2) for triage of severe/critical patients ≥65 years old [20]. Overall, AUC for ROC curves for triage of severe/critical disease is less with AUC for ROC curves of up to 0.7 (for CTSS1, CTSS2 and CTSS4) [13,20]. *Hence, we recommend using CTSS for triage of patients aged ≥65, more specifically CTSS2 or CTSS5. If CTSS is to be used in all patients irrespective of age, using CTSS1, CTSS2, or CTSS4 is recommended.*

Although CTSSs on presentation CT scans show acceptable AUCs for ROC curves to be used in prediction of severe/critical or critical COVID-19 (for prognostication) with AUCs of 0.76-0.79, the best performance is present for patients aged ≥65 (AUC= 0.81-0.92) with outstanding figures of 0.92 for CTSS2 and 0.90 for CTSS1 and CTSS5 in prediction of severe/critical disease [20]. *Thus, we recommend using CTSS2, CTSS1, or CTSS5 for prognostication in patients aged ≥65, although the use of all CTSSs in all age groups is also an acceptable practice for prognostication.*

References

1. Jin YH, Cai L, Cheng ZS, Cheng H, Deng T, Fan YP, Fang C, Huang D, Huang LQ, Huang Q, Han Y. (2020). A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). Military Medical Research. 7(1):1-23.
2. Xie X, Zhong Z, Zhao W, Zheng C, Wang F, Liu J. (2020). Chest CT for typical coronavirus disease 2019 (COVID-19) pneumonia: relationship to negative RT-PCR testing. Radiology. 296(2):41-45.
3. Zhao W, Zhong Z, Xie X, Yu Q, Liu J. (2020). Relation between chest CT findings and clinical conditions of coronavirus disease (COVID-19) pneumonia: a multicenter study. American Journal of Roentgenology. 214(5):1072-1077.
4. Zhou S, Wang Y, Zhu T, Xia L. (2020). CT features of coronavirus disease 2019 (COVID-19) pneumonia in 62 patients in Wuhan, China. American Journal of Roentgenology. 214(6):1287-94.
5. Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, Cui J, Xu W, Yang Y, Fayad ZA, Jacobi A. (2020). CT imaging features of 2019 novel coronavirus (2019-nCoV). Radiology. 295(1):202-207.
6. Li K, Fang Y, Li W, Pan C, Qin P, Zhong Y, Liu X, Huang M, Liao Y, Li S. (2020). CT image visual quantitative evaluation and clinical classification of coronavirus disease (COVID-19). European radiology. 30(8):4407-4416.
7. Pan F, Ye T, Sun P, Gui S, Liang B, Li L, Zheng D, Wang J, Hesketh RL, Yang L, Zheng C. (2020). Time course of lung changes on chest CT during recovery from 2019 novel coronavirus (COVID-19) pneumonia. Radiology.
8. Saeed GA, Gaba W, Shah A, Al Helali AA, Raidullah E, Al Ali AB, Elghazali M, Ahmed DY, Al Kaabi SG, Almazrouei S. (2020). Correlation between Chest CT Severity Scores and the Clinical Parameters of Adult Patients with COVID-19 pneumonia. Radiology Research and Practice.
9. Xiong Y, Sun D, Liu Y, Fan Y, Zhao L, Li X, Zhu W. (2020). Clinical and high-resolution CT features of the COVID-19 infection: comparison of the initial and follow-up changes. Investigative radiology.

10. Yang R, Li X, Liu H, Zhen Y, Zhang X, Xiong Q, Luo Y, Gao C, Zeng W. (2020). Chest CT severity score: an imaging tool for assessing severe COVID-19. Radiology: Cardiothoracic Imaging. 2(2):200047.
11. Islamic Republic of Iran, Ministry of Health and Medical Education, [Guide to the diagnosis and treatment of Covid-19 disease at the levels of outpatient and inpatient services].
12. Aminzadeh B, Layegh P, Foroughian M, Tavassoli A, Emadzadeh M, Teimouri A, Maftouh M. (2021). Evaluation of the Prognostic Value of Chest Computed Tomography Scan in COVID-19 Patients. Iranian Journal of Radiology. 18(2).
13. Nokiani AA. (2021). CT-severity Score in COVID-19 patients, Assessment of Performance in Triage and Outcome Prediction: A Comparative Study of Different Methods. Authorea Preprints.
14. Hajiahmadi S, Shayganfar A, Janghorbani M, Esfahani MM, Mahnam M, Bakhtiarvand N, Sami R, Khademi N, Dehghani M. (2021). Chest Computed Tomography Severity Score to Predict Adverse Outcomes of Patients with COVID-19. Infection & chemotherapy. 53(2):308.
15. Aziz-Ahari A, Keyhanian M, Mamishi S, Mahmoudi S, Bastani EE, Asadi F, Khaleghi M. (2022). Chest CT severity score: assessment of COVID-19 severity and short-term prognosis in hospitalized Iranian patients. Wiener Medizinische Wochenschrift. 8:1-7.
16. Ng WH, Tipih T, Makoah NA, Vermeulen JG, Goedhals D, Sempa JB, Burt FJ, Taylor A, Mahalingam S. (2021). Comorbidities in SARS-CoV-2 patients: a systematic review and meta-analysis. MBio. 12(1):03647-03620.
17. Yonas E, Alwi I, Pranata R, Huang I, Lim MA, Gutierrez EJ, Yamin M, Siswanto BB, Virani SS. (2021). Effect of heart failure on the outcome of COVID-19—a meta-analysis and systematic review. The American journal of emergency medicine. 46:204-211.
18. Sokolski M, Reszka K, Suchocki T, Adamik B, Doroszko A, Drobnik J, Gorka-Dynysiewicz J, Jedrzejczyk M, Kaliszewski K, Kilis-Pstrusinska K, Konopska B. (2022). History of Heart Failure in Patients Hospitalized Due to COVID-19: Relevant Factor of In-Hospital Complications and All-Cause Mortality up to Six Months. Journal of Clinical Medicine. 11(1):241.
19. Lohia P, Sreeram K, Nguyen P, Choudhary A, Khicher S, Yarandi H, Kapur S, Badr MS. (2021). Preexisting respiratory diseases and clinical outcomes in COVID-19: a multihospital cohort study on predominantly African American population. Respiratory research. 22(1):1-9.
20. Alireza Almasi Nokiani, Razieh Shahnazari, Mohammad Amin Abbasi, Farshad Ddivsalar, Marzieh Bayazidi, Azadeh Sadatnaseri, Caspian journal of internal medicine. 13.

DOI: 10.31579/2693-4779/090