

# RAPID score in Covid-19 patients: a clinical-radiological index for the safe discharge from the Emergency Department. A preliminary report

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## Abstract

To evaluate the performance of a clinical-radiological index (RAPID-Covid score) in achieving Safe Discharge (SD) of patients accessing the Emergency Department (ED) with symptoms suggesting Covid-19. Clinical and radiological data were retrospectively collected from 853 consecutive patients admitted to the ED during the pandemic with symptoms suggesting Covid-19. Illness severity was graded with RAPID-Covid score, composed of chest X-ray findings, clinical symptoms and PaO<sub>2</sub>/FiO<sub>2</sub>. Patients with RAPID-Covid score  $\geq 5$  were admitted. Primary outcome was SD of patients to home care. SD was defined as survival of the patient, without evidence of second access to ED requiring hospitalization. 212/853 patients were discharged. 27/212 had a score  $\geq 5$  but refused admission. 185/212 were discharged with score  $< 5$ : 147/185 (79,5%) survived and did not re-access ED; 1/185 (0,5%) died at home after first ED-dismissal; 37/185 (20,0%) had a second access. Of these 15/37 (8,1%) were newly dismissed and one of them (1/15) died at home; 22/37 (11,9%) were hospitalized, 1/22 died during hospitalization. SD was obtained in 161/185 patients (87%). Readmissions occurred 5,1 $\pm$ 2,6days from first discharge. Follow-up was 16,7 $\pm$ 6,0days. RAPID-Covid score proves useful for SD of Covid-19 to home care. 6-10days may further increase confidence.

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Key words: Covid-19; triage; score; RAPID-Covid score; Chest X-Ray

Conflict of interest: No one. This work was not supported by any grant. Ethics approval and consent to participate: The manuscript does not contain any individual person's data in any form.

Received for publication: 17 June 2020.

Accepted for publication: 7 November 2020.

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Emergency Care Journal 2020; 16:9192

doi:10.4081/ecj.2020.9192

## Introduction

Coronavirus disease 2019 (Covid-19) is a respiratory tract infection caused by a newly emergent coronavirus, SARS-CoV-2. The pathogen caused an outbreak of respiratory illness that rapidly spread worldwide becoming a public health emergency. On February 20<sup>th</sup> 2020, the first Italian case of Covid-19 was reported in Lombardy. With the exponential spread of the disease, the provinces of Cremona, Lodi, Bergamo and Brescia became the epicenter of the epidemic in Italy. From February 23<sup>rd</sup> to April 2<sup>nd</sup> 2020, a total of 5402 people was admitted to the Emergency Department (ED) of *ASST Spedali Civili* of Brescia with symptoms suggesting infection from SARS-CoV-2. The whole system was stressed and the crowding in the ED was a major concern. From the available data, while the majority of people with Covid-19 have uncomplicated or mild illness (81%), some develop pneumonia, and approximately 5% will require Intensive Care Unit treatment.<sup>1</sup> In the first stages of the epidemics, given the little experience in dealing with the new disease, admission rates were high, even amongst patients with relatively modest symptoms. By the time the disease spread, a higher number of critical patients accessed the ED. The shortage of bed places imposed difficult admission choices. Patients with mild illness may not require hospitalization, unless there is significant likelihood of fast deterioration of clinical conditions that might impede timely return to the hospital. Early identification of signs of severe illness, such as bilateral pneumonia, allows prompt initiation of optimized treatments.<sup>2,3</sup> Currently, there are no guidelines supporting the decision between discharge and hospitalization in Covid-19 patients. In particular, a criterion for the Safe Discharge (SD) of patients presenting to the ED has not been identified yet. Several Italian hospitals employ Chest X-Ray (CXR) as a first-line triage tool, due to long Reverse Transcription Polymerase Chain Reaction (RT-PCR) turnaround times. Although Computed Tomography (CT) outperforms CXR in sensitivity and specificity,<sup>4,6</sup> CXR currently remains the imaging modality of choice, due to the high workload of patients in need of evaluation and the concerns on radiation exposure.<sup>7</sup>

This article reports the preliminary results of our experience in clinical and radiological assessment of suspect Covid-19 patients accessing the ED. Given the lack of agreed guidelines on the hospitalization of such patients, our decision-making process was critically and retrospectively analyzed. The aim was to identify SD criterion in Covid-19 patients.

## Materials and Methods

### Study Design and Time period

We retrospectively analyzed medical records of 853 consecu-

tive patients admitted to the ED from March 4<sup>th</sup> to April 24<sup>th</sup>, 2020 with suspect Covid-19. Despite 5402 patients accessing our ED, we considered the first 853 patients only. The choice was due to limited resources and time. In order to avoid any possible bias, we collected data from the first consecutive patients accessing ED, applying no inclusion or exclusion criteria (except that from symptoms suggesting Covid-19 at presentation).

### Study Design

The suspect of SARS-CoV-2 infection was defined as the presence of clinical symptoms (fever, cough, dyspnea, and gastrointestinal symptoms), hypoxia, and/or the presence of interstitial infiltrates on CXR or CT.

We recorded the clinical data, laboratory parameters (PaO<sub>2</sub>/FiO<sub>2</sub> ratio), and radiological findings.

All patients, according to institutional protocols, underwent vital parameters assessment (arterial blood pressure, body temperature, heart rate, peripheral non-invasive oxygen saturation), Arterial-Blood-Gas (ABG) analysis, routine venous blood laboratory tests, ECG and CXR or CT.

Two scores, locally designed, were applied to assess the patients.

The first is the CXR score: a radiological score, aimed at evaluating Covid-19 manifestation in the lung.<sup>8</sup> As preliminary data from CXR score application show, radiological imaging plays a crucial role in the detection and management of Covid-19 patients. It shows good inter-operator reproducibility and correlates with clinical outcome, with higher scores predicting higher death rates among a population of 100 Covid-19 hospitalized patients.

The second score is the RAPID-Covid score (Rapid evaluation of Anamnesis, PO<sub>2</sub>, Imaging disease, Dyspnea-Covid Score), a clinical-radiological index retrospectively applied to grade the severity of the disease and based on clinical symptoms, PaO<sub>2</sub>/FiO<sub>2</sub> and the CXR score (Table 1).

The RAPID-Covid score ranges from 1 to 10 points, assigned as follows:

- Presence of symptoms: fever, cough, gastrointestinal symptoms =1pt; dyspnea =2pts;
- PaO<sub>2</sub>/FiO<sub>2</sub> ratio: >350=0pt; 350-300=2pts; <300=4pts
- CXR score: 0pts if CXR score ≤ 3; 2pts if CXR score 4 or 5; 4pts if CXR score ≥6.

RAPID-Covid score ≥ 5pts was considered as indicative of severe disease and therefore adopted as threshold for hospitalization: in fact, such score may be reached when respiratory insufficiency ensues (4 pts from PaO<sub>2</sub>/FiO<sub>2</sub> pts, 1 or more from symp-

toms) or when CXR shows severe pneumonia (4 pts from CXR, 1 or more from symptoms).

The final decision (discharge or hospitalization) was recorded.

### Outcome Measures

SD of patients was considered the primary outcome. Patients with no second access to the ED and not reported as dead by the regional registry were classified as safely discharged.

### Data Analysis

SD was evaluated as a time-dependent variable and was analyzed by means of a Kaplan-Meier survival curve.

Numerical data is reported as medium value ± one standard deviation value ( $\mu \pm \sigma$ ).

Data processing and analysis was performed using SPSS Statistics 22.0 software for Windows.

## Results

Overall, 641/853 (75,1%) patients were hospitalized and excluded from the evaluation of the primary outcome. A total of 212/853 (24,9%) patients were discharged. Twenty-seven out of 212 (12,7%) patients manifesting severe disease (due to desaturation – PaO<sub>2</sub>/FiO<sub>2</sub><350 - and/or chest X ray findings), classified with RAPID-Covid score ≥5 were not hospitalized because they refused admission. They were discarded from the study.

The analysis is therefore based on 185 patients (93 males and 92 females, average age of 51,2 ± 14,2 years) discharged from the ED, all classified with RAPID-Covid score <5. Covid-19 was confirmed through RT-PCR-testing in 131/185 (70,8%). Patients with uncertain (12/185; 6,5%), unavailable (8/185; 4,3%) or negative (34/185; 18,4%) RT-PCR were treated as Covid-19 positive based on clinical and radiological findings: in 8/185 patients (4,3%) Covid-19 diagnosis was based on CT findings.

The distribution of the RAPID-Covid score points in the population is reported in Table 2.

Thirty-seven out of 185 patients (20,0%) had a second access to the ED, motivated by the worsening of the initial symptoms or the onset of dyspnea. Patients accessing the ED a second time underwent a new, complete assessment, including new CXR acquisition and evaluation, vital parameters assessment, ABG analysis and venous blood laboratory tests. After re-assessment of the clinical condition, hospital admission was not deemed necessary in 15/37 (40,5%; corresponding to 8,1% of the patients initially dis-

**Table 1. RAPID-Covid score.**

Criteria	Points	
Suggestive symptoms: (fever, cough, gastrointestinal symptoms)	- without dyspnea	1 pt
	- with dyspnea	2 pts
PaO <sub>2</sub> /FiO <sub>2</sub> :	- >350	0pts
	- 350-300	2pts
	- <300	4pts
CXR Score:	- ≤3	0 pts
	- 4 or 5	2 pts
	- ≥6	4pts
<b>TOTAL SCORE</b>	1-10 pts	
<b>RAPID-Covid score range</b>	<b>Suggested Choice</b>	
1-4 Points	Safe-discharge	
5-10 Points	Hospitalization	

charged); 1/15 died at home 7 days after the second discharge from ED. 22/37 (59,5%; 11,9% of the patients initially discharged) were hospitalized. On average, hospitalization occurred  $5,1 \pm 2,6$  days (min 2, max 10) after the first access. 1/22 patients hospitalized after second access died due to Covid-19 related complications (4,6%): on second ED admission, the patient presented bilateral pneumonia (progressing to 13pts in CXR score).

148 out of 185 patients (80,0%) were discharged to home care with no new access; to our knowledge, after cross-check with the regional death-registry, 147/148 (99,3%) are alive, while 1/148 (0,7%) died at home 20 days after discharge. Alive patients after first and second discharge from ED were considered safely discharged, for a total of 161/185 (87%).

The average length for the follow-up of discharged patients (n=148) was  $16,7 \pm 6,0$  days (range 2-36 days); at day 3 there were 179 patients in follow-up and 8 cumulative events were registered; at day 9, 147 patients and 22 events; at day 15, 129 patients and 22 events.

Figure 1 shows Kaplan-Meier analysis of the re-admission rate during time in the population under evaluation.

## Discussion

### Interpretation of findings

Covid-19 epidemic spread resulted in an overwhelming number of accesses to the ED, in a context of shortage of logistic resources in hospitals.<sup>9</sup>

Our purpose was to identify a simple and immediate tool, aimed at supporting the ED physician in the decision on the single patient's triage and management. Preliminary data<sup>10-13</sup> on the clinical course of Covid-19 illness suggest the frequent event of major complications intervening in apparently stable and non-critical patients in sub-acute setting.<sup>14</sup> We wanted, therefore, to address the necessity of ED physicians to confidently identify patients at low risks that can be "safely" discharged.

The RAPID-Covid score was specifically intended to be as rapid and simple as possible and thus was designed on clinical data, ABG analysis and CXR assessment. It must be emphasized that, consequently, the RAPID-Covid score cannot account for other variables that influence the decision-making about the single

patient (e.g. comorbidities). Therefore, the RAPID-Covid score aids the decisional process with no aim to replace the physician's judgement based on a global clinical evaluation. From a clinical perspective, as severe pneumonia is the most common diagnosis in Covid-19 patients, PaO<sub>2</sub>/FiO<sub>2</sub> ratio was chosen as a relevant and easily accessible parameter. The threshold in PaO<sub>2</sub>/FiO<sub>2</sub> was assessed on clinical experience in accordance with published literature focusing on the criteria for the diagnosis of acute lung injury, both in Covid-19<sup>15-20</sup> and non-Covid-19 patients.<sup>21,22</sup> The choice to assign a score based on presence of suggestive symptoms (fever, cough, gastrointestinal symptoms =1pt; dyspnea =2pts) was based on evidence reporting worsening of the disease and onset of pneumonia on average 5-7 days after the onset of symptoms.<sup>16,17,10</sup> The event is usually announced by the onset or the fast worsening of

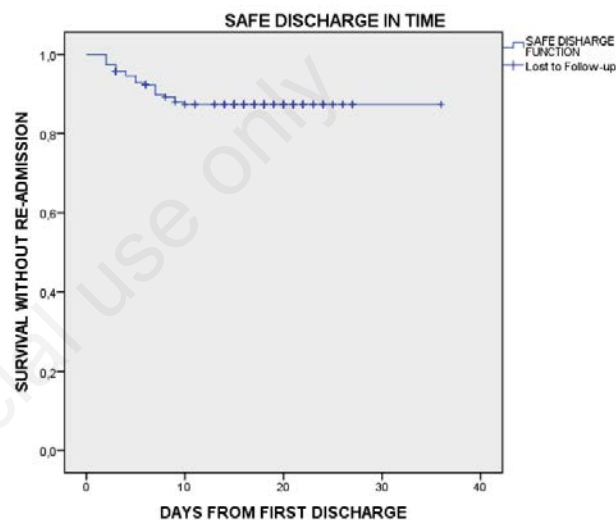


Figure 1. Figure 1. The chart shows Kaplan-Meier analysis of survival without re-admission in the population under evaluation. The average length for the follow-up of discharged patients (n=148) was  $16,7 \pm 6,0$  days (range 2-36 days); at day 3 there were 179 patients in follow-up and 8 cumulative events were registered; at day 9, 147 patients and 22 events; at day 15, 129 patients and 22 events.

Table 2. RAPID-Covid score data distribution.

RAPID-Covid score points	Number of patients	%	Cumulative %
Clinical evaluation (1;2pts)			
1	158	85,4	85,4
2	27	14,6	100,0
PaO <sub>2</sub> /FiO <sub>2</sub> evaluation (0;2pts)			
0	179	96,8	96,8
2	6	3,2	100,0
4	0	0	100,0
Radiological evaluation (0;2;4pts)			
0	173	93,5	93,5
2	12	6,5	100,0
4	0	0	100,0
Overall evaluation (1-10 pts)			
1	146	78,9	78,9
2	21	11,4	89,3
3	11	6,0	95,3
4	7	3,7	100,0
>4	0	0	100,0

dyspnea and CXR findings. In the most severe cases, the disease evolves to acute respiratory distress syndrome and multi-organ failure.<sup>16,23</sup>

CXR assessment considered the presence of interstitial and/or alveolar abnormalities, as described by Borghesi *et al.*<sup>8</sup> in the CXR score. CXR scores were grouped in the RAPID-Covid score in three clusters. Mild and prevalently interstitial disease in different lung fields (CXR score 0-3) was given 0 points in the RAPID-Covid score. CXR score 3 may be assigned also when alveolar consolidation affects a single unilateral territory: in this case, however, Covid-19 would be unlikely and an alternative diagnosis should be considered (*e.g.* lobar pneumonia of bacterial origin). At the other end of the spectrum, multiple alveolar consolidations, suggesting bilateral or multilobar alveolar disease (CXR score  $\geq 6$ ) corresponded to 4 points in the RAPID-Covid score.

A CXR scoring system for Covid-19 pneumonia was reported also by Wong *et al.*,<sup>24</sup> aimed at quantifying the extent of the infection. Wong criteria assessed only the extent of lung involvement (expressed in percentage), without differencing between interstitial or alveolar alterations. In our opinion, this feature should be taken into consideration because it proves relevant in the differential diagnosis of Covid-19 and indicates two different stages of disease severity in the affected lung. The sensitivity of CXR for detection of Covid-19 pneumonia is known to be limited, compared to second-level techniques such as CT.<sup>25</sup> The latter better depicts focal ground-glass consolidations and linear interstitial thickening, typical manifestations of the disease. As a result, CXR should not be used as a rule-out exam for Covid-19. On the other hand, however the impact of the limited sensitivity of CXR on the effectiveness of RAPID-Covid score is expected to be negligible: for the purposes of the scoring system, CXR contributes mainly quantifying the extent of the disease rather than defining its presence/absence (which is confirmed by RT-PCR-testing). Diffuse interstitial disease or alveolar consolidations are easily seen on CXR, contributing to stratify patients in need of hospitalization. To sum up, CXR is not an excellent tool for rule-out, but is effective in discriminating mild from extensive lung involvement, which is the goal of RAPID-Covid score assessment.

Several authors report the use of Lung UltraSound (LUS) as an extremely sensitive, cost-effective and readily available triage tool.<sup>26</sup> LUS is, however, poorly specific. A score correction for patients with negative CXR and positive LUS findings might also be considered. Further studies are required in order to see if such a correction in RAPID-Covid score composition could further increase its good performance in terms of safe discharge rate.

As the Kaplan-Meier survival analysis suggests, following the RAPID-Covid score a SD could be obtained in 87% of the patients with good confidence (129 patients still in follow-up and 22 re-admission events at day 15).

The timing of re-admission to ED, re-hospitalization or death in our series suggests that in the majority of cases clinical worsening or complications should be expected within 6 days from the first access.

### Clinical Implications

In a context characterized by the overwhelming number of patients, long illness duration and, consequently, relative shortage of human and logistical resources, the identification of a SD criterion is essential to aid the ED physician and to relieve the hospitals from the heavy burden of accesses and admissions. In addition, it could prevent unnecessary hospitalization events, which might result in avoidable complications and nosocomial infections. Even in the case of a subsequent re-admission, the hospital bed demand

may be diluted in time, delaying the peak of hospitalized patients and assuring the availability of standard of care to critical patients.

In the described scenario, the first organizational step is the expansion of hospital bed places, but the second has to be the implementation of territorial, out-of-hospital care units. The application of RAPID-Covid score might produce beneficial effects on the rationalization of both in-hospital and territorial resources.

### Strengths and Limitations

We acknowledge the limitations of our experience. First of all, the inclusion criteria resulted in a limited population. Secondly, this is a retrospective report of the strengths and limitations of two scores which were empirically produced at the beginning of the Covid-19 emergency, with few data and little scientific evidence available. Furthermore, no data on the potential "overtreatment" of the admitted patients is retrievable at the moment, even if this is expected to be actually minor. Similarly, a more extensive analysis, including further investigation on admitted patients scoring  $< 5$  and on admitted patients on the whole, could be interesting. This would add supplemental precious information on RAPID-Covid score safety and predictive potential, however it should be kept in mind that this study aimed at evaluating the performance of the score as a dismissing tool from ED. We are aware that the elements we used to build our score do not include all the potentially predictive factors, further investigation of the predictive value and complementary role of other clinical parameters and imaging findings (LUS) is to be encouraged.

### Conclusions

RAPID-Covid score demonstrated the potential to be a useful tool in discharging patients, even if monitoring at a territorial level is mandatory for 6-10 days from discharge. Despite the limitations, we hope our experience may prove useful for colleagues facing epidemic outbreaks as intense as the one occurred in Lombardy.

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