Chest CT in the emergency department for suspected COVID-19 pneumonia

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Abstract
Purpose In overwhelmed emergency departments (EDs) facing COVID-19 outbreak, a swift diagnosis is imperative. CT role was widely debated for its limited specificity. Here we report the diagnostic role of CT in two EDs in Lombardy, epicenter of Italian outbreak.

Material and methods Admitting chest CT from 142 consecutive patients with suspected COVID-19 were retrospectively analyzed. CT scans were classified in “highly likely,” “likely,” and “unlikely” COVID-19 pneumonia according to the presence of typical, indeterminate, and atypical findings, or “negative” in the absence of findings, or “alternative diagnosis” when a different diagnosis was found. Nasopharyngeal swab results, turnaround time, and time to positive results were collected. CT diagnostic performances were assessed considering RT-PCR as reference standard.

Results Most of cases (96/142, 68%) were classified as “highly likely” COVID-19 pneumonia. Ten (7%) and seven (5%) patients were classified as “likely” and “unlikely” COVID-19 pneumonia, respectively. In 21 (15%) patients a differential diagnosis was provided, including typical pneumonia, pulmonary edema, neoplasia, and pulmonary embolism. CT was negative in 8/142 (6%) patients. Mean turnaround time for the first COVID-19 RT-PCR was 30 ± 13 h. CT diagnostic accuracy in respect of the first test swab was 79% and increased to 91.5% after repeated swabs and/or BAL, for 18 false-negative first swab. CT performance was good with 76% specificity, 99% sensitivity, 90% positive predictive value and 97% negative predictive value.

Conclusion Chest CT was useful to streamline patients’ triage while waiting for RT-PCR in the ED, supporting the clinical suspicion of COVID-19 or providing alternative diagnosis.

Keywords COVID-19 · Diagnosis · Computed tomography · Triage · Emergency

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SARS-CoV-2 spread worldwide causing coronavirus disease 2019 (COVID-19) which may overlap seasonal flu and other respiratory diseases. COVID-19 lung involvement progresses toward a severe pneumonia in 15–20% of cases, requiring critical care in 5–10% of them [1]. Thus, expeditious and reliable diagnosis is imperative.

The cornerstone of COVID-19 diagnosis is RT-PCR from oral-nasopharyngeal swab. RT-PCR has near-perfect specificity, but limited sensitivity (30–70%) varying according to viral burden, symptoms severity, and time from symptoms onset [2]. Moreover, the turnaround time for results may be long in overwhelmed laboratories, as during pandemic...
growth [3]. Chest imaging showed good performance in COVID-19 pneumonia diagnosis [4–6], with chest X-ray representing the first line due to wide availability and portability [6], and CT outperforming RT-PCR sensitivity even in the early stages of the disease [5].

Despite the high sensitivity, the usage of CT to triage symptomatic patients with suspected COVID-19 pneumonia was questioned for a matter of specificity, being CT findings potentially overlapping to other viral pneumonia [7]. The aim of the study was to investigate the value of chest CT in triaging patients with suspected COVID-19 pneumonia in two emergency departments (EDs) in Lombardy, Italy.

We retrospectively analyzed 142 chest CT scans performed from March 8 to 30, 2020, at two tertiary-care University Hospitals in patients referring to the EDs for suspected COVID-19 pneumonia, with inconclusive or possible false-negative X-ray results [8]. Chest CT was performed on a dedicated scanner with a separated access applying standardized protocols for infection control.

According to RSNA Expert Consensus [9], chest CT scans were classified into: (i) “highly likely COVID-19” in the presence of typical findings, (ii) “likely COVID-19” in the presence of indeterminate findings, (iii) “unlikely COVID-19” in the presence of atypical findings for COVID-19, (iv) “alternative diagnosis” in case of findings indicative for a different causes of symptoms, and (v) “negative” (Fig. 1).

Nasopharyngeal swabs results were collected, including turnaround time, number of swabs performed, and time-to-positive results.

CT sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were measured, considering results from repeated swabs or bronchoalveolar lavage (BAL) as reference standard. Statistical analyses were performed using SPSS v.25.0.

All 142 patients (M = 101; median age 61 y.o. [interquartile range (IQR) 50–73]) suffered from fever (≥37.5 °C from a median of 7 days [IQR 3–10]), associated most frequently with cough (75/142, 53%), and dyspnea (45/142, 32%). Acute chest pain and gastrointestinal symptoms were rare (8/142, 6%, in both cases). At arrival, median oxygen saturation (SatO2) was 94% [89–96%].

CT and swab results are summarized in Fig. 2.

Chest CT was acquired without contrast, except in 8 patients to exclude vascular events.

Chest CT showed typical findings for COVID-19 pneumonia in most of cases (96/142, 68%), while it was...
classified as “likely COVID-19 pneumonia” in 10/142 (7%), “unlikely” in 7/142 (5%), and “negative” in 8/142 (6%). In 15% of patients (21/142) CT showed alternative diagnosis including lobar pneumonia, pulmonary edema, and neoplasia.

Turnaround time for first RT-PCR result was 30 ± 13 h (range 2–48 h). A median of 2 swabs was performed per patient.

Swab was negative for SARS-CoV2 infection in all CT scan classified as “unlikely” and “alternative diagnosis,” while was positive in a single case of “negative” CT. The first swab was positive in 77/106 (73%) and negative in 29/106 (27%) patients classified as “highly likely” and “likely” at CT. In 18/29 (62%) patients, negative swabs turned to positive after repetition or BAL (mean time for positivization: 5 ± 4 days) (Fig. 3). In the remaining 9 patients, laboratory test and clinical course were highly suggestive for COVID-19. In one case classified as “likely COVID-19 pneumonia” H1N1 virus was isolated.

CT diagnostic accuracy was 79% in respect of first swab and raised to 91.5% after repeated swabs and/or BAL. Chest CT performance in triaging symptomatic patients suspected for COVID-19 was good with 76% specificity, 99% sensitivity, 90% PPV, and 97% NPV.

Our data showed that during the rise of COVID-19 epidemic the integration of chest CT in triaging patients has high PPV and NPV in line with previous results [10, 11], with higher sensitivity than swab [5], which often needed to be repeated and is affected by long turnaround time. One false negative was observed in a patient with CT performed within 2 days of symptoms onset, probably related to the known lower prevalence of parenchymal involvement in the earliest stages of disease [12, 13]. In our setting, CT specificity and PPV were slightly higher than in most previous reports [5, 10], probably in relation to the better clinical management of patients.
Our findings highlight the unique capability of CT to provide alternative diagnoses in a substantial number of cases, which cannot be addressed with chest X-ray. In fact, although COVID-19 pneumonia was the prevalent cause of respiratory dysfunction during the outbreak, it was not the unique.

In agreement with the recent Fleischner Society expert consensus document [14], our data support the integration of CT in triaging suspected patients because it may streamline decision making in overwhelmed EDs, where oral-nasopharyngeal swab may not yet provide trustworthy and fast results, and avoiding exposure in non-COVID-19 patients.

Importantly, one case of H1N1 pneumonia was reported, for the known possibility of overlapping CT findings, highlighting the necessity to provide a microbiological confirmation also in patients with highly suggestive CT findings [8].

Our findings are applicable in a scenario of high prevalence of disease (around 40%), as occurred during the ascending phase of epidemic curve [11]; therefore, they cannot be generalized to low prevalence situation where could be expected a poor PPV [11].

The application of chest CT in triage suspected COVID-19 patients is related to the availability of a dedicated scanner, because long downtime (30–60 min after imaging a suspected patient) for room decontamination and passive air exchange may significantly interfere with routine clinical activity.

In conclusion, in the specific context of the overwhelmed EDs facing COVID-19 outbreak, chest CT may fasten triaging, while waiting for RT-PCR results, by supporting the clinical suspicion of COVID-19 or providing an alternative diagnosis with overlapped clinical presentation.

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Compliance with Ethical Standards

Conflict of interest Authors have no conflict of interest to disclose.

Ethical standards Our research study includes human participants. The study protocol complies with the Declaration of Helsinki and was approved by the local hospital ethics committee (protocol no. 34/INT/2020). Patients able to provide a signed informed consent were consented prior to data collection. The ethics committee waived the requirement for obtaining written informed consent for patients who had died or were unreachable after discharge.

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