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Case Report

Imaging & other potential predictors of deterioration in COVID-19☆☆

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A B S T R A C T
This case report describes a young patient with COVID-19 who is initially diagnosed with CT chest imaging. Upon admission to the hospital, his clinical condition deteriorates requiring ventilatory support. We explore the value of imaging and other potential predictors of deterioration.

1. Introduction

COVID-19 pandemic is an international crisis in 2020. There are difficulties in diagnosis (lack of medium for testing), difficulties in assessing severity of illness, and difficulties in preventing spread to clinicians. This case report highlights the benefits and limitations of emergency department (ED) imaging of patients suspected to be infected with COVID-19. The discussion will highlight predictors of decompensation, common chest radiograph findings that distinguish viral COVID-19 from bacterial pneumonia and whether findings on chest radiograph can predict severity of illness.

2. Case report

39-year-old male with past medical history of diabetes mellitus on metformin and high cholesterol on a statin drug presents to a New York City ED with fever and cough after travel to Italy and London. Symptoms of subjective fever and chills began 8 days prior to arrival in the ED. Intermittent cough was present over the prior week, for which patient completed a course of azithromycin. In the ED, the patient’s primary complaint is malaise, chills and body aches. No congestion, rhinorrhea, shortness of breath, chest pain, nausea, vomiting, diarrhea, or abdominal pain. Multiple co-workers who traveled through Europe with patient have similar symptoms. Review of systems is otherwise negative. Patient denies smoking or vaping. No known drug allergies.

Vital signs on arrival include temperature 37.4 °C, heart rate 130, blood pressure 138/93, respiratory rate of 15, and oxygen saturation of 98%. On exam, patient was noted to be in mild respiratory distress and diaphoretic. The remainder of the exam was unremarkable: sclera was without icterus and neck was supple; chest was clear to auscultation without crackles, rales or wheezes; heart was tachycardic without murmurs; abdomen was soft, non-tender, non-distended; extremities did not have swelling or tenderness; skin was warm and well-perfused.

Chest radiograph, nasal swab for respiratory virus panel, labs and intravenous fluids were ordered. WBC was normal at 4.1 with 69.5% neutrophils and 20.2% lymphocytes. Creatinine was 1.46 mg/dL (upper limit of normal is 1.27 mg/dL) and glucose was 266 mg/dL; otherwise, all initial laboratory testing was negative including a d-dimer and troponin. Portable chest radiograph was read as “bibasilar opacity felt to represent atelectasis from low lung volumes, pneumonia should be excluded clinically” (see Fig. 1).

After discussion with the department of health, the decision was made that the patient was not a “person under investigation”. Soon thereafter, a nurse astutely noted oxygen desaturation after the patient stood up. A Chest CT was ordered which revealed “lower lobe predominat peribronchovascular and peripheral ground-glass opacities with superimposed areas of consolidation” (see Fig. 2), which can be seen in the setting of COVID-19.

Patient was admitted for further evaluation and management, including COVID-19 testing which was positive the next day. In the...
subsequent 12 h, the patient deteriorated. He developed a progressively higher oxygen requirement and eventually required respiratory support with invasive ventilation. After 3 days on the ventilator, patient was extubated and after 7 days in the hospital, patient was discharged home in usual health without an oxygen requirement.

3. Discussion

3.1. Clinical risk factors

Risk factors for severe illness with COVID-19 are fairly clear; in a systematic review and meta-analysis, the common underlying diseases among hospitalized patients were: hypertension, cardiovascular disease, smoking, diabetes, COPD, malignancy and chronic kidney disease [1]. Older age is also a clear risk factor for mortality among those infected with COVID-19 [2]. The critical question for clinicians, particularly regarding the younger patient populations including our patient, is whether there are known risk factors for acute deterioration.

Our patient was <40 years old. His only past medical history was well-controlled diabetes and hyperlipidemia. Diabetes mellitus has been suggested to be a contributor to a precipitous decompensation. One analysis, where patients with other comorbidities were excluded, compared patients with diabetes against those without diabetes and found higher inflammatory markers, CT imaging severity scores, and rates of rapid deterioration [3]. It is possible that diabetics (regardless of age) may be at higher risk for an excessive and uncontrolled inflammatory and hypercoagulable response (“cytokine storm”).

A few specific predictors of deterioration have been identified but all based on small data sets (see Table 1). Two single-center studies, of 125 patients [4] and 338 patients [5] found a higher likelihood of diabetes among patients who deteriorated. Other than diabetes, most of the factors identified in the literature for deterioration were inconsistent with our patient. A lymphocyte count below 1500 μL has been identified as a factor but was normal in our patient [6]. One multicenter study of 78 admitted patients with COVID-19 pneumonia found that the 14% who deteriorated were older, more likely to be smokers and equally likely to have diabetes compared to those who improved [7]. Two of the aforementioned studies [5,7] also noted elevated temperature at admission to be associated with deterioration; while our patient had a history of subjective fevers, his temperature on presentation was normal. Older age was found to be a risk factor for ARDS and death in a single-center study of 201 patients [8]. A possible association between Chest CT findings and severe COVID-19, suggested in a study of 104 patients aboard the “Diamond Princess” cruise ship [9], is discussed below.

3.2. Chest radiograph risk factors

Chest radiography has not demonstrated the ability to predict severity of illness in COVID-19. Radiologic findings may not be appreciably different from community-acquired pneumonia where CT-only pneumonia has the same disease severity and outcomes as cases where signs of pneumonia are visible on chest radiograph [10]. Chest radiographs are not routinely recommended in the workup for immunocompetent patients in the setting of acute respiratory illness [11]. However, when differentiating between viral and bacterial etiologies is clinically challenging, a chest radiograph may be useful.

The most common cause of community-acquired lobar pneumonia is S. pneumoniae. On chest radiographs, lobar pneumonia often appears as a peripheral and focal opacity, usually abutting the pleura [12]. Occasionally the infection can spread to involve the entire lobe (Fig. 3).

Table 1
Articles that identified factors associated with clinical deterioration.

| Study         | Total N | Deterioration (N, %) | Predictors                                      |
|---------------|---------|----------------------|-------------------------------------------------|
| Huang 2020 [4]| 125     | 32 (25.6%)           | Comorbidities, RR > 24, elevated CRP, elevated LDH |
| Zeng 2020 [5] | 338     | 76 (31.9%)           | Age, BMI, fever, history of hypertension, diabetes |
| Ji 2020 [6]   | 49      | 15 (30.6%)           | Comorbidity, age > 50, lymphocyte count <1500/μL, serum ferritin <400 ng/mL |
| Liu 2020 [7]  | 78      | 11 (14.1%)           | Age, smoking, max temp, elevated CRP             |
| Wu 2020 [8]   | 201     | 84 (41.8%)           | Age                                             |
| Tabata 2020 [9]| 104    | 8 (7.7%)             | Consolidation on Chest CT and lymphopenia        |
Chest radiographs are of limited sensitivity for the detection of COVID-19. Reported sensitivities of chest radiographs vary between 25% and 69% [13,14]. Nevertheless, when present, radiographic manifestations of COVID-19 are often described as bilateral, peripheral, mid and lower lung predominant opacities [14] (Fig. 4).

It is important to keep in mind that these imaging findings are not specific for COVID-19 and can be seen in other etiologies, both infectious and inflammatory, such as aspiration or organizing pneumonia. When severe it can be indistinguishable from acute lung injury or multifocal bacterial pneumonia.

3.3. CT risk factors

Chest CTs are not recommended for screening or diagnosis of COVID-19 because early in the disease, Chest CT is negative in about 50% of cases [15]. Thus, a negative Chest CT does not rule out disease. RT-PCR remains the gold standard for diagnosis. In the setting of high clinical suspicion for COVID-19, a negative CT can be detrimental as it can lead to false reassurances. On the “Diamond Princess” cruise ship, Chest CT abnormalities were found in 56.6% (43/76) of the non-severe cases and 82.1% (23/28) of the severe cases [9]; although there is a clinically significant difference in the number of abnormal CTs, clinical decisions on likelihood of deterioration would be unreliable.

RT-PCR has a sensitivity of approximately 89% therefore false negatives will not be infrequent [16]. In the right clinical setting (high pre-test probability for COVID-19 but negative RT-PCR test), ground glass opacities on CT can raise the suspicion for a false negative RT-PCR test, allowing the clinician to appropriately advise the patient. It should be noted that the imaging finding of ground glass opacities is not specific for COVID-19 as it is present in a number of other etiologies [17]. A positive Chest CT is not helpful without clinical suspicion.

Despite the limited utility of Chest CT in screening and diagnosis, the imaging findings are important. Clinicians should be familiar with the imaging appearances of COVID-19. Chest CT findings have been described as bilateral, posterior, and peripheral ground glass and consolidation [15]. They often have a rounded morphology (Fig. 5). Later in the disease process the findings can become denser with areas of subpleural sparing.

4. Conclusion

Despite knowing the major risk factors for severe COVID-19 infection, the risk factors for precipitous deterioration remain unclear. Our case report and review of the literature highlight the importance of diabetes and diminish the utility of imaging.

The initial reporting literature perhaps overemphasized the importance of imaging, in particular Chest CT, in the detection of COVID-19. In clinical practice, the utility of imaging is limited given the lack of sensitivity and specificity of Chest CT as a diagnostic test. In fact, many of the radiologic societies have come out with statements stating that imaging (CT and X-ray) has a limited role in the workup and management
of these patients. Imaging should be reserved to evaluate for complications.

Declaration of competing interest

None of the authors have conflicts to report.

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