

CT Scans Obtained for Nonpulmonary Indications: Associated Respiratory Findings of COVID-19

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Background: Atypical manifestations of coronavirus disease 2019 (COVID-19) are being encountered as the pandemic unfolds, leading to non–chest CT scans that may uncover unsuspected pulmonary disease.

Purpose: To investigate patients with primary nonrespiratory symptoms who underwent CT of the abdomen or pelvis or CT of the cervical spine or neck with unsuspected findings highly suspicious for pulmonary COVID-19.

Materials and Methods: This retrospective study from March 10, 2020, to April 6, 2020, involved three institutions, two in a region considered a hot spot (area of high prevalence) for COVID-19. Patients without known COVID-19 were included who presented to the emergency department (ED) with primary nonrespiratory (gastrointestinal or neurologic) symptoms, had lung parenchymal findings suspicious for COVID-19 at non–chest CT but not concurrent chest CT, and underwent COVID-19 testing in the ED. Group 1 patients had reverse transcription polymerase chain reaction (RT-PCR) results obtained before CT scan reading (COVID-19 suspected on presentation); group 2 had RT-PCR results obtained after CT scans were read (COVID-19 not suspected). Presentation and imaging findings were compared, and outcomes were evaluated. Descriptive statistics and Fisher exact tests were used for analysis.

Results: Group 1 comprised 62 patients (31 men, 31 women; mean age, 67 years \pm 17 [standard deviation]), and group 2 comprised 57 patients (28 men, 29 women; mean age, 63 years \pm 16). Cough and fever were more common in group 1 (37 of 62 [60%] and 29 of 62 [47%], respectively) than in group 2 (nine of 57 [16%] and 12 of 57 [21%], respectively), with no significant difference in the remaining symptoms. There were 101 CT scans of the abdomen or pelvis and 18 CT scans of the cervical spine or neck. In group 1, non–chest CT findings provided the initial evidence of COVID-19–related pneumonia in 32 of 62 (52%) patients. In group 2, the evidence was found in 44 of 57 (77%) patients. Overall, the most common CT findings were ground-glass opacity (114 of 119, 96%) and consolidation (47 of 119, 40%). Major interventions (vasopressor medication or intubation) were required for 29 of 119 (24%) patients, and 27 of 119 (23%) died. Patients who underwent CT of the cervical spine or neck had worse outcomes than those who underwent abdominal or pelvic CT ($P = .01$).

Conclusion: In a substantial percentage of patients with primary nonrespiratory symptoms who underwent non–chest CT, CT provided evidence of coronavirus disease 2019–related pneumonia.

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Coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2, initially centered in Hubei Province of the People's Republic of China at the end of December 2019, is now the cause of a major pandemic. The most common presenting symptoms consist of fever, cough, nasal congestion, fatigue, and other signs of respiratory tract infection (1). In some patients, these symptoms may progress to chest pain, shortness of breath, and dyspnea with pneumonia (1).

Symptoms of severe acute respiratory syndrome coronavirus 2 resemble those of the severe acute respiratory syndrome coronavirus that emerged in 2003 and the Middle East respiratory syndrome that emerged in 2012. There is growing evidence that coronavirus infections may share similar pathways and mechanisms. Severe acute respiratory syndrome coronavirus 2 enters the human host cell through angiotensin-converting enzyme 2 receptor, which

can be found in human lung parenchyma, airway epithelium, vascular endothelium, kidney cells, and small intestines (2). Middle East respiratory syndrome coronavirus infection uses dipeptidyl peptidase-4 to enter the human cell and can be found in the lower respiratory tract, kidney, small intestine, liver, and immune system (2). Therefore, in addition to pulmonary manifestations, patients with COVID-19 may present with atypical symptoms, such as neurologic and gastrointestinal (GI) symptoms.

It has been reported that nearly 20% of patients with COVID-19 present with GI symptoms, including vomiting, diarrhea, and abdominal pain (3). Gu et al (4) and Han et al (5) described a small percentage of patients with COVID-19 who presented only with digestive symptoms or digestive symptoms that preceded their respiratory symptoms. Patients who present solely with GI symptoms are more likely to receive no diagnosis and

Abbreviations

COVID-19 = coronavirus disease 2019, ED = emergency department, GI = gastrointestinal, RT-PCR = reverse transcription polymerase chain reaction

Summary

Radiologists should maintain a high index of suspicion with respect to the lungs in patients with primary extrapulmonary clinical symptoms who undergo non-chest CT studies to facilitate earlier diagnosis of coronavirus disease 2019–related pneumonia.

Key Results

- The presence of pneumonia in the visualized lung parenchyma was established on the basis of non-chest CT scans in 76 of 119 (64%) patients and led to a diagnosis of coronavirus disease 2019 (COVID-19) in 44 of 119 (37%) patients.
- Overall, patients with a diagnosis of COVID-19 presenting with primary nonrespiratory symptoms often had poor outcomes, developing severe symptoms requiring major interventions, and, in many cases, these patients ultimately died (23%).

remain in their community, posing a continued infectious risk to the population.

There are several case reports of individuals presenting solely with neurologic symptoms related to COVID-19, such as altered mental status, diminished sense of smell and taste, headache, confusion, strokes, and seizures with encephalitis-like symptoms (6). In Italy, dedicated neurology–COVID-19 units caring for patients presenting with neurologic deficits have been established (7).

Patients not known to have a positive COVID-19 test result who have either GI or neurologic symptoms may undergo cross-sectional imaging, which includes portions of the lung out of necessity. In this study, we evaluated patients not known to be positive for COVID-19 who presented to the emergency department (ED) with substantial nonrespiratory symptoms, who underwent CT of the abdomen or pelvis or CT of the cervical spine or neck (in conjunction with head CT), and who were noted to have findings suspicious for COVID-19 pneumonia in the imaged lungs.

Materials and Methods

Study Design and Patients

The institutional review board approved this retrospective multicenter study, and written informed consent was waived. Montefiore Medical Center (site 1) and Mount Sinai Medical Center (site 2) were located in a COVID-19 hot spot (a region with high disease prevalence) (at the time of the study on March 31, New York City had 541 cases per 100 000 people), and the University of Maryland Medical System (site 3) was located where the disease was less prevalent (36 cases per 100 000 people on March 31, 2020) and was not considered overwhelming (8). The study extended from March 10, 2020, to April 6, 2020; sites 1 and 3 investigated patients over the entire period, and site 2 investigated patients from March 22, 2020, to March 29, 2020, because of limited resources during this pandemic.

At each site, the medical record was queried for all patients during the target time frame whose primary symptoms were nonrespiratory and who underwent ED CT of the abdomen or pelvis or ED CT of the cervical spine or neck (ie, non-chest CT). Patients who had concurrent chest CT were excluded, as were those with a diagnosis of COVID-19 prior to presentation in the ED. All patients underwent reverse transcription polymerase chain reaction (RT-PCR) testing during ED admission. A review of final interpretations was performed, and patients with lung parenchymal findings suspicious for pneumonia were recorded. The medical record was reviewed to determine the timing of the non-chest CT report relative to obtaining the RT-PCR results (Abbott Laboratories, Abbott Park, Ill; Roche Diagnostics, Basel, Switzerland). The patients were divided into two groups. Group 1 comprised patients for whom RT-PCR results were obtained prior to the non-chest CT report and who were deemed to have high suspicion for COVID-19 at presentation. Group 2 comprised patients for whom RT-PCR results were obtained after the non-chest CT report and who were judged to have low or no suspicion for COVID-19 prior to that report. On the basis of this method, group 1 comprised 66 patients (31 men, 31 women; mean age, 67 years \pm 17 [standard deviation]), and group 2 comprised 57 patients (28 men, 29 women; mean age, 63 years \pm 16). A total of 119 patients (59 men, 60 women; mean age, 65 years \pm 16) formed the final assessment cohort (Fig 1).

CT Protocol

CT was performed with a commercial multidetector CT scanner (Somatom; Siemens, Tokyo, Japan) or a 64-slice CT scanner (GE Medical Systems, Milwaukee, Wis) with or without contrast material. For CT acquisition, the tube voltage was 120 kV with automatic tube current modulation with a maximum of 600 mA. Acquisition parameters were modified to minimize patient radiation exposure while maintaining sufficient resolution. All studies were reconstructed with a slice thickness less than or equal to 4 mm using a lung reconstruction kernel.

Image Analysis

The reports of the original interpreting physicians were reviewed to determine whether they described findings of pneumonia on the non-chest CT image. In addition, CT scans of patients with positive COVID-19 results were rereviewed by five radiologists (R.H., M.S.L., J.A., B.Z., and C.S.W.; with 4, 2, 1, 17, and 29 years of experience, respectively) to provide a more uniform characterization of the pulmonary findings using a common spreadsheet. Four of five radiologists were fellowship trained in cardiothoracic imaging. One radiologist evaluated each CT scan, and each radiologist was blinded to the initial radiologic report. Parameters evaluated included the presence or absence of ground-glass opacity, consolidation, crazy paving, and central versus peripheral distribution. Severity of the parenchymal findings were also graded as mild (range, 1%–25%), moderate (range, 26%–50%), or severe (>51%) involvement of the visualized lungs. Other features, such as pleural effusion, pleural thickening, bronchiectasis, and air trapping, were also recorded.

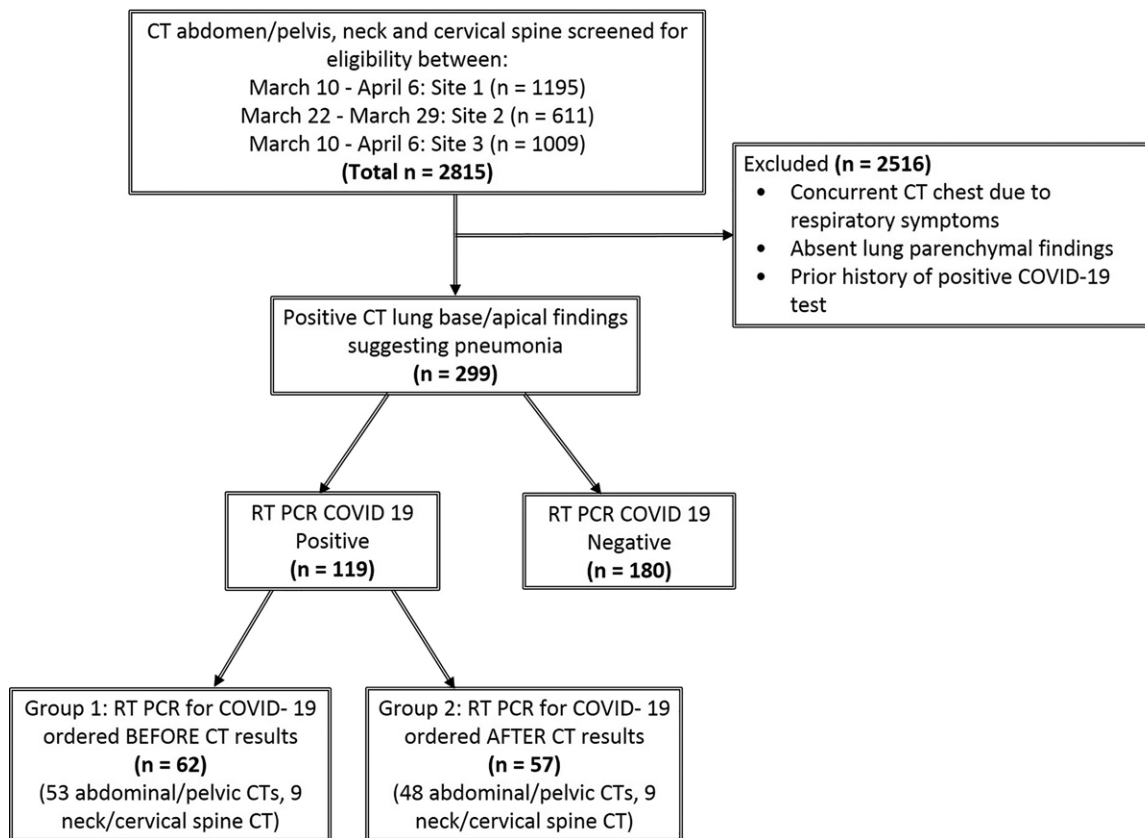


Figure 1: Flowchart of the study. COVID-19 = coronavirus disease 2019, RT PCR = reverse transcription polymerase chain reaction.

The medical record was reviewed for both group 1 and group 2 patients to assess whether patients had undergone chest radiography at the time of the ED visit. If the chest radiograph was obtained prior to the non-chest CT scan and was interpreted as showing pneumonia, then the patient was deemed to have COVID-19–related pneumonia on the basis of the chest radiograph, not on the basis of the non-chest CT scan.

In contrast, if no chest radiograph was obtained during the ED visit, the chest radiograph was obtained after the non-chest CT scan, or the chest radiograph obtained prior to CT was not diagnostic of pneumonia (ie, interpreted as negative or with a nonspecific finding, such as atelectasis), then the patient was deemed to have COVID-19–related pneumonia on the basis of the non-chest CT scan (determination was made on the basis of a subsequent positive RT-PCR finding). For the CT scan to be considered the basis for diagnosing COVID-19, the original CT interpretation was required to describe findings consistent with pneumonia, although it was not necessarily required to describe COVID-19 pneumonia explicitly. The percentage of patients in groups 1 (COVID-19 suspected) and 2 (COVID-19 unsuspected) whose diagnosis of COVID-19–related pneumonia was based on the CT was calculated.

In addition, we reviewed the final interpretations of CT of the abdomen or pelvis and CT of the cervical spine or neck to determine whether there were findings corresponding to the indications for these studies.

Outcomes Data

We extracted demographic data and clinical characteristics, including respiratory symptoms, neurologic symptoms, and GI symptoms at admission. Treatments and clinical outcomes (including discharge from the ED; admission; leaving against medical advice; do-not-resuscitate or do-not-intubate status; necessity for major interventions, such as vasopressor or intubation; or death) were documented.

Statistical Analyses

Statistical analyses were performed using R Core Team software (2020; R Foundation for Statistical Computing, Vienna, Austria). Continuous variables were presented as the mean \pm standard deviation. Categorical variables were presented as frequencies and percentages. The comparisons of categorical data were performed using the Fisher exact test, and odds ratios were calculated. The statistical significance level was set at a P value less than .05.

Results

Among patients who had lung abnormalities on non-chest CT scans, COVID-19–related pneumonia was significantly more common among institutions in the hot spot area than in the institution in the non-hot spot area (46.6% [119 of 255] of patients in the hot spot area vs 3.2% [two of 62] of patients in the non-hot spot area [$P < .001$]). Demographics and clinical characteristics of the study population are summarized in Table 1. Group 1 comprised 62 patients (31 men, 31 women;

Table 1: Demographics and Clinical Characteristics of Population with COVID-19 with Lung Disease on Non-CT Scans

Parameter	All Patients (n = 119)	Group 1: RT-PCR Order before CT (n = 62)	Group 2: RT-PCR Order after CT (n = 57)	P Value
Patient demographics				
Mean age (y)*	65 ± 16 (23–98)	67 ± 16 (23–98)	63.1 ± 16 (24–89)	NA
Men	59 (50)	31 (50)	28 (49)	NA
Women	60 (50)	31 (50)	29 (51)	NA
CT of cervical spine or neck	18 (15)	9 (15)	9 (15%)	NA
CT of abdomen or pelvis	101 (85)	53 (86)	48 (84)	NA
Signs or symptoms				
Flulike	61 (51)	35 (57)	26 (46)	.27
Nausea, vomiting, or diarrhea	60 (50)	35 (57)	25 (44)	.20
Cough	46 (39)	37 (60)	9 (15)	<.01
Fever	41 (34)	29 (47)	12 (21)	<.01
Neurologic	34 (29)	18 (29)	16 (28)	>.99
Hospital course				
Discharged from emergency room	23 (19)	13 (21)	10 (18)	.65
Admitted	93 (78)	48 (77)	45 (79)	>.99
Left against medical advice	3 (3)	1 (2)	2 (4)	.60
Required increased intervention	29 (24)	12 (19)	17 (30)	.53
Death	27 (23)	12 (19)	15 (26)	.83

Note.—Data in parentheses are percentages. COVID-19 = coronavirus disease 2019, NA = not applicable, RT-PCR = reverse transcription polymerase chain reaction, SD = standard deviation.

* Data are mean ± standard deviation. Data in parentheses are the range.

mean age, 67 years ± 17), and group 2 comprised 57 patients (28 men, 29 women; mean age, 63 years ± 16). In group 1, there were 53 CT scans of the abdomen or pelvis and nine CT scans of the cervical spine or neck; in group 2, there were 48 CT scans of the abdomen or pelvis and nine CT scans of the cervical spine or neck.

Cough and fever were more common in group 1 (37 of 62 [60%] and nine of 57 [16%], respectively; $P < .001$) than in group 2 (29 of 62 [47%] and 12 of 57 [21%], respectively; $P < .004$). For flulike symptoms; nausea, vomiting, or diarrhea; and neurologic symptoms, there was no significant difference (Table 1).

Imaging Findings

In group 1 (patients suspected of having COVID-19), the diagnosis of COVID-19–related pneumonia was established based on CT scans in 32 of 62 (52%) patients. In group 2 (patients not initially suspected of having COVID-19), the diagnosis of pneumonia (confirmed to be COVID-19–related after RT-PCR findings were obtained) was established on the basis of CT scans in 44 of 57 (77%) patients (Table 2). Overall, non–chest CT established the diagnosis of COVID-19–related pneumonia in 76 of 119 (64%) patients and led ultimately to an unsuspected COVID-19 diagnosis in 44 of 119 (37%) patients. The original interpreting radiologist described 111 of 119 (93%) of abnormal lung findings on non–chest CT studies as suspicious.

The lung findings based on the retrospective evaluation of all 101 CT scans of the abdomen or pelvis and 18 CT scans of the cervical spine or neck are summarized in Figure 2. Among the CT findings, peripheral ground-glass opacities were most

common (114 of 119, 96%), followed by consolidation (47 of 119, 40%) and crazy paving (27 of 119, 23%). Sixty (50%) patients had mild disease at CT, whereas 36 (30%) patients had moderate disease, and 23 (19%) patients had severe involvement (Fig 3). Air trapping was present in six of 119 (5.0%) patients, and bronchiectasis was noted in eight (6.7%). Pleural effusions were noted in 13 of 119 patients (11%), and pleural thickening was noted in eight (6.7%). Examples of a CT scan of the abdomen or pelvis (Fig 4) and from a CT scan of the cervical spine (Fig 5) are shown.

With respect to the findings for which the non–chest CT scans were originally ordered, no acute or clinically important findings were seen on 69 of 101 (68%) of abdominal or pelvic CT scans. The top three findings on abdominal or pelvic CT scans directly related to the indications for the study were enteritis or colitis (seven of 32, 22%), renal calculi (five of 32, 16%), and pancreatitis (three of 32, 9.4%). No acute or significant findings were identified on 16 of 18 (89%) CT scans of the cervical spine or neck. The two clinically important findings on the CT scans of the cervical spine or neck were internal carotid artery occlusion and moderate left internal carotid artery occlusion.

Outcomes

Twenty-three (19%) patients were discharged directly from the ED with referral for self-isolation. Three patients left against medical advice after their COVID-19 diagnosis, and the remaining 93 (78%) were admitted. Twenty-nine (24%) patients required major interventions such as vasopressors or intubation, 19 (20%) patients were placed in a do-not-resuscitate or do-not-intubate status, and 27 (23%) patients died during the hospital admission.

Table 2: Diagnosis of COVID-19 Pneumonia Based on Imaging Modality

Modality Used to Diagnose COVID-19 Pneumonia	RT-PCR before CT (Group 1)	RT-PCR after CT (Group 2)
CT	32*	44†
Chest radiography	30	13

Note.—COVID-19 = coronavirus disease 2019, RT-PCR = reverse transcription polymerase chain reaction.

* The diagnosis of COVID-19 pneumonia was established based on a CT scan from a patient suspected of having COVID-19.

† The diagnosis of COVID-19 pneumonia was established based on a CT scan from a patient not suspected of having COVID-19.

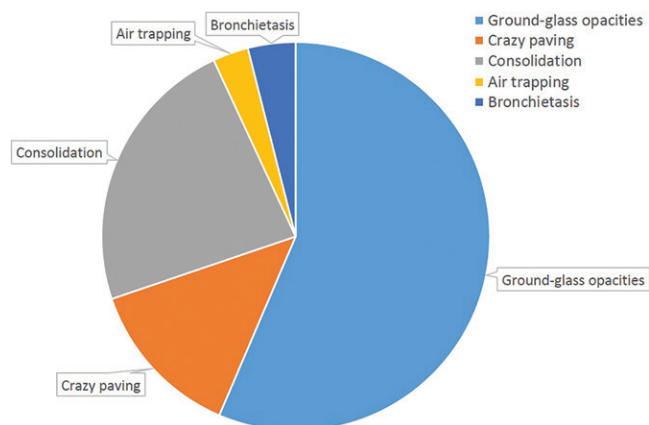


Figure 2: Diagram of lung parenchymal findings present on non-chest CT scan.

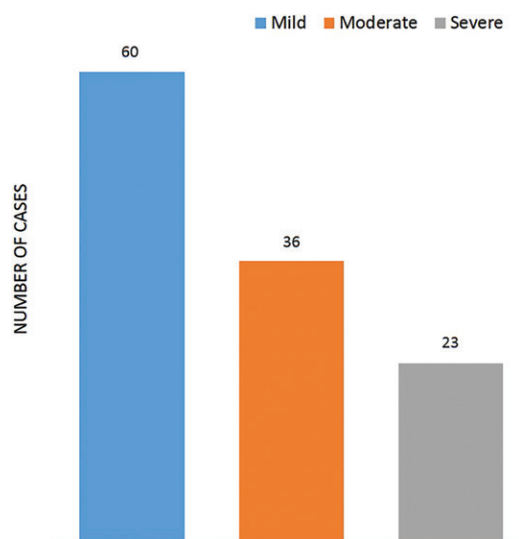


Figure 3: Graph of severity of parenchymal findings on CT scan.

A poor outcome as defined by the need for major intervention, such as vasopressors or intubation, or death during hospital admission occurred in 24% (29 of 119 patients) of our cohort. There was no statistical difference between increased density of the parenchyma (consolidation, ground-glass opacity, or both) and poor outcomes. In addition, there was no statistical correlation

between severity at CT, based on a score of mild versus moderate or severe, and poor outcomes. However, patients who underwent CT of the cervical spine or neck had worse outcomes in comparison with those who underwent abdominal or pelvic CT ($P = .01$).

Discussion

In this study, we found that in a substantial percentage of patients who presented to the emergency department primarily with gastrointestinal or neurologic symptoms, the presence of pneumonia in the visualized lungs on the resultant CT scans of the abdomen or pelvis or CT scans of the cervical spine or neck was unsuspected in 63.9% of the cases. In addition, coronavirus disease 2019 (COVID-19)-positive status was ultimately established on the basis of the non-chest CT findings in 37% of patients. In most patients, there was no specific abdominal or neurologic finding on the CT scan to account for the symptoms that led to the study.

To our knowledge, this study is among the largest to evaluate the diagnosis of pulmonary COVID-19 findings on non-chest CT scans in patients presenting with nonprimary respiratory symptoms and the first to include patients with primary neurologic symptoms. Two recent studies have been published describing patients presenting with abdominal symptoms who had imaging findings suggestive of COVID-19 in the lung bases, with the larger report, consisting of 23 patients undergoing abdominal CT, retrospectively evaluating the findings in the lungs but not evaluating their impact on diagnosis (9,10).

Our study highlights the importance of evaluating lung imaging findings from non-chest CT scans at both the lung bases and the apices, as they may suggest COVID-19 positivity and be the initial indication of COVID-19-related pneumonia, particularly in high-disease-prevalence areas. Earlier diagnosis in patients with unsuspected COVID-19 with atypical symptoms on the basis of these CT findings allows for more rapid triage and presumably leads to improvement in their care. Additionally, because of the inherent stress on medical resources during the pandemic, appreciation of such features may facilitate rapid confirmation of COVID-19 status with RT-PCR testing.

In our study of 101 CT scans of the abdomen or pelvis and 18 CT scans of the cervical spine or neck acquired in patients presenting with primary nonrespiratory symptoms, vague flu-like symptoms were present in the majority (61 of 119, 51.3%). Twenty-seven (22.7%) patients ultimately died during this hospital admission. In particular, patients who underwent CT of the cervical spine or neck were more likely to die ($P = .004$).

Although most patients with COVID-19 present with respiratory symptoms, there have been several reports of patients with predominant GI symptoms. Gu et al (4) reported that 99 of 206 (46%) patients who tested positive for COVID-19 presented with digestive tract symptoms, including anorexia (83.8%),

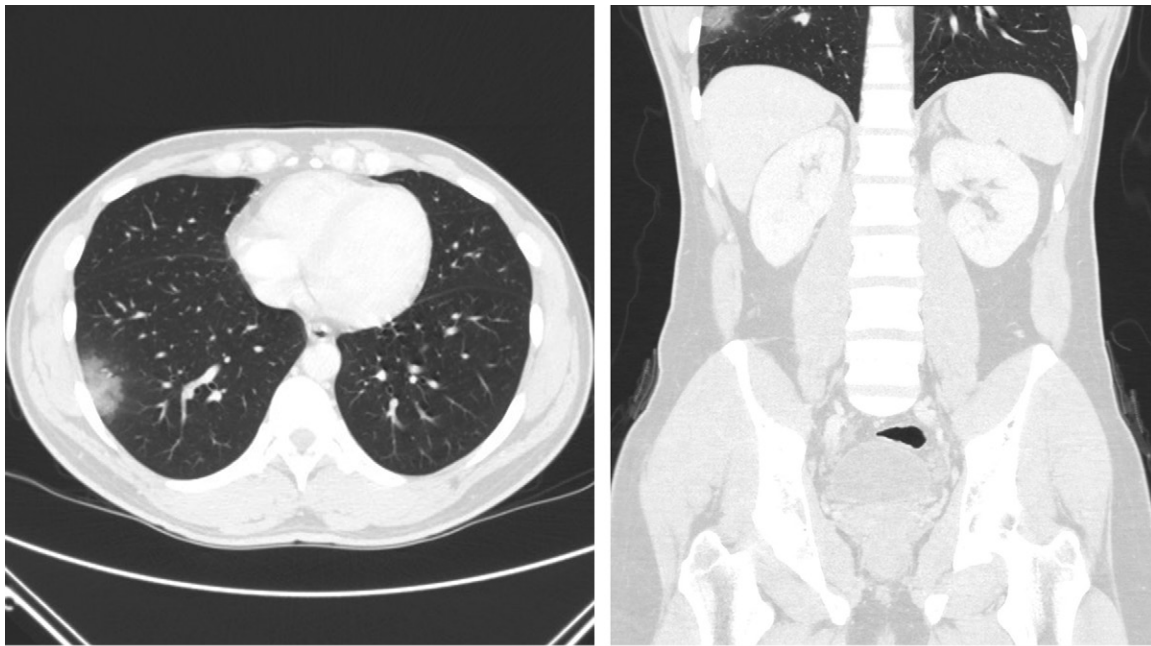


Figure 4: Images in a 33-year-old man presenting with right lower-quadrant abdominal pain found to have acute appendicitis on abdominal or pelvic CT scan. **(a)** Axial and **(b)** coronal views on lung windows demonstrate focal peripheral ground-glass opacity in the right lung base.

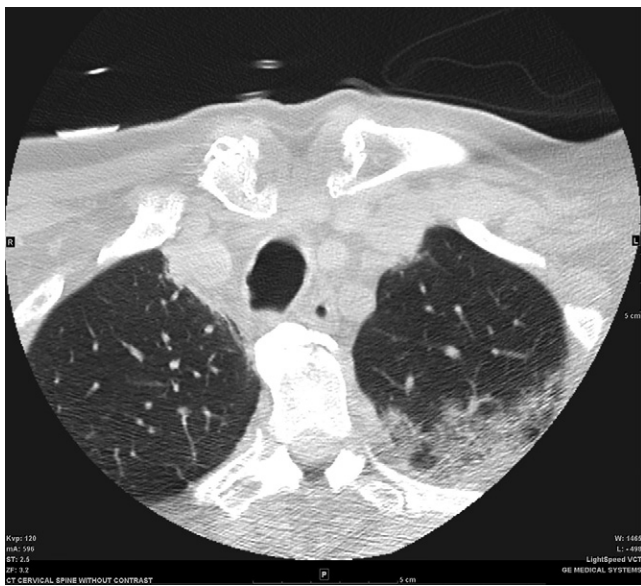


Figure 5: Image in an 84-year-old man with dementia and a history of cerebrovascular accident presenting with altered mental status and an unwitnessed fall. Axial cervical spine CT views on lung windows demonstrate partially visualized left upper-lobe peripheral mixed consolidative and ground-glass opacities.

diarrhea (29.3%), vomiting (8.1%), and abdominal pain (4%). A small percentage of patients (3%) presented solely with digestive-tract symptoms. GI symptoms can manifest early in the disease course of patients with COVID-19, and it has been reported that diarrhea may be the only initial symptom, preceding respiratory symptoms in some patients (11). Severe acute respiratory syndrome coronavirus 2 RNA has also been identified in stool specimens and rectal or anal swab specimens (12,13). Han et al (5) reported 206 patients with digestive symptoms who

tested positive for COVID-19 RNA in the stool and found that they experienced a longer delay in viral clearance and a longer time to diagnosis compared with those who presented only with respiratory symptoms.

Reports of neurologic manifestations of COVID-19 are being published with increasing frequency. In the United States, a case report of acute necrotizing encephalopathy secondary to COVID-19 was reported in a female airline worker who presented with fever, cough, and altered mental status (14). In a study by Mao et al (6), neurologic symptoms were present in 78 of 214 (36.4%) patients who tested positive for COVID-19 and were more common in patients with severe respiratory infection. These neurologic symptoms were divided into three categories: central nervous system, peripheral nervous system, and skeletal muscle symptoms. The authors concluded that in comparison with nonsevere respiratory infection, patients with COVID-19 and severe infection commonly developed neurologic symptoms, such as acute cerebrovascular disease (five [5.7%] vs one [0.8%]), impaired consciousness (13 [14.8%] vs three [2.4%]), and skeletal muscle injury (17 [19.3%] vs six [4.8%]) (6). Thus, it is not surprising that such patients who later prove to have COVID-19 may initially be referred for cross-sectional imaging outside the chest.

In our study, most patients had ground-glass opacity (95.8%) followed by consolidation (39.5%) in the imaged lungs. This is similar to findings reported for patients who undergo dedicated chest CT for COVID-19 in the early phases of the disease. Other less frequent findings, such as air trapping, bronchiectasis, crazy paving, pleural effusion, or thickening, were not commonly present. These have also been noted with less frequency (or are absent) in the COVID-19 chest CT literature (15).

In this cohort of patients with COVID-19 pneumonia, the mortality rate was 22.7%. This is lower than in other studies of patients with COVID-19 pneumonia presenting with respiratory symptoms, in which in-hospital mortality ranged from 28% to 67% (16,17). The reason for the lower mortality rate is unclear but may be due to the overall less severe pulmonary symptoms in our group and differences in our study populations. In addition, some patients remain hospitalized at the time of publication, and their outcomes remain indeterminate.

Patients presenting primarily with nonrespiratory symptoms, such as neurologic and GI symptoms, may be triaged differently than those suspected of having COVID-19. Thus, radiologists may not be focused on the possibility of that diagnosis when abnormalities are encountered in the lung parenchyma adjacent to the area of interest. Knowledge and awareness of pulmonary imaging manifestations of COVID-19 present on non-chest CT scans is important. As the number of COVID-19 cases continues to rise globally, clinicians and radiologists must have a high degree of suspicion when evaluating the lungs on non-chest CT scans of patients presenting with primary nonrespiratory symptoms as a potential initial presentation of COVID-19, even in patients in whom COVID-19 is suspected. These imaging findings may not only impact immediate patient care but may also help mitigate public transmission of the disease. In addition, such unsuspected findings should be a catalyst for immediate action, including notification of the ordering clinician, isolation and testing of the patient, and communication to all members involved in the patient's care, as well as decontamination of the imaging service area.

This study was limited by its retrospective nature, which may have led to selection bias. In addition, one site investigated a shorter time frame than the entire time span because of scarcity of available resources in the middle of a pandemic. However, the selected time frame was in the center of the entire time frame to provide the best approximation. A further limitation was that in the retrospective evaluation, each study was reviewed by one reviewer, although all reviewers had substantial experience with chest CT and the appearance of COVID-19–related lung findings. Each patient in our cohort was confirmed to be positive for COVID-19 by RT-PCR testing either before or after the non-chest CT, but it is known that such testing falls short of 100% sensitivity and specificity. Although some patients reported a history of cough at presentation, this was neither the primary nor the most concerning symptom reported by the patient, and in many cases, it was the CT scan of the abdomen or pelvis or the CT scan of the cervical spine or neck that was critical to establishing the diagnosis.

In summary, radiologists should maintain a high index of suspicion with respect to the lungs in patients with primary extrapulmonary clinical symptoms who undergo non-chest CT studies of adjacent body parts to facilitate earlier diagnosis of coronavirus disease 2019 (COVID-19)–related pneumonia during the current pandemic. These patients demonstrate typical

pulmonary findings of COVID-19 at the upper or lower margins of the scan, most commonly peripheral ground-glass opacity, followed by consolidation.

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References

1. Velavan TP, Meyer CG. The COVID-19 epidemic. *Trop Med Int Health* 2020; 25(3):278–280.
2. Li YC, Bai WZ, Hashikawa T. The neuroinvasive potential of SARS-CoV2 may play a role in the respiratory failure of COVID-19 patients. *J Med Virol* 2020;92(6):552–555.
3. Pan L, Mu M, Yang P, et al. Clinical characteristics of COVID-19 patients with digestive symptoms in Hubei, China: a descriptive, cross-sectional, multicenter study. *Am J Gastroenterol* 2020;115(5):766–773.
4. Gu J, Han B, Wang J. COVID-19: gastrointestinal manifestations and potential fecal-oral transmission. *Gastroenterology* 2020;158(6):1518–1519.
5. Han C, Duan C, Zhang S, et al. Digestive symptoms in COVID-19 patients with mild disease severity: clinical presentation, stool viral RNA testing, and outcomes. *Am J Gastroenterol* 2020;115(6):916–923.
6. Mao L, Jin H, Wang M, et al. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurol* 2020;77(6):1–9.
7. Talan J. COVID-19: Neurologists in Italy to colleagues in US: look for poorly-defined neurologic conditions in patients with the coronavirus. *Neurology Today* Web site. <https://journals.lww.com/neurotodayonline/blog/breakingnews/pages/post.aspx?PostID=920>. Accessed April 10, 2020.
8. Coronavirus map: tracking the global outbreak. *New York Times* Web site. <https://www.nytimes.com/interactive/2020/world/coronavirus-maps.html>. Updated June 23, 2020. Accessed May 1, 2020.
9. Siegel A, Chang PJ, Jarou ZJ, et al. Lung base findings of coronavirus disease (COVID-19) on abdominal CT in patients with predominant gastrointestinal symptoms. *AJR Am J Roentgenol* doi: 10.2214/AJR.20.23232. Published online April 17, 2020. Accessed April 23, 2020.
10. Dane B, Brusca-Augello G, Kim D, Katz DS. Unexpected findings of coronavirus disease (COVID-19) at the lung bases on abdominopelvic CT. *AJR Am J Roentgenol* doi: 10.2214/AJR.20.23240. Published online April 22, 2020. Accessed April 23, 2020.
11. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 2020;323(11):1061–1069.
12. Zhang W, Du RH, Li B, et al. Molecular and serological investigation of 2019-nCoV infected patients: implication of multiple shedding routes. *Emerg Microbes Infect* 2020;9(1):386–389.
13. Tang A, Tong ZD, Wang HL, et al. Detection of novel coronavirus by RT-PCR in stool specimen from asymptomatic child, China. *Emerg Infect Dis* 2020;26(6):1337–1339.
14. Poyiadji N, Shahin G, Noujaim D, Stone M, Patel S, Griffith B. COVID-19-associated acute hemorrhagic necrotizing encephalopathy: CT and MRI features. *Radiology* doi: 10.1148/radiol.2020201187. Published online March 31, 2020. Accessed April 23, 2020.
15. Caruso D, Zerunian M, Polici M, et al. Chest CT Features of COVID-19 in Rome, Italy. *Radiology* doi: 10.1148/radiol.2020201237. Published online April 3, 2020. Accessed April 23, 2020.
16. Guan WJ, Liang WH, Zhao Y, et al. Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis. *Eur Respir J* 2020;55(5):2000547.
17. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020;395(10229):1054–1062. [Published correction appears in *Lancet* 2020;395(10229):1038.] [https://doi.org/10.1016/S0140-6736\(20\)30566-3](https://doi.org/10.1016/S0140-6736(20)30566-3).