Original Article

Clinical and CT diagnosis of 50 cases of *Chlamydia psittaci* pneumonia

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Background: This is a retrospective cross-sectional study aiming to explore the clinical and imaging manifestations of *Chlamydia psittaci* pneumonia (CPP), thus improving its diagnosis, guiding its early clinical treatment, and reducing its mortality rate.

Methods: Fifty cases of CPP diagnosed by hospitals across the country with metagenomics next-generation sequencing (mNGS) from January 2019 to March 2021 were collected. Its clinical symptoms, laboratory test results, and computed tomography (CT) features were discussed.

Results: Forty patients had a history of poultry exposure; 37 experienced respiratory symptoms, 48 had a fever, 14 experienced gastrointestinal symptoms, and 12 experienced neurological symptoms; 34 patients had normal blood cell counts, 49 patients had elevated C-reactive protein, and 24 showed decreased serum sodium. Imaging manifestations: (I) Distribution: lesions were limited to a single lung in 31 patients, lesions were distributed in bilateral lungs in 19 patients; (II) Signs: 37 patients developed the "fine mesh sign". Necrosis, cavity and "tree-in-bud" were not observed. Pleural effusion occurred in 33 patients, mediastinal lymphadenopathy in 18, and splenomegaly in 15 patients.

Conclusions: Patients with CPP often have a history of poultry exposure and present with fever and increased C-reactive protein. White blood cells may be slightly increased or completely normal. Hyponatremia may occur in some patients, and multiple systems may be clinically involved. The imaging can show lesions with unilateral or bilateral lung distribution and a rapid progression. Both the lung parenchyma and the interstitium are involved. Fine mesh sign is the most common sign. Necrosis, cavitation, and tree-in-bud signs are not observed. In conclusion, imaging examinations are helpful for the early diagnosis of this disease and the evaluation of the treatment effect.

Keywords: *Chlamydia psittaci*; radiography; computed tomography (CT)

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Introduction

Over 20 kinds of chlamydia have already been discovered, among which *Chlamydia* pneumoniae, *Chlamydia trachomatis* and *Chlamydia psittaci* are closely related to human diseases. *Chlamydia psittaci*, as a pathogen, may cause community-acquired pneumonia (CAP) among adults (1). Psittacosis, also known as bird fever, is mainly transmitted among a variety of birds with occasional transmission to humans by animals carrying the bacteria (2). When humans are infected with this pathogen and it results in lung inflammation, it is called *Chlamydia psittaci* pneumonia (CPP). Infection in humans often occurs via direct contact and respiratory tract inhalation (3). With advances in economic development, the number of pets, including birds, has greatly increased, and reports of CPP cases have also been on the rise year by year (4). CPP accounts for 1.03% of all CAP cases (1). However, these data may be biased due to the empiric treatment of CAP.

With the clinical application of metagenomics next-generation sequencing (mNGS), an increasing number of CPP cases have been reported (5). MNGS is a high-throughput sequencing technology that compares the microbial nucleic acid sequences in samples with the existing sequences in the database for analysis, to identify the suspected pathogenic microorganisms in the sample in an efficient and accurate manner. MNGS is widely used in identifying infectious diseases (6). The previous literature mainly includes individual cases, and lacks a summary of large samples. For example, Dai *et al.* published 2 cases of CPP (7). Zhao *et al.* reported a comparative study of 6 CPP cases with 31 COVID-19 cases (8). In the past two years, a large number of CPP cases have been confirmed by mNGS in China, and some articles have also been reported. For example, Yang *et al.* reported 27 patients in southwest China (9). Unfortunately, they only focused on the clinical manifestations. There is an urgent need to summarize and discuss the computed tomography (CT) features of this disease. This paper is the first work to analyze the CT manifestations of CPP in detail. By collecting the data of 50 confirmed CPP cases from multiple hospitals, this paper discusses its clinical manifestations, laboratory tests and imaging manifestations to strengthen radiologists' familiarity with the disease and improve its early diagnosis. We present the following article in accordance with the STROBE reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-22-809/rc).

Methods

A retrospective analysis was conducted to analyze the clinical, laboratory and imaging data of 50 patients suspected of being infected with *Chlamydia psittaci* from multiple hospitals across China from January 20, 2019 to March 1, 2020. The present study was approved by the ethics committee of Nanjing Medical University. Written informed consent was obtained from all subjects. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Inclusion criteria: (I) Respiratory symptoms occurring within one month. (II) Pulmonary CT showed abnormal changes. (III) All cases tested positive for *Chlamydia psittaci* after applying mNGS to bronchoalveolar lavage fluid. (IV) Clinical and imaging improvement after targeted treatment.

Exclusion criteria: mNGS showed other pathogenic bacteria that may cause disease.

The cases in this study came from five hospitals: (I) Department of Radiology of Nanjing First Hospital; (II) Department of Imaging Centre for Tuberculosis Control of Guangdong Province; (III) Department of Respirology & Critical Care Medicine of the Third Xiangya Hospital of Central South University; (IV) Department of Respiratory Diseases of the Sixth Affiliated Hospital of Wenzhou Medical University; (V) Department of Respiratory and Critical Care Medicine, Inflammation & Allergic Diseases Research Unit of the Affiliated Hospital of Southwest Medical University. And the testing results were further confirmed after analyzing their clinical and imaging manifestations. After targeted treatment, the conditions of all of the patients improved, and they were discharged from the hospital.

General clinical information included age, sex, and poultry contact history. Information on clinical symptoms included general symptoms (fever, fatigue,

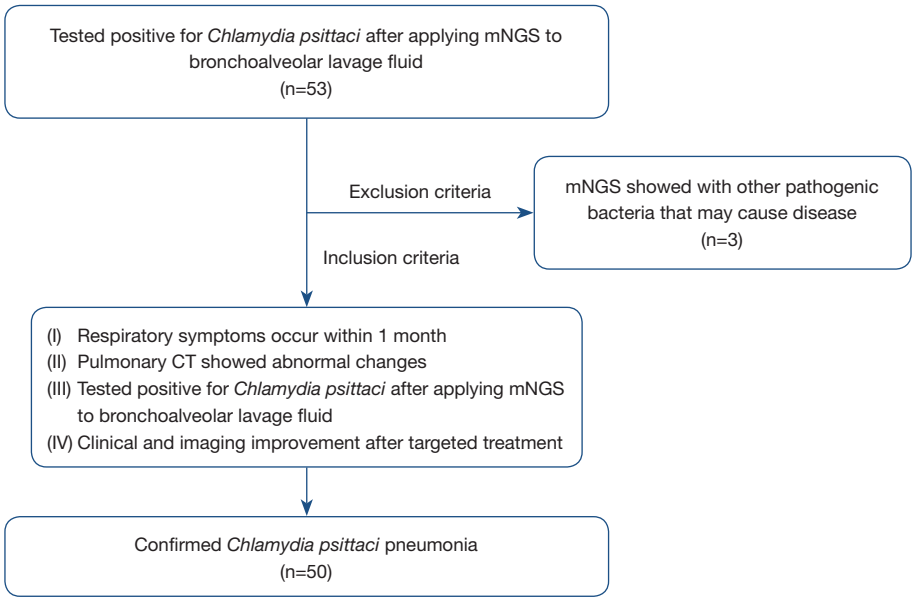

Figure 1 Patient selection flowchart. mNGS, metagenomics next-generation sequencing; CT, computed tomography.

night sweats, muscle soreness, skin rash); respiratory symptoms (cough, expectoration, dyspnea, chest pain); digestive tract symptoms (abdominal pain, diarrhea, poor appetite); neurological symptoms (dizziness, headache, unconsciousness, and gait instability); and urinary system symptoms (frequent micturition, urgent micturition, hematuria, changes in urine output). The laboratory tests included white blood cell count, procalcitonin, C-reactive protein, liver function, kidney function, cardiac function, electrolytes.

The types of CT equipment used by hospitals varied, including (I) SOMATOM Definition AS 128-slice spiral CT (Siemens, Germany); (II) NeuViz 128-slice Jing Rui CT (Neusoft, China); and (III) Light Speed V spiral CT (GE, USA). Each device adopts end-inspiratory scanning with a slice thickness of 5 mm and a reconstruction slice thickness of 1.5 mm. Through online collaboration, three doctors with over five years of work experience completed all of the work. The expert team consisted of 2 radiologists (attending physician) with over 8 and 10 years of experience in respiratory imaging and 1 pneumologist (associated chief physician). Three doctors reached a concern on the diagnosis of imaging features before diagnostics. When disagreements occurred, a meeting was held for discussion, and final decision was made by voting.

The CT appearance (unilateral lung/bilateral lung), involvement (single lobe/multiple lobes), distribution (subpleural distribution/secondary pulmonary lobule distribution/bronchial vascular bundle distribution/diffusion to all pulmonary lobes), and density (ground-glass shadows/consolidation) were all observed on the patients' lung images. Statistical imaging signs included the number of cases and the proportion of patients with air bronchogram, bronchiectasis, "fine mesh sign", "halo sign", "reversed halo sign", "tree-in-bud sign", necrosis or cavity, pleural effusion, enlarged mediastinal lymph nodes, and enlarged spleen. A follow-up CT scan is usually performed about a week after the first CT scan. Patients completed approximately two to four times CT scans according to their respective conditions until they were discharged from the hospital. In terms of statistical methods, this study adopted the *t*-test to calculate the median and standard deviation of the patients' ages.

Results

Among the 50 patients (*Figure 1*), there were 31 male patients (accounting for 62%, 95% CI: 0.47–0.75) and 19 female patients (accounting for 38%, 95% CI: 0.25–0.53) with a male-to-female ratio of 1.6:1. The onset age of CPP ranged from 33 to 80 (58.54±11.24) years old. In total, 80% (40/50, 95% CI: 0.66–0.90) of the patients had a history of

poultry exposure, which included raising or coming into contact with birds such as parrots, chickens, and ducks and being exposed to poultry droppings.

The patients had several symptoms, including fever, night sweats, muscle soreness and fatigue. In addition, they might have experienced abnormalities in several systems, such as the respiratory system, digestive system, neurological symptoms, and urinary system. Among them, 74% (37/50, 95% CI: 0.60–0.85) of patients experienced respiratory abnormalities on admission: 70% (35/50, 95% CI: 0.55–0.82) had cough, 56% (28/50, 95% CI: 0.41–0.70) had expectoration, and 32% (16/50, 95% CI: 0.20–0.47) had short of breath. In addition, 96% (48/50, 95% CI: 0.85–0.99) of patients developed fever, 18% (9/50, 95% CI: 0.09–0.32) developed muscle soreness, 32% (16/50, 95% CI: 0.20–0.47) developed fatigue, and 4% (2/50, 95% CI: 0.01–0.15) developed night sweats. Moreover, 28% (14/50, 95% CI: 0.17–0.43) of patients had digestive symptoms, including 12% (6/50, 95% CI: 0.05–0.25) abdominal pain, 16% (8/50, 95% CI: 0.08–0.30) diarrhea and 18% (9/50, 95% CI: 0.09–0.32) poor appetite. Furthermore, 24% (12/50, 95% CI: 0.14–0.38) of the patients developed neurological symptoms, including dizziness and headache (22%, 11/50, 95% CI: 0.12–0.36), unconsciousness (2%, 1/50, 95% CI: 0.00–0.12) and gait instability (2%, 1/50, 95% CI: 0.00–0.12). Detailed information can be found in *Table 1*.

A white blood cell count (4.0–10.0)×10^9/L was taken as the normal standard value. Among the patients, 68% (34/50, 95% CI: 0.53–0.80) had normal white blood cell numbers, and 32% (95% CI: 0.20–0.47) had increased white blood cell numbers, with the highest value being 16×10^9/L. In addition, 98% (95% CI: 0.88–1.0) of patients had increased C-reactive protein, 48% (95% CI: 0.34–0.62) of them had hyponatremia (blood sodium level <135 mmol/L), 50% (25/50, 95% CI: 0.36–0.64) of patients suffered from liver damage, and 22% (11/50, 95% CI: 0.12–0.36) and 24% (12/50, 95% CI: 0.14–0.38) of patients experienced damage to their renal and cardiac functions (abnormality of troponin and CK-MB), respectively. Detailed information can be found in *Table 1*.

The time from onset to the first CT examination was between 2–30 days, with an average of 7 days. Concerning the imaging appearance, distribution, involvement, density and signs, the following was noted:

(I) Imaging appearance and distribution: 62% (31/50) of the patients presented with a unilateral lung distribution, of which 28% (14/50, 95% CI: 0.17–0.43) with a left lung distribution, 34% (17/50, 95% CI: 0.22–0.49) with a right lung distribution, and 38% (19/50, 95% CI: 0.25–0.53) presented with a bilateral lung distribution. In addition, among all of the lesions on CT of 50 patients, 66% (33/50, 95% CI: 0.51–0.78) were located in the subpleural area, 50% (25/50, 95% CI: 0.36–0.64) were located in the secondary pulmonary lobules, 68% (34/50, 95% CI: 0.53–0.80) were located in the bronchovascular bundles, and 40% (20 /50, 95% CI: 0.27–0.55) spread to all lobes. Detailed information can be found in *Figure 1*.

(II) Involvement: 34% (17/50, 95% CI: 0.22–0.49) of the lesions were confined to one pulmonary lobe, while 66% (33/50, 95% CI: 0.51–0.78) of the lesions involved multiple lobes.

(III) Density: ground-glass shadows were observed in 100% (50/50, 95% CI: 0.91–1.00) of the patients, and consolidation accounted for 98% (49/50, 95% CI: 0.88–1.00).

(IV) Air bronchogram sign was observed in 80% (40/50, 95% CI: 0.66–0.90) of the patients, 46% (23/50, 95% CI: 0.32–0.61) showed bronchial wall thickening, and 32% (16/50, 95% CI: 0.20–0.47) showed bronchiectasis sign.

(V) Signs: “Fine mesh sign”, “halo sign” and “reversed halo sign” were observed in 74% (37/50, 95% CI: 0.59–0.85), 10% (5/50, 95% CI: 0.04–0.23) and 6% (3/50, 95% CI: 0.02–0.18) of the cases, respectively. Detailed information can be found in *Table 2*.

(VI) No case showed necrosis, cavities and "tree-in-bud sign”.

(VII) Other findings: 66% (33/50, 95% CI: 0.51–0.78) of the patients had pleural effusion, of whom 46% (23/50, 95% CI: 0.32–0.61) had unilateral pleural effusion, and 20% (10/50, 95% CI: 0.11–0.34) had bilateral pleural effusion. In addition, 36% (18/50, 95% CI: 0.23–0.51) of the patients experienced enlarged mediastinal lymph nodes, and 30% (15/50, 95% CI: 0.18–0.45) had enlarged spleens. Detailed information can be found in *Table 2*.

Discussion

Psittacosis pneumonia is an uncommon disease caused by *Chlamydia psittaci*, which accounts for approximately

Table 1 Information of the general conditions, clinical manifestations and laboratory tests of 50 patients with *Chlamydia psittaci* pneumonia

Characteristics	Number (case)	Percentage	95% CI
Gender			
Male	31	62%	0.4716–0.75
Female	19	38%	0.25–0.5284
Poultry exposure	40	80%	0.6586–0.895
Clinical symptoms			
Respiratory system	37	74%	0.5939–0.8492
Cough	35	70%	0.5522–0.8171
Expectoration	28	56%	0.4135–0.6973
Chest pain	7	14%	0.0628–0.2736
Short of breath	16	32%	0.1993–0.4683
Constitutional symptoms			
Fever	48	96%	0.8514–0.993
Muscular soreness	9	18%	0.0905–0.3192
Fatigue	16	32%	0.1993–0.4683
Night sweats	2	4%	0.007–0.1486
Digestive system	14	28%	0.1667–0.4271
Abdominal pain	6	12%	0.0497–0.25
Diarrhea	8	16%	0.0764–0.2966
Poor appetite	9	18%	0.0905–0.3192
Nervous system	12	24%	0.1352–0.3849
Dizziness & headache	11	22%	0.1199–0.3633
Gait instability	1	2%	0.001–0.1201
Unconsciousness	1	2%	0.001–0.1201
Urinary system	4	8%	0.0259–0.2011
Frequent & urgent micturition	3	6%	0.0156–0.1754
Hematuria	2	4%	0.007–0.1486
Laboratory tests			
Normal white blood cell count	34	68%	0.5317–0.8007
Increased white blood cell count	16	32%	0.1993–0.4683
Increased C-reactive protein	49	98%	0.8799–0.999
Hyponatremia	24	48%	0.3388–0.6242
Elevated procalcitonin	31	62%	0.4716–0.75
Abnormal liver function	25	50%	0.3572–0.6428
Abnormal renal function	11	22%	0.1199–0.3633
Abnormal cardiac function	12	24%	0.1352–0.3849

Table 2 Imaging signs of 50 patients with *Chlamydia psittaci* pneumonia

Characteristics	Number (case)	Percentage	95% CI
Range			
Single left lung	14	28%	0.1667–0.4271
Single right lung	17	34%	0.2159–0.4886
Bilateral lungs	19	38%	0.25–0.5284
Number			
Single pulmonary lobe	17	34%	0.2159–0.4886
Multiple pulmonary lobes	33	66%	0.5114–0.7841
Distribution			
Subpleural	33	66%	0.5114–0.7841
Bronchial vascular bundle	34	68%	0.5317–0.8007
Secondary pulmonary lobule	25	50%	0.3572–0.6428
Diffusion to all pulmonary lobe	20	40%	0.2673–0.548
Density			
Ground glass	50	100%	0.9111–1
Consolidation	49	98%	0.8799–0.999
Other signs			
Bronchial wall thickening	23	46%	0.3206–0.6055
Bronchiectasis	16	32%	0.1993–0.4683
Air bronchogram	40	80%	0.6586–0.895
Tree-in-bud sign	0	0%	0–0.0889
Necrosis and cavity	0	0%	0–0.0889
Fine mesh sign	37	74%	0.5939–0.8492
Halo sign	5	10%	0.0374–0.2259
Reversed halo sign	3	6%	0.0156–0.1754
Concomitant signs			
Pleural effusion	33	66%	0.5114–0.7841
Unilateral pleural effusion	23	46%	0.3206–0.6055
Bilateral pleural effusion	10	20%	0.105–0.3414
Enlarged spleen	15	30%	0.1829–0.4478
Enlarged lymph nodes	18	36%	0.2329–0.5086

1% of CAP cases worldwide (1), but recently, it has been increasingly found in China. In a recent study (10), only a few cases of CPP have been reported, and no conclusion on its imaging manifestations has been shared. This article summarizes the clinical characteristics and laboratory results, focuses on a detailed analysis of the disease's imaging and represents the first work related to the imaging manifestations of CPP.

Clinical manifestations

In this study, 80% of the cases had a history of poultry exposure, which is consistent with the previous report (11). The contact history was of great value for the diagnosis of psittacosis. Almost all patients develop fever, usually lasting for 10 to 14 days, while in severe cases, it may last for 3 to 7 weeks (12). *Chlamydia psittaci* can cause constitutional symptoms, and respiratory symptoms are the most common, accounting for 74% of cases. *Chlamydia psittaci* mainly infects the respiratory tract through inhalation and may subsequently infect multiple systems including the spleen, liver, kidneys and neurological system (13). Multisystem involvement is an important feature that can be used to differentiate from other common pathogens.

Laboratory tests

In this study, most of the patients had normal or mildly elevated white blood cell counts (14). Interestingly, in this study, 98% of patients had increased C-reactive protein. In addition, hyponatremia and liver, renal and cardiac damage may occur. These may be indicators of an atypical pathogen infection and can be used as important markers to distinguish the pathogen from other bacterial infections except for *Legionella* which behaves very similarly to *Chlamydia psittaci*, requiring a combination of exposure history for its identification. In addition, patients with psittacosis were found to have different procalcitonin levels. Procalcitonin is not specific to *Chlamydia psittaci* and thus cannot be used for its differentiation from other pathogens (15,16).

Imaging manifestations

The focus of CPP may be located in unilateral lung or bilateral lung. According to the follow-up observation of patients, most of the lesions originated in the unilateral lung; If the corresponding treatment is not carried out in time, it can rapidly progress to biliary lung. In addition, the lesions can be distributed under the pleura, around the bronchovascular bundle, secondary pulmonary lobule and diffusion to all pulmonary lobes (*Figure 2*). The above distribution mode can be observed in the CT of one patient. According to our observation, the lesion first occurs in the center of the secondary pulmonary lobule, causing interstitial changes around small blood vessels (17). Then it spreads to the surrounding alveoli/lung parenchyma, rapidly forming a large amount of exudation in the alveoli. The image thus shows a large area of consolidation and ground glass opacity (18,19). When the disease is not treated in time, multiple lesions may fuse with each other and eventually spread to all lobes (*Figure 2*).

Among the imaging signs, a "fine mesh sign" (*Figure 3A*) appeared most frequently (74%). The main reason was that the lesions were distributed in the interstitium, and the fine mesh corresponded to the thickening of the interlobular septum. This sign was viewed as an important one that distinguished CPP from general bacterial infections. Some negative signs were also highly critical in disease identification. For example, the "tree-in-bud sign" did not appear in any of the 50 cases of this study, which is helpful for distinguishing it from other pathogens such as tuberculosis and mycoplasma pneumonia. Similarly, the appearance of necrosis and cavities could rule out the possibility of CPP infection, which can be found in pyogenic bacterial infections. Furthermore, the bronchus of the CPP was unobstructed overall, and an air bronchogram was commonly seen. When the disease enters the recovery period and becomes organized, bronchiectasis may be seen (*Figure 3B*). In addition, CPP often has several important concomitant signs, such as pleural effusion, enlarged lymph nodes and spleen. Interestingly, 30% of patients experienced splenomegaly, which is consistent with the previous study (11). It is believed that *Chlamydia psittaci* is an intracellular parasitic bacterium that can affect the human reticuloendothelial system and proliferate within lymphatic tissue (5). *Figure 4* shows the complete disease course of a patient.

Our results showed that chest CT has an important role in diagnosis and could help in differentiating

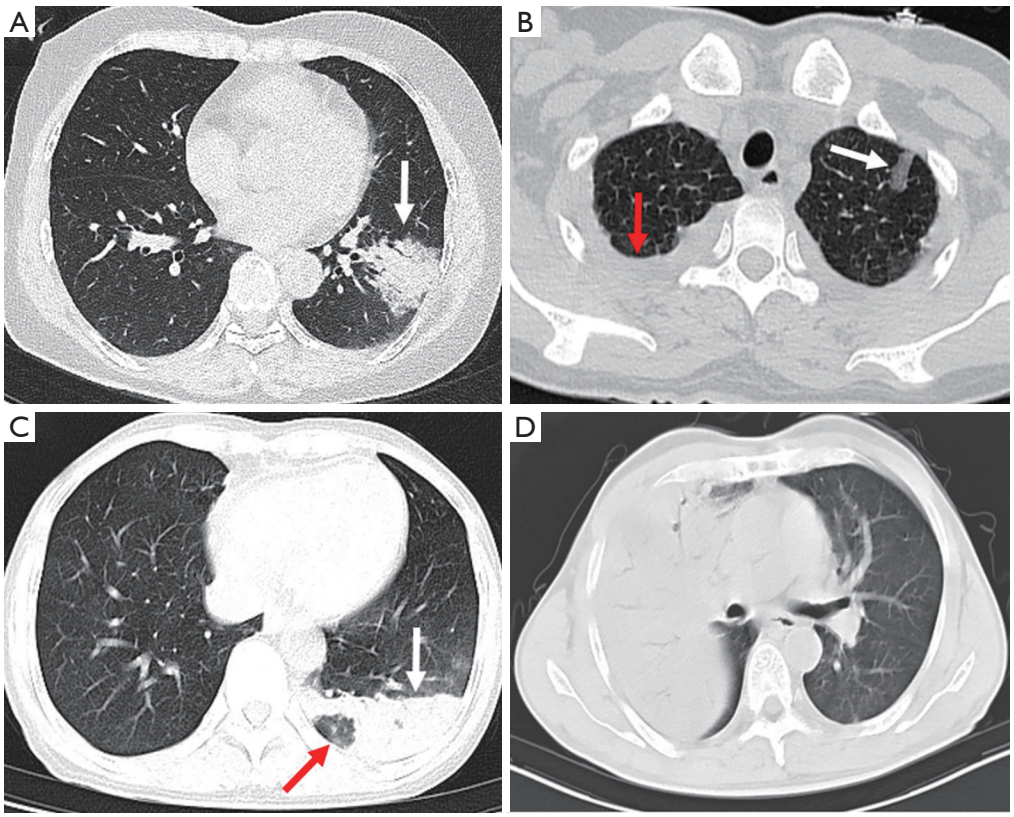

Figure 2 CT distribution patterns of CPP. (A) The lesion was the distribution of bronchial vascular bundle which was parallel to the bronchial vascular bundle as shown by the white arrow. Air bronchogram was observed inside, the center of the lesion was with consolidation shadows and ground-glass shadows were observed around the center. (B) The lesion was the ground-glass shadows of the secondary pulmonary lobules, as shown by the white arrow. In addition, bilateral pleural effusions could be observed, as shown by the red arrow. (C) The lesion was distributed under the pleura as shown by the white arrow. In addition, the red arrow showed the pulmonary lobule idling sign, indicating that the lesion was formed by the fusion of the secondary pulmonary lobules, while the local secondary pulmonary lobules were not affected and were with a relatively low density. (D) The lesion was diffusion to all pulmonary lobes with air bronchogram observed inside. In addition, the bronchus was compressed and narrowed but still unobstructed. CT, computed tomography; CPP, *Chlamydia psittaci* pneumonia.

Chlamydia psittaci from other infections. The distribution of the interstitium and parenchyma on the image is an important point of identification and can be used for virus identification (20). There is no tree-in-bud sign, necrosis or cavity, which may help to differentiate against tuberculosis and other purulent bacteria, such as *Staphylococcus aureus* and *Klebsiella* pneumoniae. Of course, the combination of clinical and laboratory tests is also particularly important.

Treatment

Traditional methods to detect *Chlamydia psittaci* infection are mainly based on etiological culturing, serological testing or polymerase chain reaction (PCR). The etiological culturing method is highly dangerous to laboratory personnel thus difficult to use in clinical practice. Although the cost of adopting such a method is inexpensive, the sensitivity and specificity of serological testing are both unsatisfactory. Using PCR-probe may be more sensitive and rapid, but the identification of rare *Chlamydia psittaci* serotypes is usually unreliable. With the widespread use of mNGS in clinical practice, an increasing number of *Chlamydia psittaci* cases have been detected (6,21). However, although mNGS is very important for diagnosis, it also has some limitations.

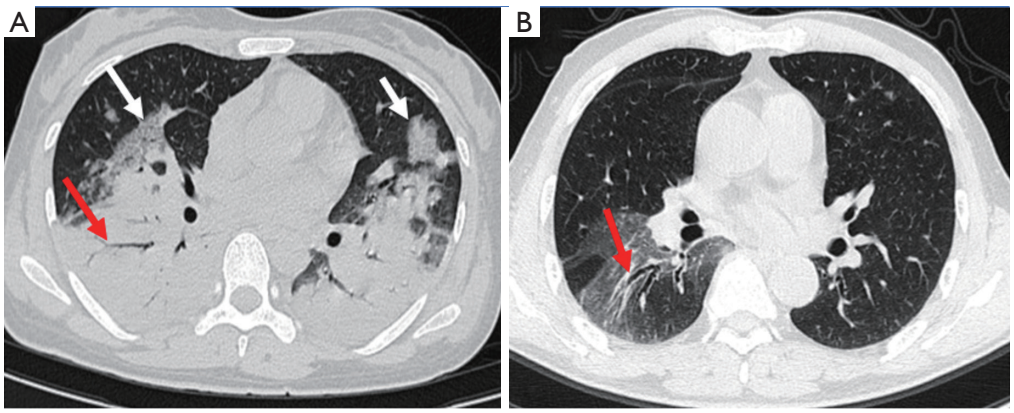

Figure 3 CT signs of CPP. (A) The "fine mesh sign" could be seen in the lesion, which represented the thickening of the interlobular septum, indicating that the lesion was distributed along the interstitium, as shown by the white arrows. In addition, air bronchogram could be observed, and the bronchus was unobstructed, as shown by the red arrow. (B) During the dissipated period of the disease, a few ground-glass shadows could still be observed. In addition, thickened bronchial wall and dilated bronchial lumen were observed inside, as shown by the red arrow. CT, computed tomography; CPP, *Chlamydia psittaci* pneumonia.

First, it is very expensive and will not be considered for routine cases. This examination is recommended only when the disease is highly suspected by clinical and imaging (22). Second, mNGS often does not detect a single patient, which also needs to be combined with clinical and imaging diagnostics.

Chlamydia psittaci is an intracellular pathogen without a typical cell wall and is inherently resistant to wall-breaking antibiotics (such as β-lactams). Doxycycline and macrolides such as azithromycin can be used to treat psittacosis, but doxycycline can penetrate chlamydia in a rapid manner with a high cure rate and mild adverse reactions. Therefore, it is the first choice for the treatment of psittacosis for adults (23). Psittacosis is very sensitive to treatment, and the fever of most psittacosis patients can be abated within 48 hours after initiation of doxycycline (24). Therefore, for patients whose symptoms have not been improved within 72 hours after treatment, the possibility of other infections should be considered (25).

Limitations

Our retrospective study has several limitations. First, the number of cases in this study was small, which might lead to statistical deviations. We will continue to increase the sample size for more in-depth research. Second, the lack of histopathology in this study makes it impossible to explore the relationship between various imaging findings and pathology. Third, the selection bias of patient recruitment may also exist. Fourth, the authors found that it may still be challenging to distinguish CPP from other bacteria on the basis of clinical infections, laboratory tests and imaging. Therefore, we will introduce a control group in the future to conduct comparative studies.

Conclusions

Patients affected with *Chlamydia psittaci* often involve multiple systems, the respiratory system is the most common. Untreated severe *Chlamydia psittaci* can rapidly progress to ARDS. CT is of great value for the early diagnosis of this disease. The lesions were usually distributed in the secondary pulmonary lobules, around the bronchovascular bundles, under the pleura or diffusely. Both the lung parenchyma and the interstitium are involved. Therefore, consolidation and ground-glass opacities are always visible, and the fine mesh sign is a common sign of importance. Necrosis, cavitation, and tree-in-bud signs were not observed. With these evocative images, supported by the contact history, clinical symptoms, and laboratory findings, mNGS examination should be carried out to provide appropriate early treatment.

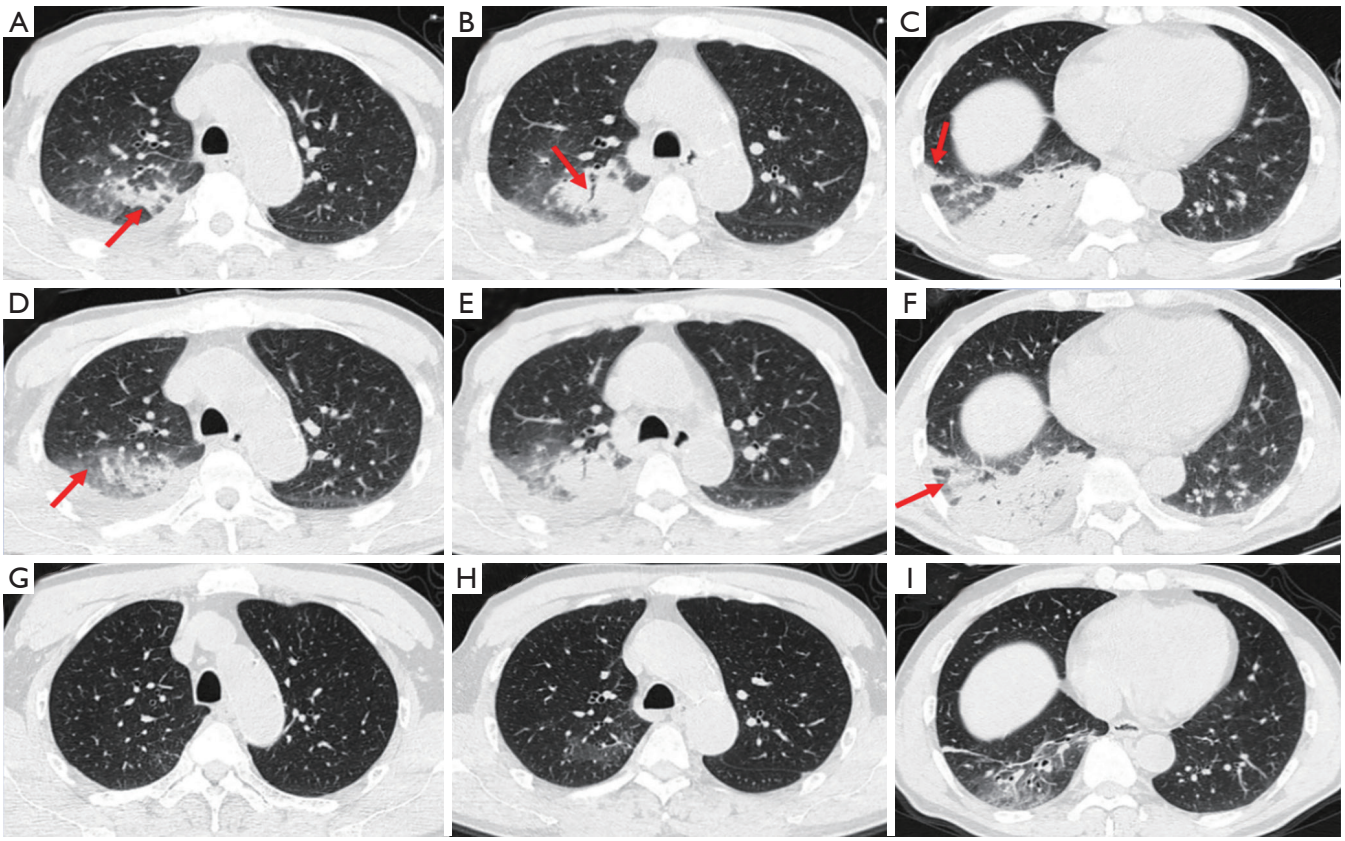

Figure 4 CT follow-ups in a patient of CPP. A 68-year-old male patient with cough and sputum and had a contact history with poultry. The patient was admitted to the hospital for 8 days. In addition, he experienced muscle soreness, fatigue, chest tightness and short of breath with a body temperature of 39.8 ℃. During the course of the disease, diarrhea occurred. The laboratory tests were presented as: normal white blood cell number, increased C-reactive protein number, abnormal liver function and decreased blood sodium level. (A-C) were results of the first CT examinations after admission (October 29, 2020). (A) presented the consolidation of the secondary pulmonary lobules of the right upper lobe with ground-glass shadows around it, as shown by the red arrow. (B) showed that the lesion was distributed along the bronchial vascular bundle, and the bronchus was unobstructed, as shown by the red arrow in the figure. In addition, in (C), the consolidation shadows which were subpleurally distributed in the right lower lobe and the small patch consolidation shadows of the secondary pulmonary lobules were presented. Pleural effusion on the right side (red arrow) was observed in the first CT result. (D-F) demonstrated the results of the second reexamination of pulmonary window using the same-slice CT control (November 4, 2020). Compared with the result shown by (A), (D) presented more ground-glass shadows (red arrow). Compared with (C), (F) showed formations of new foci in secondary pulmonary lobules, which was indicated by the red arrow. After mNGS diagnosis, the patient was confirmed to be infected with *Chlamydia psittaci*. After doxycycline treatment, the examination results of pulmonary window were shown by (G-I) using the same-slice CT control (December 10, 2020). As shown by the results, lesion absorption was observed. In (I), ground-glass shadows and striped shadows were still observed. Also, the bronchus was slightly dilated compared to the previous results. CPP, *Chlamydia psittaci* pneumonia; CT, computed tomography; mNGS, metagenomics next-generation sequencing.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-22-809/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The present study was approved by the ethics committee of Nanjing Medical University. Written informed consent was obtained from all subjects. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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