

Metagenomic Next-Generation Sequencing Contributes to the Diagnosis of Pneumonia Caused by *Chlamydia abortus* in a Male Patient: Case Report and Literature Review

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Background: *Chlamydia abortus* is generally considered as the main cause of ruminants abortion, but it rarely causes human infection resulting in abortion or pneumonia.

Case Presentation: We report a case of male patient with pneumonia caused by *Chlamydia abortus*. Results of next generation sequencing (NGS) in the bronchoalveolar lavage fluid (BALF) indicated *Chlamydia abortus* infection. The patient was treated with intravenous infusion of doxycycline. The clinical symptoms of this patient were ameliorated significantly, and all these improvement were indicated by laboratory parameters significantly. Shown as chest computed tomography (CT), most of the inflammation had been absorbed after doxycycline treatment.

Conclusion: *Chlamydia abortus* mainly infects ruminants and occasionally humans. NGS has its own advantages of rapidity, sensitivity and specificity in detecting *Chlamydia abortus*. Doxycycline exhibits a great therapeutic effect on pneumonia caused by *Chlamydia abortus*.

Keywords: *Chlamydia abortus*, pneumonia, human, metagenomic next-generation sequencing, case report

Introduction

Chlamydia abortus is a subspecies of *Chlamydia psittaci* and is a kind of zoonotic pathogen. It was reported to infect a variety of animals including goats, sheep, pigs, yaks, horses, guinea pigs, rabbits and mice.^{1–5} The infections caused by this pathogen are a major cause of abortion in sheep and goats. In addition, *Chlamydia abortus* is also the causative pathogen of abortion in humans.⁶ The first case was discovered in 1967 by Roberts et al.⁷ In humans, *Chlamydia abortus* infection is rare. Most patients with *Chlamydia abortus* infections are pregnant women, and cases of extra-pregnancy infection are seldom observed.⁸ Only two case of pneumonia caused by *Chlamydia abortus* in male patient has been reported worldwide.^{9,10} Here, we report a case of pulmonary infection caused by *Chlamydia abortus* in a male patient, which was diagnosed using metagenomic next-generation sequencing (mNGS). Further, we discuss the clinical characteristics, treatment protocol, and prognosis of this case, so as to provide a clinical reference for the future.

Case Report

A 51-year-old man was admitted to the hospital with a fever (39.0°C) accompanied by shortness of breath and limb weakness. After admission, he was treated with supplemental oxygen via nasal cannula (4 L/min), and his oxygen saturation reached 92%. Laboratory investigations revealed an elevated white blood cell count ($15.7 \times 10^9/L$) and neutrophil ratio (0.96) as well as increased procalcitonin (PCT) (35.96 µg/L), C-reactive protein (CRP) (423.61 mg/L), IL-6 (>5000 pg/mL), alanine



Figure 1 CT image of the chest before the treatment of pneumonia caused by *Chlamydia abortus*.

aminotransferase (201 U/L), aspartate aminotransferase (468 U/L), and creatinine levels (128 $\mu\text{mol/L}$). Chest computed tomography (CT) revealed patchy high-density shadows in the right lung (Figure 1).

The patient was involved in farming. Due to chicken and duck breeding (chickens and ducks do not show obvious symptoms of infection), psittacosis pneumonia could not be ruled out. The BALF samples were collected and sent for mNGS; subsequently, doxycycline and meropenem were empirically administered as anti-infective therapy. Testing via mNGS revealed the presence of “*Chlamydia abortus*” alone in the BALF (sequence number: 6977) (Table 1). Meropenem was discontinued, while doxycycline treatment was continued. Two weeks later, the patient’s temperature returned to normal, and the oxygen saturation remained stable at 99%. His hematological and laboratory parameters were

Table 1 Next Generation Sequencing Results in the BALF

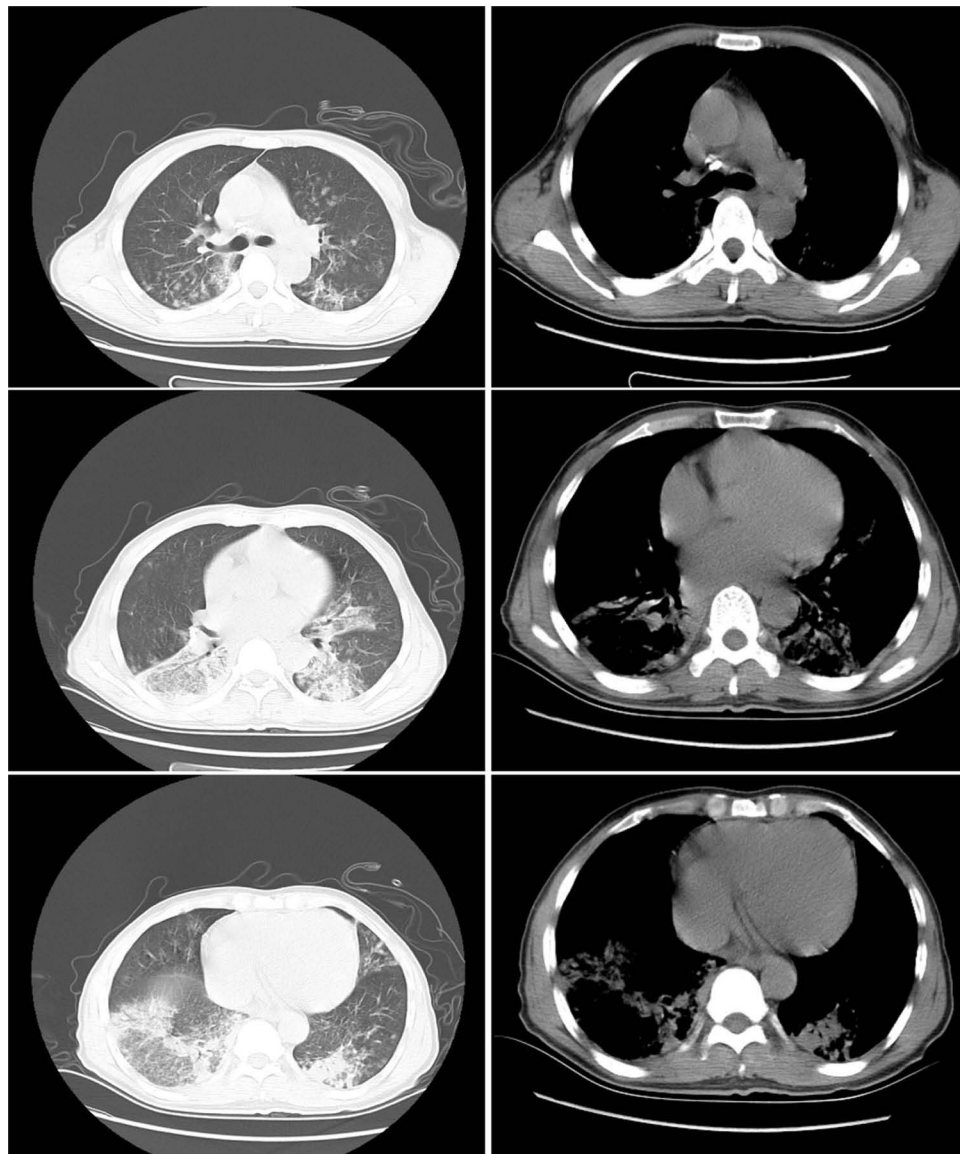
Genus	Species	Sequence Number	Confidence
<i>Chlamydia</i>	<i>Chlamydia abortus</i>	6977	99%

Table 2 Laboratory Examination of Hematological and Biochemical Parameters in a Patient with Pneumonia Due to *Chlamydia Abortus* Infection

	WBC (/L)	Neutrophil Ratio	PCT ($\mu\text{g/L}$)	CRP (mg/L)
Day 1	15.7×10^9	0.96	35.96	423.61
Day 14	8.6×10^9	0.84	0.74	22.49
	IL-6 (pg/mL)	ALT (U/L)	AST (U/L)	Creatinine ($\mu\text{mol/L}$)
Day 1	>5000	201	468	128
Day 14	>60.86	279	462	65

Abbreviations: WBC, white blood cell; PCT, procalcitonin; CRP, C-reactive protein; ALT, alanine aminotransferase; AST, aspartate aminotransferase.

as follows: white blood cell count, $8.6 \times 10^9/\text{L}$; neutrophil ratio, 0.84; PCT, 0.74 $\mu\text{g/L}$; CRP, 22.49 mg/L; IL-6, >60.86 pg/mL; alanine aminotransferase, 279 U/L; aspartate aminotransferase, 462 U/L; and creatinine, 65 $\mu\text{mol/L}$ (Table 2). Three weeks later, the results of chest CT showed a decrease in lesion enhancement in the right lower lobe (Figure 2). The

**Figure 2** CT image of the chest after three weeks the treatment of pneumonia caused by *Chlamydia abortus*.

patient's condition improved, and he was discharged. At the 1-month follow-up, the patient's general condition appeared to be good, and there was no recurrence of infection.

Discussion

Chlamydia abortus is a subspecies of *Chlamydia psittaci* (*Chlamydia psittaci* serovar 1). It is found mainly in ruminants and occasionally in humans. Although the clinical manifestations of the two infections are similar,¹¹ the pathogens causing psittacosis in birds and endemic abortion in sheep and goats have completely different phenotypic and genetic characteristics. Therefore, these two pathogens were reclassified as *Chlamydia psittaci* and *Chlamydia abortus*.¹² The urine, milk, and feces of infected animals contain *Chlamydia abortus* and are the main vectors for these infections in humans.¹³ In the case reported herein, the male patient had a clear history of contact with poultry (chicken and duck). This indicated that *Chlamydia abortus* could be transmitted through contact with infected birds and could cause lung infection in male patients, and that individuals who were not immunocompromised could also be susceptible.

In most cases, *Chlamydia abortus* infections manifest as a flu-like illness at onset, causing symptoms such as fever, headache, nausea, vomiting, and limb weakness. They then progress and can lead to thrombocytopenia, decreased white blood cell counts, increased C-reactive protein levels, liver and kidney damage, and disseminated intravascular coagulation.^{14,15} In our male patient, the clinical manifestations of *Chlamydia abortus*-induced pulmonary infection were non-specific. Interestingly, the PCT level was elevated to 35.96 µg/L in this patient who only had a *Chlamydia abortus* infection. This value was much higher than the typical range of PCT observed during *Chlamydia* infections. Lung CT showed a high-density, non-specific infiltrate in the unilateral lung.

Previously, powerful methods for diagnosing pneumonia caused by *Chlamydia abortus* were unavailable in clinical settings. Traditional methods for pathogen identification include specimen culture, serological tests, and PCR. However, these methods have certain limitations in terms of detection time, rate of positivity, and specificity. mNGS, known as high-throughput parallel sequencing, can sequence hundreds to billions of DNA or RNA fragments simultaneously and independently.^{16,17} It can theoretically detect any nucleic acids from pathogenic microbes and is incredibly valuable for diagnosing infectious diseases.¹⁸ The emergence of mNGS has enabled rapid diagnosis with advantages such as speed, sensitivity, and specificity.¹⁹ Further, unlike sputum specimens and throat swabs, BALF is not contaminated by oral bacteria and serves as a high-quality respiratory specimen. In our case, the patient underwent blood and sputum culture after admission, and no definite pathogen was identified. However, using mNGS technology, *Chlamydia abortus* was detected in the BALF.

Chlamydia abortus lacks a cell wall, and β-lactam antibiotics are ineffective against this bacterium. Therefore, tetracyclines are used as first-line treatment agents,¹⁴ while other treatment alternatives include macrolides²⁰ and fluoroquinolones.²¹ In one study, Walder et al used clarithromycin to treat a *Chlamydia abortus* infection with sufficient efficacy.²⁰ For treatment, the recommended duration of antibiotic administration is 10 to 21 days, as this ensures efficacy and prevents disease recurrence. In this case, the patient's condition improved after doxycycline treatment, demonstrating the good efficacy of this drug in the treatment of pneumonia caused by *Chlamydia abortus*.

Conclusion

To summarize, in this report, we used mNGS technology to confirm the case of *Chlamydia abortus* pneumonia in a male patient and summarized its clinical characteristics. Our findings show that *Chlamydia abortus* can be transmitted to humans from poultry birds. Its clinical symptoms and imaging findings are not specific, but patients may show significantly elevated PCT levels and develop liver and kidney damage. Doxycycline is effective in treating pneumonia caused by *Chlamydia abortus*. mNGS enables the quick and accurate detection of pathogens, allowing doctors to conduct targeted treatment early on and improve patient prognosis. Therefore, for pneumonia patients with a history of contact with poultry or livestock, when PCT levels are significantly increased, liver and kidney function is impaired, and β-lactam antibiotics are ineffective, *Chlamydia abortus* infection should be considered in the differential diagnosis. At present, few cases of human *Chlamydia abortus* infection have been reported. Thus, additional studies are necessary to guide the clinical diagnosis and treatment of *Chlamydia abortus* pneumonia.

Ethics Approval and Consent for Publication

This study has been reviewed and approved by the Research Ethics Committee of the First People's Hospital of Huaihua (HHSYY-EC-202301-C1). The patient provided informed consent for publication of the clinical details including lung CT images, and written informed consent was obtained. Written informed consent was provided by the patient for the publication of the case details and images. Details of the case can be published without institutional approval.

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Disclosure

The authors report no conflicts of interest in this work.

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