BMC Infectious Diseases

CASE REPORT Open Access

Community-acquired pneumonia associated with influenza co-infection caused by *fusobacterium necrophorum*: a case report and literature review

Min Cao[1], Lin Huang[1] and Rong Zhang[1*]

Abstract

Background *Fusobacterium necrophorum* is a rare pathogen associated with community-acquired pneumonia (CAP), particularly among healthy adults. This case report presents a rare documented case of CAP caused by *F. necrophorum* in a young individual, providing valuable insights for the diagnosis and treatment of similar cases.

Case presentation The patient was initially diagnosed with influenza, and subsequently developed CAP caused by *F. necrophorum*. Despite one week of outpatient treatment with moxifloxacin, the symptoms persisted, leading to hospitalisation. Treatment with piperacillin tazobactam/imipenem and doxycycline, which target atypical pathogens, did not result in improvement after admission. Conventional diagnostic methods failed to identify the causative pathogen; however, metagenomic next-generation sequencing of bronchoalveolar lavage fluid confirmed it to be *F. necrophorum*. The patient showed significant improvement after ten days of targeted treatment with ornidazole and imipenem/piperacillin tazobactam, and was discharged.

Conclusion Uncommon pathogens, such as *F. necrophorum*, should be considered as potential culprits in young individuals with CAP when conventional cultures yield negative results but there is a strong suspicion of infection, especially if initial antibiotic therapy is ineffective.

Keywords Community-acquired pneumonia, *Fusobacterium necrophorum*, Fever, Infection

Background

Community-acquired pneumonia (CAP) poses a significant health burden and is associated with considerable morbidity and mortality [1]. It can be caused by bacteria, viruses, or fungi [2]. However, the distribution of pathogens responsible for CAP varies across regions, age groups, and study periods. Anaerobic organisms are rarely reported as causative agents of CAP [3]. *Fusobacteriu. necrophorum* is a common cause of Lemierre's syndrome and sometimes a pathogen of necrotising pneumonia [4, 5]. In this study, we present a case of CAP caused by *F. necrophorum*, which co-occurred with influenza infection. This case report, along with a relevant literature review, aims to improve the clinical awareness, diagnosis, and treatment of this disease.

*Correspondence:
Rong Zhang
zhang-rong@zju.edu.cn
[1]Department of Clinical Microbiology, The Second Affiliated Hospital of Zhejiang University School of Medicine, Hangzhou, Zhejiang 310009, China

Case presentation

A thirty-year-old man was admitted to the hospital on December 27th, 2023, due to a persistent cough lasting over 20 days, recurrent fever (Fig. 1D), and progressive pain in the right chest for more than 10 days.

Nine days prior to admission, the patient had visited a fever clinic presenting with flu-like symptoms, including sore throat, runny nose, and cough. He attempted to self-treat with baloxavir marboxil, but experienced no improvement. Upon physical examination, his temperature was 39.2 ℃, blood pressure was 132/94 mmHg, heart rate was 107 bpm, and oxygen saturation was 97%, respectively. Laboratory investigations indicated a markedly elevated white blood cell (WBC) count of 21.9×10^9/L (normal range 4– 10×10^9/L), with a neutrophil percentage of 89.5% (normal range 50– 70%). The patient also exhibited an international normalised ratio of 1.5 (normal range 0.9– 1.1), an activated partial thromboplastin time of 53.2s (normal range 30–45 s), a D-dimer level of 2880 μg/L (normal range < 500 μg/L), and a C-reactive protein (CRP) level of 175.4 mg/L (normal range < 10 mg/L). Other blood tests did not reveal any significant abnormalities. Result of the influenza A virus antigen test was positive. The doctor then initiated empirical treatment with moxifloxacin for seven days (Table 1).

On the day before admission, the patient's blood tests still indicated persistently high levels, with a WBC count of 21.7×10^9/L, neutrophil percentage of 84.8%, and CRP level of 159.6 mg/L. Chest computed tomography (CT) revealed further progression of inflammation and consolidation in the lower right lung (Fig. 2A, B). The patient was subsequently admitted to the hospital for further evaluation and management, and his medication was switched to piperacillin-tazobactam.

After admission, a series of tests were performed to detect bacteria, fungi, and viruses. The pathogen test results were negative for all except influenza A virus nucleic acid (Table 2). Despite the addition of oseltamivir on the third day of admission and doxycycline the next

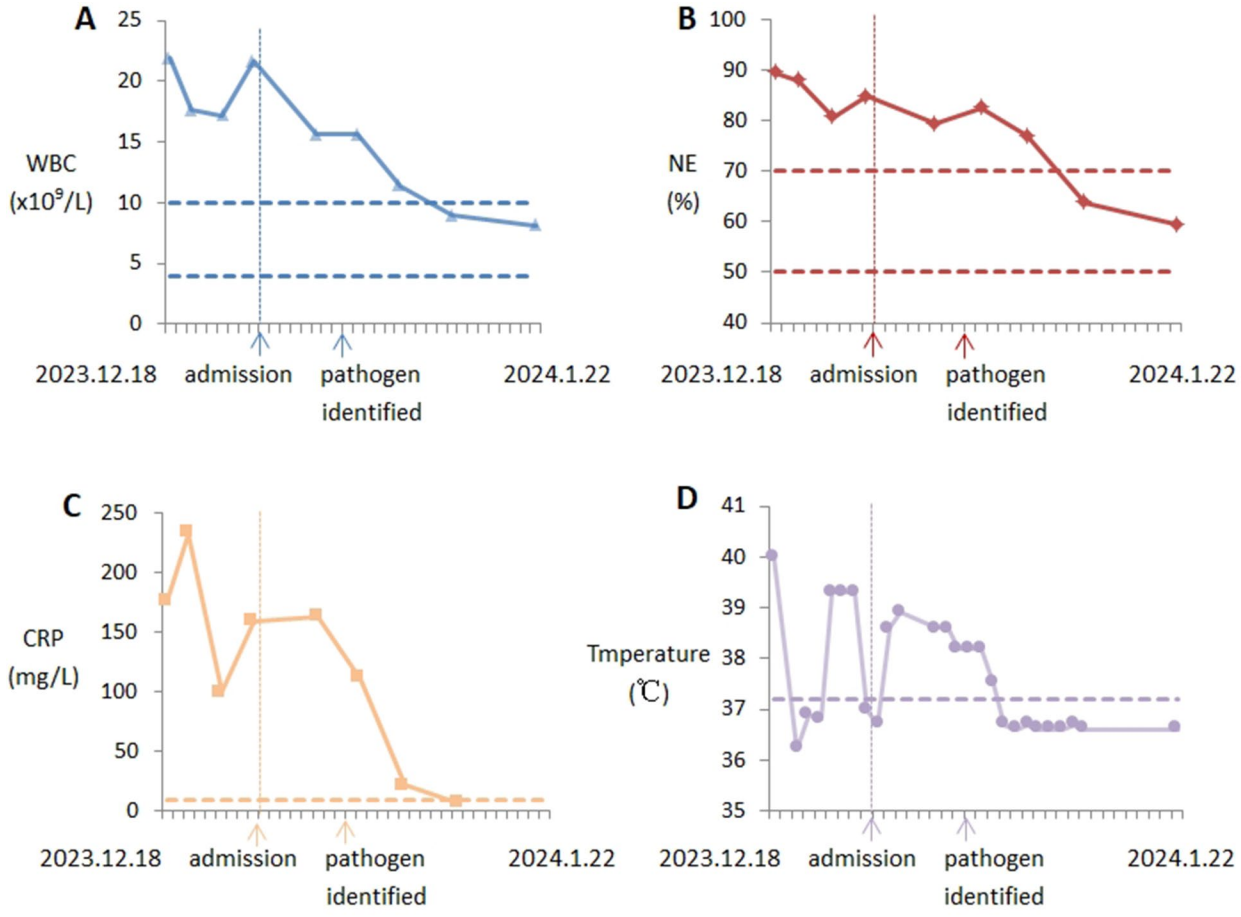

Fig. 1 Illustrates the changes in inflammatory markers and temperature of the patient from onset to discharge. The horizontal line represents the normal reference range. **A**: white blood cell (WBC) count, **B**: neutrophil percentage, **C**: C-reactive protein (CRP), D: Temperature

Table 1 Medication since the onset of illness

Date	Medication
2023.12.18-2023.12.25	Moxifloxacin
2023.12.26-2023.12.29	Piperacillin tazobactam
2023.12.30	Piperacillin tazobactam + oseltamivir
2023.12.31	Piperacillin tazobactam + doxycycline + oseltamivir
2024.1.1-2024.1.3	Imipenem + doxycycline + oseltamivir
2024.1.4-2024.1.8	Imipenem + ornidazole
2024.1.9-2024.1.14	Piperacillin tazobactam + ornidazole
2024.1.15 (discharge)	Amoxicillin clavulanic acid + ornidazole

Dosage: Moxifloxacin (400 mg once a day), piperacillin tazobactam (4.5 g intravenous infusion once every 8 h), oseltamivir (75 mg once every 12 h), imipenem (500 mg intravenous infusion once every 8 h), doxycycline (100 mg once every 12 h), ornidazole (500 mg once every 12 h), amoxicillin clavulanic acid (375 mg once every 8 h)

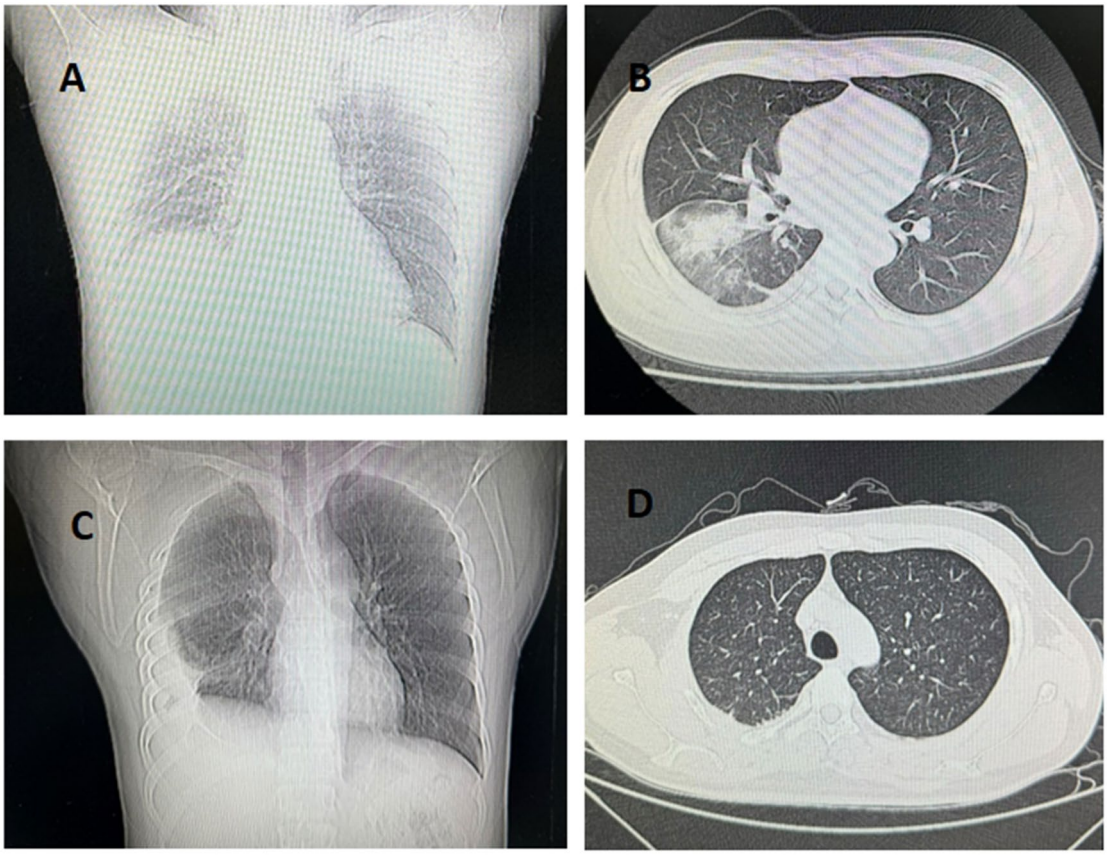

Fig. 2 Chest CT images. **A**, **B**: Multiple inflammations in both lungs with partial consolidation; **C**, **D**: Improvement of lesions in the lower lobes of both lungs after identifying the cause and administering appropriate treatment

day due to the patient's persistent fever, the fever did not subside. Consequently, on January 3rd, 2024, the patient underwent bronchoscopy examination, during which bronchoalveolar lavage fluid (BALF) specimens were collected for metagenomic next-generation sequencing (mNGS) to identify potential pathogens.

During the bronchoscopy, a small amount of white secretion was observed in the right lower lobe cavity, whereas no apparent abnormalities were detected in the bronchial segments on either side. The mNGS analysis revealed presence of *F. necrophorum* (sequence number 6421) and influenza A virus (sequence number 1) (Fig. 3). The bilateral internal jugular vein colour Doppler ultrasound examination (Fig. 4) and blood culture results were normal, ruling out Lemierre's syndrome. After treatment with ornidazole and imipenem, the patient's temperature and inflammatory indicators returned to normal (Fig. 1), and chest CT showed significant improvement in absorption (Fig. 2C, D). The patient was discharged after 17 days in the hospital and switched to a four-week course of oral amoxicillin clavulanic acid and oral ornidazole.

Table 2 Inspection during the process from onset to identification of the pathogens

Inspection	result
2023.12.18	
Influenza A virus antigen	**Positive**
2023.12.28	
Blood cryptococcus antigen	negative
Blood culture	negative
T-SPOT.TB	negative
Sputum Culture	negative
Xpert mtb/rif (Sputum)	negative
2023.12.29	
Influenza A virus nucleic acid	**Positive**
Influenza B virus nucleic acid	negative
2019-nCoV antigen	negative
Legionella pneumophila antibody IgM	negative
Mycoplasma pneumoniae antibody IgM	negative
Chlamydia pneumoniae antibody IgM	negative
Adenovirus antibody IgM	negative
Respiratory syncytial virus antibody IgM	negative
Acid-fast smear (Sputum)	negative
Serum (1–3)- β- D-glucan (pg/ml)	42
Serum galactomannan	0.07
Cytomegalovirus nucleic acid (/ml)	$<10^2$
Epstein-Barr virus nucleic acid (/ml)	$<4\times10^2$
2024.1.1	
Mycoplasma pneumoniae nucleic acid	negative
2024.1.3	
Bronchoscopy	inflammatory in the right lower lobe bronchitis
Influenza A virus nucleic acid	negative
BALF Culture	negative
Xpert mtb/rif (BALF)	negative
2024.1.4	
mNGS (BALF)	**fusobacterium necrophorum**

Discussion and conclusions

Studies investigating the cause of community-acquired pneumonia (CAP) can yield varying results owing to variations in patient selection and research methods. In China, Respiratory syncytial virus is the predominant viral cause of CAP in children, *Streptococcus pneumoniae* is the primary bacterial pathogen in children, *Mycoplasma pneumoniae* in adolescents, and *Haemophilus influenzae* in adults [6]. Anaerobes are believed to play a significant role in the development of aspiration pneumonia, which predominantly affects the elderly [7, 8]. However, reports associating anaerobes with CAP are scarce [9, 10]. In this specific case, a young man initially diagnosed with influenza was subsequently found to have CAP caused by *F. necrophorum*. *F. necrophorum* is a non-spore forming obligate anaerobic Gram-negative bacillus that is part of the normal flora in the upper respiratory tract of humans and animals [11]. Influenza can weaken the immune system, damage the respiratory epithelium, and impair the normal clearance mechanisms of the respiratory tract [12], thereby facilitating the migration of bacteria like *F. necrophorum* from the upper respiratory tract to the lower respiratory tract. *F. necrophorum* is occasionally responsible for osteitis [13] and is the most common cause of Lemierre's syndrome [14]. A clinical survey in Denmark revealed that the incidence of Lemierre's syndrome was higher than previously reported, with a distinct age distribution. Early suspicion and prompt antibiotic therapy, often combined with surgical drainage, are crucial to reduce mortality [15]. In this patient, Lemierre's syndrome was ruled out based on negative results from bilateral internal jugular vein colour Doppler ultrasound examination and blood culture. *F. necrophorum* is considered a rare cause of CAP [16] and does not grow under normal aerobic cultivation methods, which often leads to its oversight by physicians. The use of inappropriate antibiotics can also prolong hospital stays [17]. If patients are not promptly diagnosed and treated, they can develop severe pneumonia and multiple organ failure, which can be fatal [18]. Treatment should include a prolonged course of intravenous beta-lactam antibiotics in combination with metronidazole [19]. In this case, the patient was initially treated with moxifloxacin, which does not target *F. necrophorum*, resulting in recurrent fever and elevated inflammatory markers. Even after admission and use of piperacillin tazobactam/imipenem, the fever persisted. It was only after utilizing

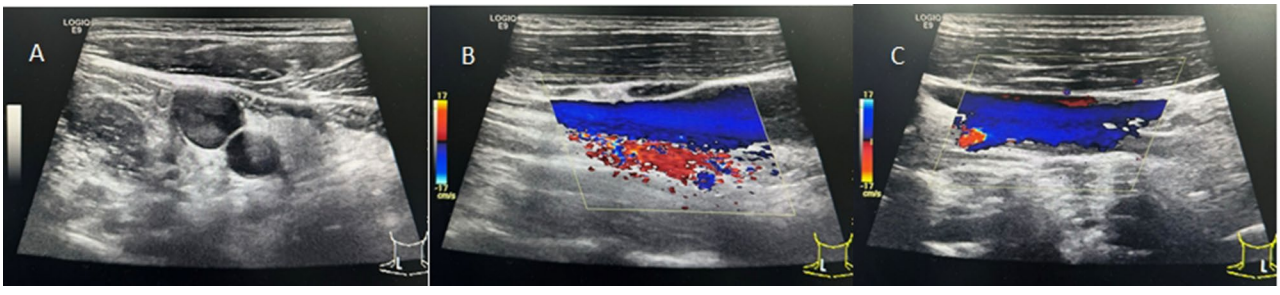

Fig. 3 Pathogen detection results of metagenomics next-generation sequencing. The number of sequences in parentheses

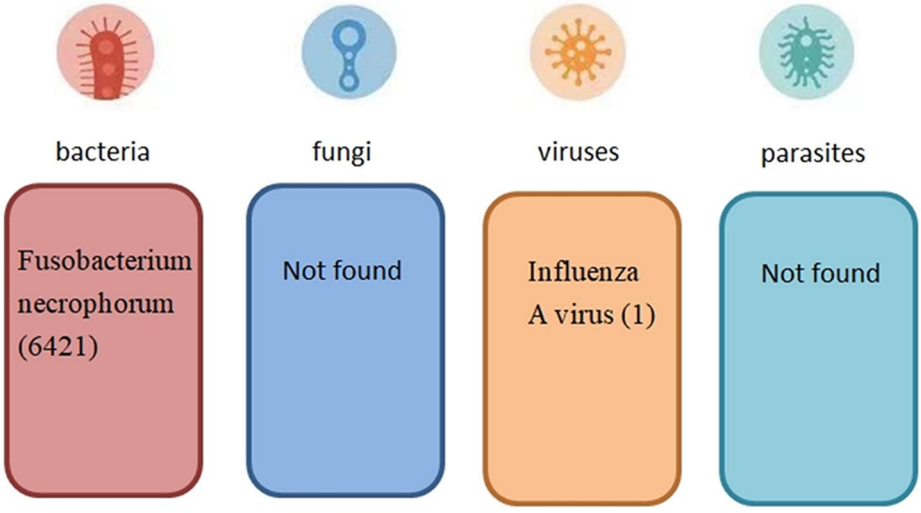

Fig. 4 Bilateral internal jugular vein color Doppler ultrasound examination. **A**: Internal jugular vein diameter; **B**, **C**: Intravenous color Doppler blood flow

metagenomic next-generation sequencing (mNGS) to identify the pathogen and adding ornidazole to the treatment that the patient's temperature normalized.

mNGS is a rapid and accurate method for identifying potential pathogens and has shown great promise in diagnosing infectious diseases [20]. It can detect non-viable DNA, making it particularly useful for patients who have already received prolonged antimicrobial therapy. This case demonstrates the value of mNGS in aiding the diagnosis of infections caused by difficult to culture bacteria or in cases where prior antibiotic use has compromised organism recovery. While the cost and availability of mNGS currently limit its widespread use, it is important to consider it when conventional cultures are negative but infection is strongly suspected.

In conclusion, *F. necrophorum* is an uncommon pathogen typically associated with CAP, especially in previously healthy adults. This case underscores the need for clinicians to consider atypical pathogens like *F. necrophorum* in young individuals with CAP when standard cultures are negative but infection is strongly suspected, particularly in cases where empirical anti-infective therapy yields unsatisfactory results. One limitation of this study is that the pathogen was not confirmed through anaerobic culture.

Abbreviations

Bpm	Beats per minute
L	Litre
mg	milligram
S	Seconds
CAP	Community-acquired pneumonia
mNGS	Metagenomic next-generation sequencing
BS	White blood cell
BS	C-reactive protein
CT	Computed tomography
BALF	Bronchoalveolar lavage fluid

Acknowledgements
Not applicable.

Author contributions
Min Cao and Lin Huang collected the patient data and conducted literature review. Rong Zhang provided consultation and summarized the literature literature. Min Cao wrote the manuscript and Rong Zhang revised the it. All authors read and approved the final manuscript.

Funding
Not applicable.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study was approved by the ethics committees of the Second Affiliated Hospital of Zhejiang University School of Medicine (approval date: April 18th, 2023).

Consent for publication
The patient in this study provided written informed consent to publish the clinical details and images.

Competing interests
The authors declare no competing interests.

Received: 6 February 2024 / Accepted: 2 May 2025
Published online: 09 May 2025

References

1. Gadsby NJ, Musher DM. The microbial etiology of community-acquired pneumonia in adults: from classical bacteriology to host transcriptional signatures. Clin Microbiol Rev. 2022;35(4):e0001522. https://doi.org/10.1128/cmr.00015-22.
2. Lanks CW, Musani AI, Hsia DW. Community-acquired pneumonia and hospital-acquired pneumonia. Med Clin North Am. 2019;103(3):487–501. https://doi.org/10.1016/j.mcna.2018.12.008.
3. Rothberg MB. Community-acquired pneumonia. Ann Intern Med. 2022;175(4):ITC49–64. https://doi.org/10.7326/AITC202204190.

4. Akagi Fukushima E, Bhargava A. Unusual case of necrotizing pneumonia caused by *Fusobacterium nucleatum* complicating influenza a virus infection. Anaerobe. 2021;69:102342. https://doi.org/10.1016/j.anaerobe.2021.102342.
5. Mohiuddin Z, Manes T, Emerson A. *Fusobacterium necrophorum* bacteremia with evidence of cavitary pulmonary lesion. Cureus. 2021;13(11):e19537. https://doi.org/10.7759/cureus.19537.
6. Liu YN, Zhang YF, Xu Q, Qiu Y, Lu QB, Wang T, et al. Infection and co-infection patterns of community-acquired pneumonia in patients of different ages in China from 2009 to 2020: a National surveillance study. Lancet Microbe. 2023;4(5):e330–9. https://doi.org/10.1016/S2666-5247(23)00031-9.
7. Marin-Corral J, Pascual-Guardia S, Amati F, Aliberti S, Masclans JR, Soni N, et al. Aspiration risk factors, microbiology, and empiric antibiotics for patients hospitalized with Community-Acquired pneumonia. Chest. 2021;159(1):58–72. https://doi.org/10.1016/j.chest.2020.06.079.
8. Yoshimatsu Y, Melgaard D, Westergren A, Skrubbeltrang C, Smithard DG. The diagnosis of aspiration pneumonia in older persons: a systematic review. Eur Geriatr Med. 2022;13(5):1071–80. https://doi.org/10.1007/s41999-022-00689-3.
9. Mandell LA, Niederman MS, Aspiration Pneumonia. N Engl J Med. 2019;380(7):651–63. https://doi.org/10.1056/NEJMra1714562.
10. Fernández Vecilla D, Roche Matheus MP, Iglesias Hidalgo G, Ugalde Zárraga E, Unzaga Barañano MJ. Díaz de tuesta Del Arco JL. Two cases of Prevotella oris causing serious pleuropulmonary infections. Rev Esp Quimioter. 2023;36(4):439–41. https://doi.org/10.37201/req/001.2023.
11. Nygren D, Wasserstrom L, Holm K, Torisson G. Associations between findings of *Fusobacterium necrophorum* or β-Hemolytic Streptococci and complications in Pharyngotonsillitis-A Registry-Based study in Southern Sweden. Clin Infect Dis. 2023;76(3):e1428–35. https://doi.org/10.1093/cid/ciac736.
12. Javanian M, Barary M, Ghebrehewet S, Koppolu V, Vasigala V, Ebrahimpour S. A brief review of influenza virus infection. J Med Virol. 2021;93(8):4638–46. https://doi.org/10.1002/jmv.26990.
13. Fernández-Vecilla D, Roche-Matheus MP, Iglesias-Hidalgo G, Aspichueta-Vivanco C. Osteitis pubis following tonsillopharyngitis. Enferm Infecc Microbiol Clin (Engl Ed). 2023;41(8):513–5. https://doi.org/10.1016/j.eimce.2023.04.005.
14. Lee WS, Jean SS, Chen FL, Hsieh SM, Hsueh PR. Lemierre's syndrome: A forgotten and re-emerging infection. J Microbiol Immunol Infect. 2020;53(4):513–7. https://doi.org/10.1016/j.jmii.2020.03.027.
15. Hagelskjaer Kristensen L, Prag J. Lemierre's syndrome and other disseminated *Fusobacterium necrophorum* infections in Denmark: a prospective epidemiological and clinical survey. Eur J Clin Microbiol Infect Dis. 2008;27(9):779–89. https://doi.org/10.1007/s10096-008-0496-4.
16. Nygren D, Holm K. Invasive infections with *Fusobacterium necrophorum* including Lemierre's syndrome: an 8-year Swedish nationwide retrospective study. Clin Microbiol Infect. 2020;26(8):1089. e7-1089.e12 https://doi.org/10.1016/j.cmi.2019.12.002.
17. Kioka MJ, DiGiovine B, Rezik M, Jennings JH. Anaerobic antibiotic usage for pneumonia in the medical intensive care unit. Respirology. 2017;22(8):1656–61. https://doi.org/10.1111/resp.13111.
18. El Chebib H, McArthur K, Gorbonosov M, Domachowske JB. Anaerobic necrotizing pneumonia: another potential Life-threatening complication of vaping?? Pediatrics. 2020;145(4):e20193204. https://doi.org/10.1542/peds.2019-3204.
19. Kuppalli K, Livorsi D, Talati NJ, Osborn M. Lemierre's syndrome due to *Fusobacterium necrophorum*. Lancet Infect Dis. 2012;12(10):808–15. https://doi.org/10.1016/S1473-3099(12)70089-0.
20. Duan H, Li X, Mei A, Li P, Liu Y, Li X, et al. The diagnostic value of metagenomic next-generation sequencing in infectious diseases. BMC Infect Dis. 2021;21(1):62–74. https://doi.org/10.1186/s12879-020-05746-5.

Publisher's note