Journal of Emergency Medicine and Care
Volume 6 | Issue 1
ISSN:2639-9253

Case Report Open Access

# Extensive Emphysema Following Mechanical Ventilation for Second COVID-19 Infection

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**Citation:** FengLin Wang, Yan Peng and XiaoYing Chen (2024) Extensive Emphysema Following Mechanical Ventilation for Second COVID-19 Infection, J Emerg Med Care 6: 101

**Received Date:** August 17, 2024 **Accepted Date:** September 17, 2024 **Published Date:** September 21, 2024

## Abstract

A 55-year-old male developed severe emphysema and complications following mechanical ventilation after a second COVID-19 infection. Persistent positive nucleic acid tests despite antiviral treatments, and the impact of prolonged immunosuppression on virus clearance and lung recovery, emphasize the need for improved antiviral strategies and careful management of ventilation-related complications.

**Keywords:** Second COVID-19 Infection; Extensive Emphysema; Mechanical Ventilation; extraperitoneal emphysema; immunosuppressive

## Case Report

A 55-year-old male with a height of 168cm and a weight of 64kg, was admitted to the Intensive Care Unit (ICU) of our hospital on May 08, 2024, presenting with a four-day history of fever and four hours of dyspnea. His medical history is notable for a laparoscopic cholecystectomy and endoscopic retrograde cholangiopancreatography (ERCP) performed half a month prior due to gallstones accompanied by cholecystitis and cholangitis. Seventeen mouths ago, the patient experienced severe COVID-19 (Figure 1A), which required mechanical ventilation and resulted in complications such as mediastinal emphysema and pneumothorax (Figure 1B). Post-treatment, his nucleic acid test for COVID-19 turned negative, and he was discharged with residual interstitial lung lesions (Figure 1C). Additionally, seven years ago, he received a left kidney transplantation due to renal failure and has been taking immunosuppressive drugs and hormones for a long time. He has a 20-year history of hypertension.

After admission, the patient tested positive for COVID-19 nucleic acid. The sputum next generation sequencing (NGS) indicated Klebsiella pneumoniae and COVID-19, and the oxygenation index was 83 mmHg. Combined with chest computed tomography (CT) scan indicated both lungs were filled with large solid shadows, considering infectious lesions combined with pulmonary edema (Figure 1D-1F), and the patient was diagnosed as severe secondary COVID-19 pneumonia.

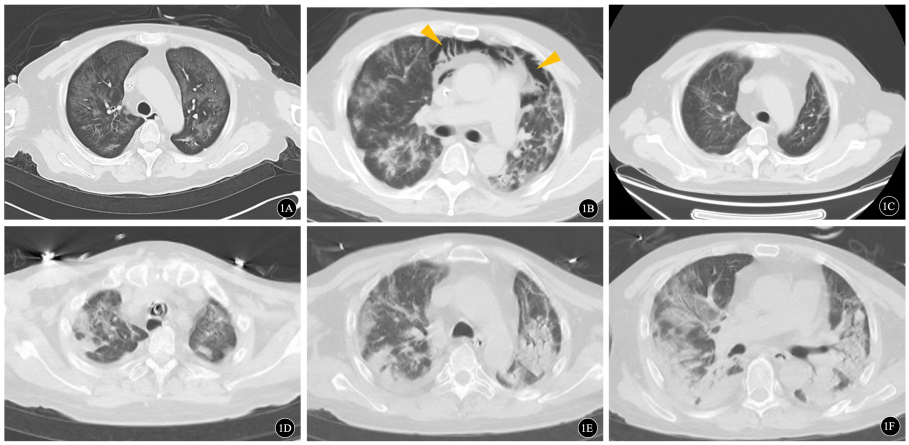


**Figure 1:** Chest CT scan imaging findings of a patient with a history of severe COVID-19 infection and related complications. (1A) Chest CT scan from 17 months ago, taken during the patient's COVID-19 infection, showing diffuse ground-glass opacities in both lungs. (1B) post-invasive mechanical ventilation chest CT scan shows persistent diffuse ground-glass opacities in both lungs, along with mediastinal emphysema. The yellow arrow indicates mediastinal gas. (1C) Residual interstitial lung disease following severe COVID-19 pneumonia. (1D-1F) Extensive areas of consolidation in both lungs.

The main treatment measures included: Ceftazidime-avibactam, Nirmatrelvir, Methylprednisolone, γ-globulin, invasive mechanical ventilation (VC-AC mode: VT 420ml, f 22 times/min, Peep 12cm$H_2O$, Ppeak 38cm$H_2O$, Pplat 26cmH2O, DP 14cm$H_2O$), incremental PEEP lung expansion, prone ventilation, and analgesic sedation (RASS -5).

After 5 days, the oxygenation index gradually increased to 391 mmHg, but emphysema was observed in the neck, subcutaneous chest and back, mediastinum, and rare extensive emphysema in the extraperitoneal space (Figure 2A-2F). We adjusted the mechanical ventilation parameters (PC-AC mode: PC 15cmH2O, VT 400ml, f 18 times/min, Peep 6cm$H_2O$, Ppeak 26cm$H_2O$, Pplat 18cm$H_2O$, DP 12cm$H_2O$), no skin incision and decompression were performed, and bronchoscopy showed no tracheal rupture. Subsequently, prone ventilation was administered three times for 20 hours, tracheotomy was performed on the 11th day, and chest CT scan examination on the 18th day indicated reduced air accumulation and reduced infectious lesions in both lungs (Figure 3A-3F).

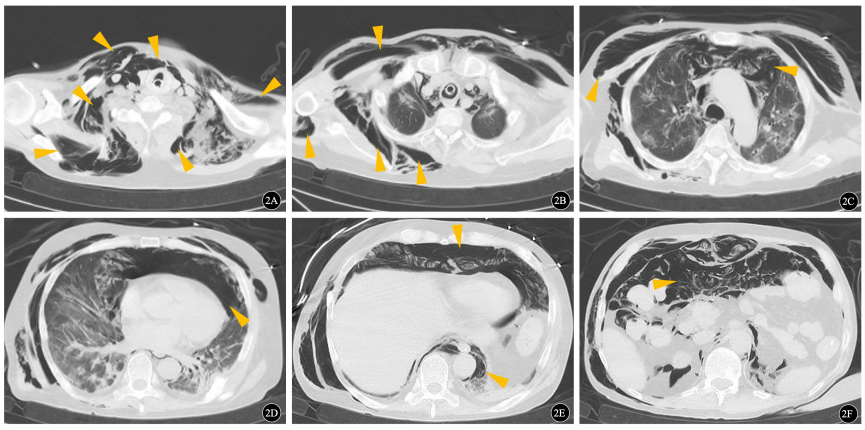

**Figure 2:** Chest CT sacn imaging on the fifth day of hospitalization. (2A-2F) Significant subcutaneous emphysema in the neck, chest, back, mediastinum, and extraperitoneal space. the yellow arrows indicate areas of emphysema.

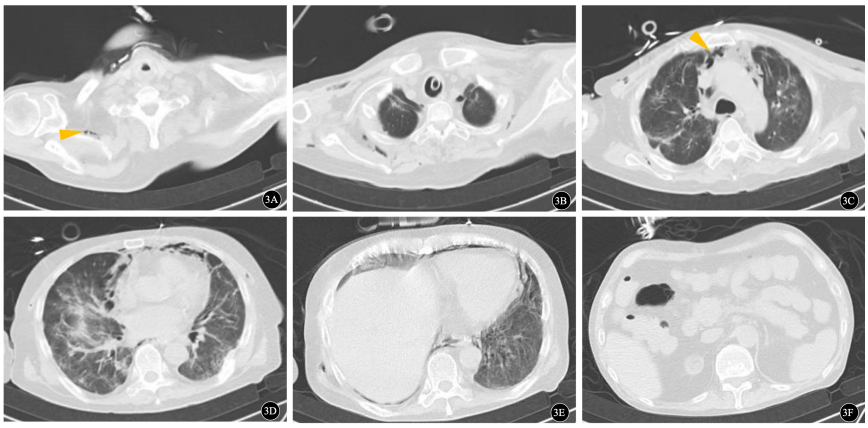

**Figure 3:** Follow-up chest CT scan on the eighteenth day of hospitalization. (3A-3F) Notable reduction in multiple air pockets within the subcutaneous tissue of the chest and back, mediastinum, and extraperitoneal spaces compared to previous scans; infectious lesions in both lungs show slight absorption and reduction.

After 10 days of Nirmatrelvir and 5 days of Molnupiravir, the patient remained positive for COVID-19 (CT value 25), leading to the cessation of antiviral therapy. On the 30th day, chect CT scan (Figure 4A-4F) was reexamined again, indicating an improvement in the condition, allowing for weaning off mechanical ventilation and subsequent transfer back to a lower-level hospital for rehabilitation.

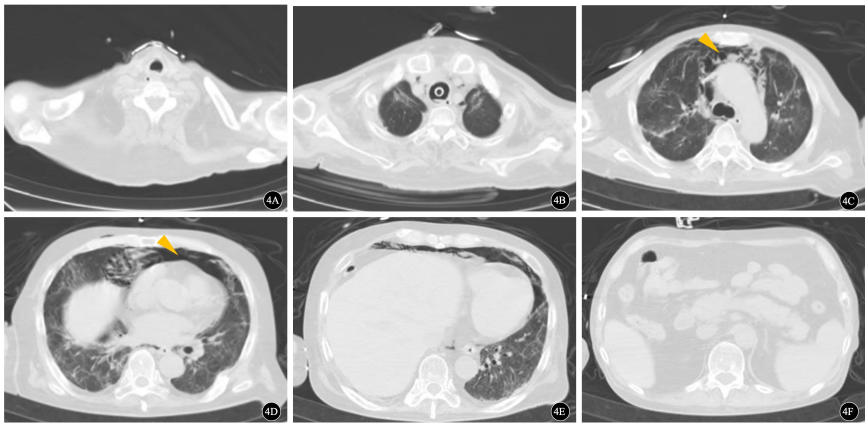

**Figure 4:** Follow-up chest CT scan on the thirtieth day of treatment. (4A-4F) Slight reduction in multiple air pockets in the anterior chest wall, mediastinum, and extraperitoneal space compared to previous evaluations; infectious lesions in both lungs are in the absorption phase, showing a slight decrease compared to prior scans.

## Discussion

In the case of a patient who contracted COVID-19 for the second time, a rapid deterioration in health was observed, characterized by severe respiratory distress and hypoxemia. Despite undergoing three courses of various anti-COVID-19 medications, including Nirmatrelvir and Molnupiravir, the patient's viral nucleic acid test results remained persistently positive, with a CT value of 25 indicating ongoing viral replication. This resistance to treatment may be linked to the prolonged use of immunosuppressive drugs, potentially hindering the body's ability to clear the virus.

The patient had residual pulmonary interstitial lesions from the initial COVID-19 infection, and a subsequent CT scan following the second infection revealed numerous solid shadows, suggestive of possible pulmonary fibrosis. Pulmonary fibrosis is a common complication of severe COVID-19, primarily stemming from severe alveolar inflammation induced by the virus, cytokine storms, and barotrauma from mechanical ventilation [1-3]. This condition can lead to irreversible lung damage, impacting respiratory function and quality of life. While specific drugs for preventing and treating pulmonary fibrosis are lacking, antifibrotic agents like pirfenidone and Nintedanib may offer some efficacy in select cases [4-7], though their use in the acute phase of severe COVID-19 remains limited. Thus, early control of inflammatory responses, avoidance of mechanical ventilator-induced lung injuries, and judicious glucocorticoid use to mitigate alveolar inflammation are crucial in preventing pulmonary fibrosis.

Mechanical ventilation is crucial in treating severe COVID-19 but can also lead to complications such as barotrauma, pneumothorax, and mediastinal emphysema [8-11]. In this case, the patient developed extensive subcutaneous, mediastinal, and extraperitoneal emphysema during mechanical ventilation post-secondary COVID-19 infection, largely due to high-pressure ventilation. To minimize barotrauma risks, close monitoring of respiratory mechanics is essential, including adjustments in tidal volume, plateau pressure, positive end-expiratory pressure, and driving pressure [9]. Gradual adjustments to mechanical ventilation parameters, specifically reducing positive end-expiratory pressure and plateau pressure, helped alleviate further barotrauma deterioration. Early prone ventilation can improve oxygenation while reducing lung pressure, thereby decreasing complication risks. Regular bronchoscopy to rule out tracheal rupture is a vital preventive measure.

Mediastinal and mesenteric emphysema are uncommon complications following mechanical ventilation and severe pulmonary inflammation. Management strategies involve adjusting ventilation parameters, such as reducing PEEP and Ppeak, as well as considering skin incisions and decompression surgery. In this case, surgical intervention was avoided through ventilation parameter adjustments and prone ventilation. Subsequent CT scan imaging revealed gradual improvement in emphysema without significant lung structural damage, underscoring the importance of prudent respiratory parameter management and timely imaging surveillance in managing such complications.

In conclusion, this case highlights the complex challenges in treating severe COVID-19 patients with secondary infections and associated complications. Despite multiple antiviral drug administrations, persistent positive viral nucleic acid test results emphasize the need for exploring more effective antiviral strategies. Simultaneously, meticulous ventilation management and timely interventions are essential in preventing and treating mechanical ventilation-related complications like barotrauma and mediastinal emphysema. Furthermore, considering the patient's immunosuppressive status in viral clearance and lung lesion recovery underscores the importance of comprehensive immune status assessment during treatment.

## Author Contribution

Dr. Chen is the deputy chief physician in the Surgical Care Unit department of The First Affiliated Hospital of Chongqing Medical University, who is mainly skilled in the diagnosis and treatment of acute critically ill diseases.

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