# Hyperbaric oxygen therapy for carbon monoxide poisoning in an adolescent with Pneumomediastinum after COVID-19 pneumonia : a case report

Hang Zhou[1], Wang Haiming[1], Liu Yiying[1], Chen Yanru[1], Zhang Haowei[1], and Wei Xiangyang[1]

[1]no affiliation

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**Abstract**

Little is known about the complications of COVID-19. What happens when a patient with carbon monoxide poisoning has complications from COVID-19 pneumonia (a disease that has emerged since 2019 and quickly caused a pandemic around the world)? We report a case of carbon monoxide poisoning with COVID-19 pneumonia resulting in secondary pneumomediastinum. The patient underwent systemic hyperbaric oxygen therapy for two weeks and most of his symptoms improved. This case illustrates the success of hyperbaric oxygen in the simultaneous treatment of COVID-19 pneumonia, pneumomediastinum, and carbon monoxide poisoning.

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ABSTRACT

Little is known about the complications of COVID-19. What happens when a patient with carbon monoxide poisoning has complications from COVID-19 pneumonia (a disease that has emerged since 2019 and quickly caused a pandemic around the world)? We report a case of carbon monoxide poisoning with COVID-19 pneumonia resulting in secondary pneumomediastinum. The patient underwent systemic hyperbaric oxygen therapy for two weeks and most of his symptoms improved. This case illustrates the success of hyperbaric oxygen in the simultaneous treatment of COVID-19 pneumonia, pneumomediastinum, and carbon monoxide poisoning.

KEYWORDS

pneumomediastinum;hyperbaric oxygen;carbon monoxide poisoning; complication;COVID-19

BACKGROUND

The patient was admitted with coma due to carbon monoxide poisoning. However, we unexpectedly found that he also had symptoms of COVID-19 pneumonia and pneumomediastinum during our routine examination. The reason for his pneumomediastinum is probably related to COVID-19 pneumonia. Pneumomediastinum has been reported among COVID-19 complications in most countries,[1, 2] but its pathogenesis remains unclear. It has been suggested that the destruction of alveoli from cytokine storm or mechanical ventilation in prone position may be the cause of pneumomediastinum[3]. We conducted a relevant search in the database and developed the hyperbaric oxygen treatment plan. During the treatment, we found that the patient's pneumomediastinum and pneumonia were cured with the improvement of the patient's poisoning symptoms.

CASE PRESENTATION

A 15-year-old adolescent with COVID-19 pneumonia was previously in good health with no history of chronic disease or family genetic history. His parents and brothers were in good health. On arrival at the hospital, he had been poisoned for 11 hours. At this time, the patient was unconscious. After an emergency CT examination, we found that he had pneumomediastinum and bilateral pneumonia. No obvious abnormalities in the brain.There was no obvious abnormality in the brain. His vital signs are lethargy, normal blood pressure, temperature 37, heart rate 86/min, respiration rate 19/min. Physical examination Both lungs breathing sounds rough, full of wet rales. Computed tomography (CT) showed patchy and clouded high-density shadows with blurred boundaries in both lungs. Gas shadows can be seen in bilateral chest wall, subcutaneous soft tissue in axilla and mediastinum. Laboratory test: FCOHb7.4%, lactate 1.7mmol/L, WBC18.89×10 ^9/L,CRP121.56mg/L, aspartate aminotransferase 114U/L, aspartate aminotransferase isoenzyme 30U/L, creatine kinase 4522U/L, lactate dehydrogenase 389U/L.

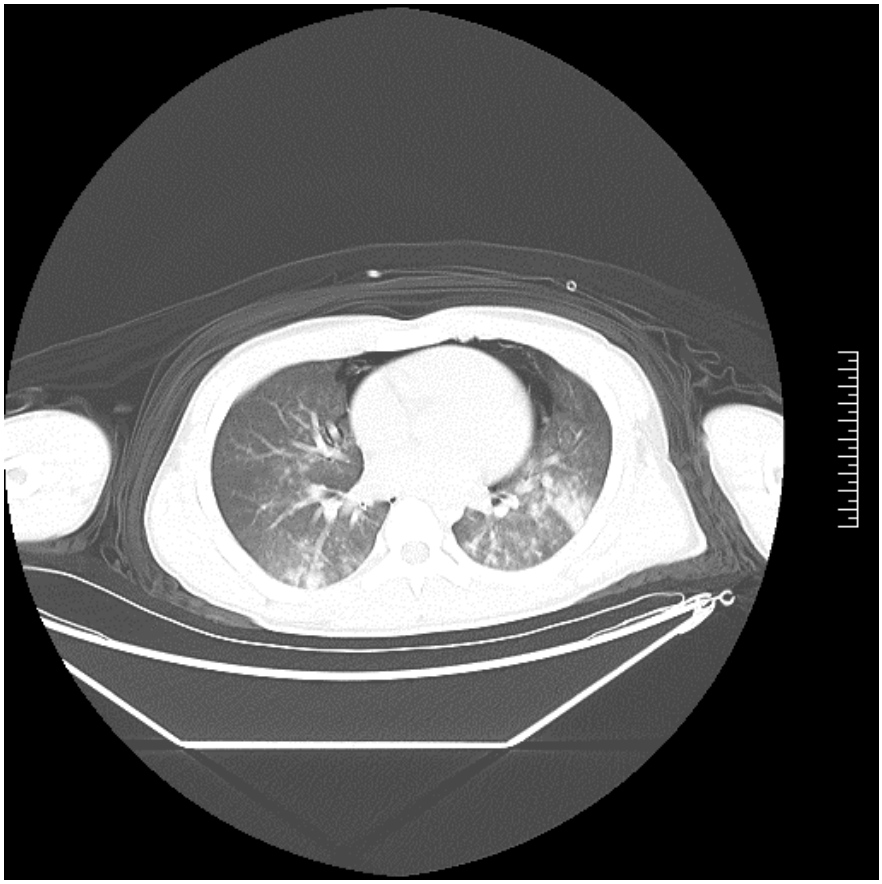
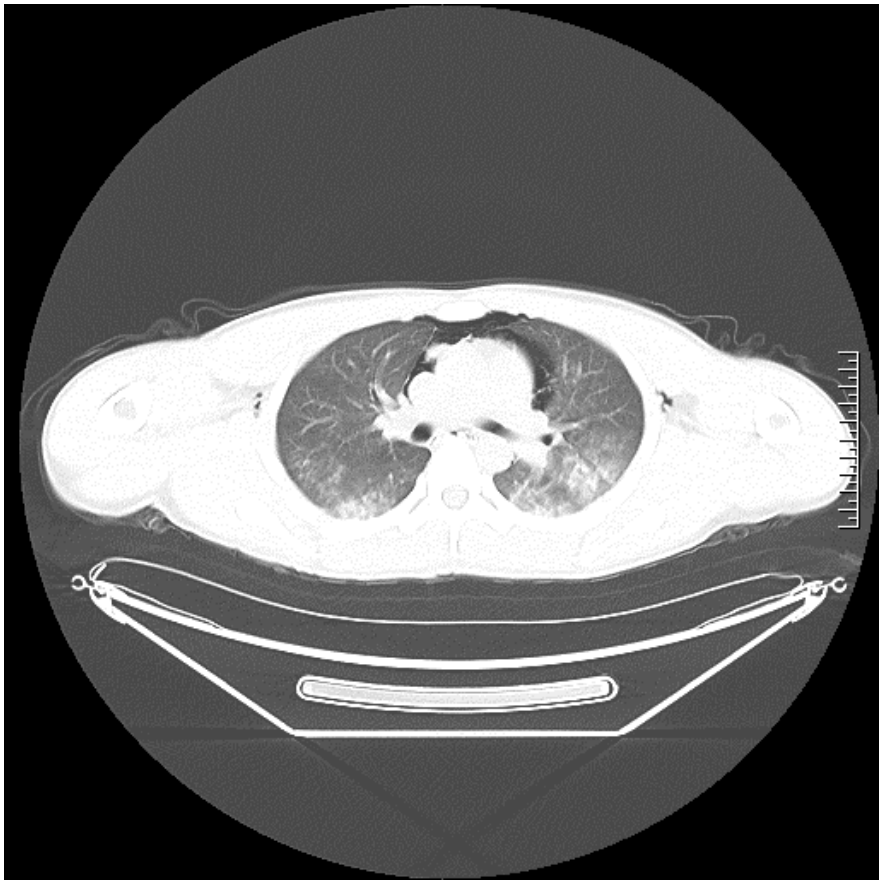


**Figure 1** $CTofchestonDay1: patchyandcloudedhigh-densityshadowswereobservedinbothlungswithunclearboundaries.Gass$

Given the hyperbaric oxygen treatment guidelines for emergency carbon monoxide poisoning, the patient was put into a hyperbaric oxygen chamber for emergency oxygen therapy in the hope of relieving lung inflammation and repairing nerve damage as much as possible, and began to take methylprednisolone, cefoperazone, citiciline sodium, omeprazole and other drugs, inhaled budesonide suspension and ambroxol hydrochloride solution for phlegm treatment, and injected compound brain peptide glycoside and niacinamide to promote nerve repair. No invasive ventilation was used. For the first hyperbaric oxygen treatment, the pressure was set to 1.3ATA(1ATA=760mmhg(101.32Kpa)) for 100 minutes using compressed air pressurization. The lethargy of the patient improved on the second day, and CT revealed that the double pneumonia and pneumomediastinum had been reduced compared with the previous day. After that, he continued to receive hyperbaric oxygen therapy at 1.3 ATA for one week. No other treatment options were changed, and after one week his CT showed that the lung inflammation and pneumomediastinum had completely subsided. After CT showed complete resolution of lung symptoms, he received consolidation oxygen at 1.6ATA for 5 days, during which time he did not develop symptoms of physical discomfort. Through follow-up, we learned that he had no symptoms of delayed encephalopathy or other complications. We will continue to follow up.



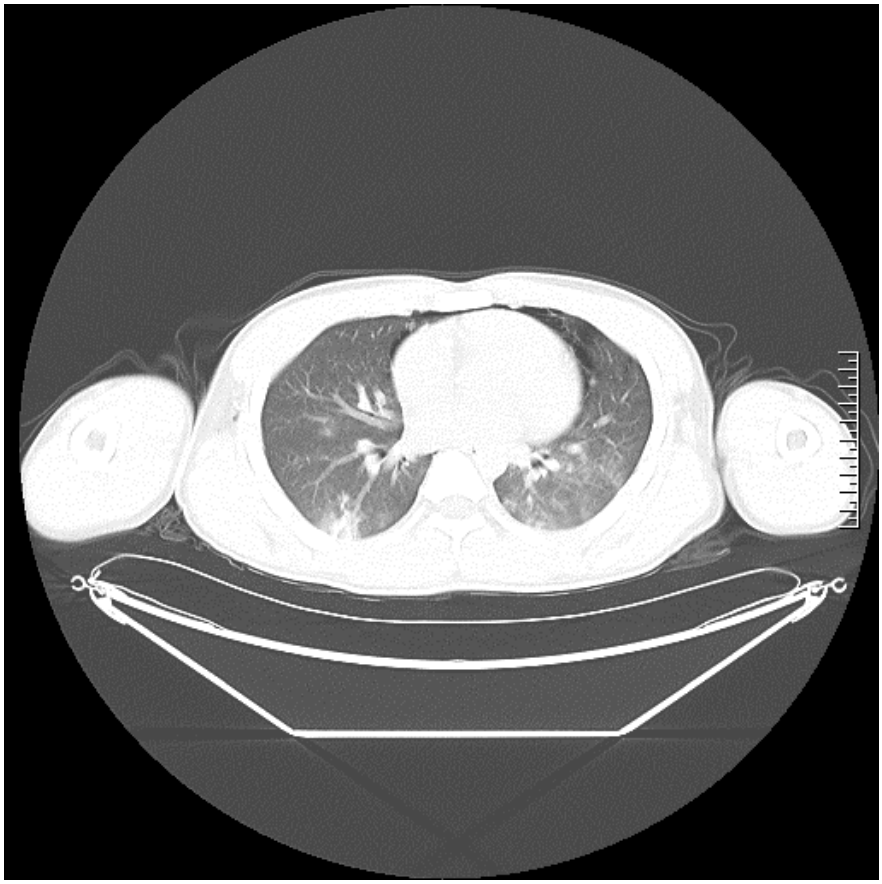


**Figure 2** $CTofchestonDay2: Pneumomediastinumanddoublepneumoniaimprovedfromthepreviousday$

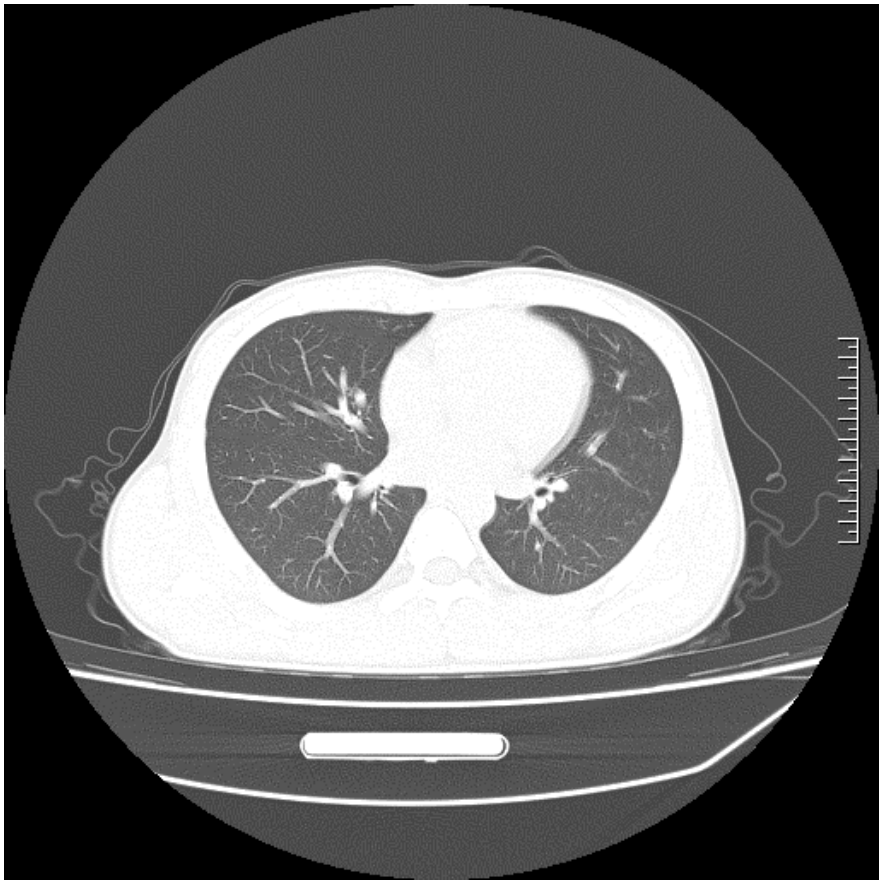


**Figure 3** $CTofchestonDay9: Noabnormaldensityshadowwasobservedinbothlungs.Noobviousabnormalitywasobservedinmed$

DISCUSSION

Hyperbaric oxygen as a routine treatment for acute carbon monoxide poisoning can not only convert the carboxyhemoglobin in mitochondrial cytochrome to oxygenated hemoglobin during carbon monoxide poisoning, but also reduce the permanent neurological and emotional effects of carbon monoxide poisoning[4]. In addition, hyperbaric oxygen therapy is particularly important in preventing long-term sequelae,it can reduce acute mortality and mortality after one year[5, 6] .In addition to acute carbon monoxide poisoning, we also found successful cases of pneumomediastinum treated with hyperbaric oxygen[7-14].

In this case, the main symptoms were acute carbon monoxide poisoning, drowsiness, bilateral pneumonia, and pneumomediastinum. After 11 hours of acute carbon monoxide poisoning, the patient was placed in 1.3 ATA chamber with compressed air. HBOT protocol was 70 minutes at 1.3 ATA with both 20 minutes of compression and decompression. After only one treatment, it was found that his consciousness was recovered after the poisoning. Computed tomography shows that pneumomediastinum and bilateral pneumonia were also reduced. The next day, the treatment was extended to 100 minutes at 1.3 ATA with both 20 minutes of compression and decompression. And the same HBOT for the next week.

In another case report we found that hyperbaric oxygen therapy in a patient with pneumomediastinum due to diving[8]. Four hours after he was injured, the patient was placed on the chamber that pressurised to 1.3 ATA, Symptoms improved after 60 minutes of 100% oxygen inhalation via a built in breathing system (BIBS) mask. Also, in another report, a 13-year-old boy with a helium-filled brain embolism and pneumomediastinum received 40 minutes of air at 165 fsw, 100 percent oxygen for 3 hours at 60 fsw, and

then 100 percent oxygen at 30 fsw. The patient's reported symptoms completely disappeared[7].Combined with the above case and the case in this paper, we assume that the patient may not require such a extensive recompression to achieve the goal of symptom relief. Maybe 10 fsw is enough to make his symptoms go away.

In an example of a patient who died due to a diving accident, it was clear that the patient was in urgent need of HBO treatment due to bilateral tension pneumothorax and pneumomediastinum caused by DCS. However, due to the shortage of hyperbaric oxygen rooms in the local area and the shortage of personnel, the patient could not receive timely treatment even when he was in an important indication[15].

These examples undoubtedly show that in the face of patients with pneumomediastinum, timely HBO treatment is very important. After the primary treatment plan is clear, the parameter setting of hyperbaric oxygen therapy is also a question worth studying. Whether we can achieve the best treatment effect through the minimum parameter setting, so as to reduce the complications caused by hyperbaric oxygen therapy. The 1.3 ATA HBO therapy used in this case has not been found to have recurrence or complications in the follow-up of the patient within half a year after discharge.

The common pneumomediastinum is usually caused by mechanical ventilation[16] or DCS, but in this case, neither of these reasons exists. Given the presence of COVID-19 pneumonia, we considered that COVID-19 had caused his symptoms of pneumomediastinum. It has been speculated that the pathophysiological mechanism of its occurrence is diffuse alveolar damage and alveolar rupture, leading to interstitial emphysema and air tracking along the bronchoalveolar sheath to the mediastinum[17]. It is mentioned in this article that high serum lactate dehydrogenase may be positively correlated with the development of pneumomediastinum in COVID-19 patients[17].

A study from China reported two patients with COVID-19 pneumonia, patients were treated with 1.5 ATA HBO with an oxygen concentration of more than 95% for 60 minutes per treatment, once a day for one week. For both patients, dyspnea and shortness of breath were immediately alleviated after the first HBO2 treatment[18]. Gorenstein et al reported a study of 20 COVID-19 patients treated with 2 ATA of hyperbaric oxygen therapy for 90 minutes daily and propensity matched controls. The results show that the in-hospital mortality rate and time to mechanical ventilation are higher in propensity matched control group comparing to cases treated with HBOT [19]. In America, 5 COVID-19 patients received hyperbaric oxygen therapy for 90 minutes at 2.0 ATA between 13 and 20 April 2020.The final results demonstrated that all the patients recovered without the need for mechanical ventilation[20]. Although the parameters in these reports are different from the 1.3ATA we used, the final results are all positive. When acute carbon monoxide poisoning was combined with pneumomediastinum due to COVID-19, we found that inhalation of hyperbaric oxygen had the desired therapeutic effect. This provides a new clinical evidence to treating not only acute carbon monoxide poisoning but also the complications of COVID-19 with HBO.

In addition, computed tomography (CT) can be an important complement to timely diagnosis and identification of the causes of respiratory impairment and lung complications associated with COVID-19[21].

## CONCLUSION

In conclusion, this case demonstrates a clear benefit of hyperbaric oxygen therapy in the treatment of pneumomediastinum caused by COVID-19 pneumonia and carbon monoxide poisoning.

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