CASE REPORT

High-Dose Pulse Steroids for the Treatment of Acute Hypoxemic Respiratory Failure in COVID-19 Pneumonia: A Simple Case Series

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Perm J 2022;26:21.090 • E-pub: 04/05/2022 • https://doi.org/10.7812/TPP/21.090

Abstract

Pulse steroids therapy is widely used to treat flare-ups of autoimmune diseases, such as systemic lupus erythematosus. The main assumption is that severe inflammation caused by an autoimmune disease must be aggressively quelled before it causes further damage. We present a series of 9 cases that explore the use of high-dose pulse steroids in hypoxemic respiratory failure. We used high-dose steroids to alter the outcome of some patients, using commonly accepted protocols such as 6 mg of dexamethasone via IV, baricitinib, and tocilizumab. The outcome of each case is discussed. The patients were treated with 500 mg of high-dose methylprednisolone via IV for 3 days, followed by 250 mg via IV for 3 days; followed by 12 or 6 mg of dexamethasone was administered daily by mouth or IV. A retrospective review of patients who received a computerized tomography pulmonary angiogram showed that these patients had organizing pneumonia features. Eight out of nine cases had a favorable outcome.

Introduction

The COVID-19 pandemic has had global negative impacts. Millions of people have died with hypoxemia from severe pulmonary inflammation (acute respiratory distress syndrome; ARDS) associated with viral pulmonary infection. Pulse steroids therapy is widely used to treat autoimmune diseases. Examples include rapidly progressive glomerulonephritis; systemic lupus erythematosus; IgA nephropathy; neuromyelitis optica; and many more. The main assumption is that severe inflammation caused by an autoimmune disease must be aggressively quelled before it causes further damage. Pulse steroids are also used in certain intensive care unit (ICU) situations, such as organizing pneumonia (OP) and acute fibrinous OP, a rare type of interstitial lung disease characterized by intra-alveolar fibrin balls and OP with a patchy distribution.

Over the years, use of steroids in ARDS has been controversial. Many educational institutions shy away from high-dose steroids in ARDS because of the associated high risks, including but not limited to opportunistic infections, diabetic ketoacidosis, deep vein thrombosis, and pulmonary embolism. Many publications, however, have found that steroids make a difference in ARDS, including in cases of ARDS associated with viral diseases. With the COVID-19 pandemic and high mortality

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Author Contributions:
Gholmieh Ghassan, MD, PhD, completed all work for this manuscript.

Disclosures
Conflicts of Interest: None declared
Funding: None declared
Consent: Informed consent was received from all case patients.

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rate associated with ARDS caused by the virus, questions arose regarding the benefits of steroids in treating COVID-19 pneumonia. Some studies have documented the benefits of steroids in COVID-19 pneumonia, as discussed in the following sections. The consensus adopted at our facility was the one used by the World Health Organization and the RECOVERY study of 6 mg of dexamethasone daily for 10 days. Administering 6 mg of dexamethasone did improve survival; however, the virus progressed in many patients even on the recommended dose of dexamethasone. Many patients were on non-rebreather masks (NRM) for many days and ended up being intubated, resulting in high death rate.

Here we present a series of non-intubated cases where we explored the use of high-dose pulse steroids (HDPS). In most cases, it was used as a salvage therapy. We used high-dose steroids to alter the outcome in patients who were not recovering despite the use of the commonly accepted protocols such 6 mg of dexamethasone via IV, baricitinib, and tocilizumab. Informed consent was obtained from all case patients.

Steroids, ARDS, and COVID-19 in the Literature

It is unclear why some people have a very mild immune response to COVID-19, some have a moderate one, and some have a severe reaction to the pulmonary infection, causing severe ARDS and untimely death. Some recent studies have linked the response to genetic risk factors. What we know, however, is that the COVID-19 virus kills its host by causing severe lung inflammation. If we can control the inflammation, we can improve oxygenation and, hence, survival rates. Many studies have been published on the benefits of steroids and pulse steroids, as we discuss here.

Figure 1: Chest X-ray #1 of case #3 on hospitalization day 1.
Steroids in general ARDS have not been shown to be consistently beneficial. Some positive evidence, however, has emerged over the years. Villar et al have shown positive results. The DEXA-ARDS trial enrolled 277 patients with moderate to severe non-COVID-19 ARDS. Patients in the steroids/dexamethasone group received an IV dose of 20 mg once daily from day 1 to day 5, which was reduced to 10 mg once daily from day 6 to day 10. The study found that patients who received high-dose dexamethasone had lower 60-day, all-cause mortality (21% vs 36%, p = 0.005) and more ventilator-free days (12 vs 7, p < 0.001).

Kolilekas et al reported a case series of 6 consecutive COVID-19 patients with severe pneumonia, ARDS, and laboratory indices of hyperinflammatory syndrome. The authors used 125 mg of methylprednisolone once daily for 3–5 days. All patients were not intubated and were not admitted to the ICU. ARDS resolved within 11.8 days (median). The authors concluded that “early administration of short course corticosteroids improves clinical outcome of patients with severe COVID-19 pneumonia and evidence of immune hyperreactivity.”

Another study by Chen et al concluded that in a retrospective study of COVID-19 patients in China treated with different doses of steroids, there was a decrease in mortality rate by 40% (HR = 0.592, [95% CI 0.406–0.862], p = 0.006). However, the study had multiple shortcomings, including the use of different types of steroids, different initiation times, and different dosages.

Tomazini et al used 20 mg of dexamethasone via IV daily for 5 days or until ICU discharge in patients with COVID-19. The primary outcome was ventilator-free days during the first 28 days. Patients randomized to the dexamethasone group had a mean 6.6 ventilator-free days (95% CI, 5.0–8.2) during the first 28 days vs 4.0 ventilator-free days (95% CI, 2.9–5.4) in the standard-care group (difference, 2.26; 95% CI, 0.2–4.38; p = 0.04).

Figure 2: Chest x-ray #2 of case #3. Patient was started on high-dose pulse steroids on hospitalization day 10.
Fadel et al used short-course methylprednisolone 0.5 to 1 mg/kg/d divided into 2 IV doses for 3 days in 213 COVID-19 patients. They measured the avoidance of ICU escalation; patients benefited from avoiding ICU escalation (34.9% vs 54.3%, p = 0.005).

Finally, the RECOVERY study concluded that “in patients hospitalized with Covid-19, the use of dexamethasone resulted in lower 28-day mortality among those who were receiving either invasive mechanical ventilation or oxygen alone at randomization but not among those receiving no respiratory support.”

Pulse Steroids, ARDS, and COVID-19 in the Literature

Recent histopathological and imaging studies have pointed out that many cases of COVID-19 ARDS progress into OP. One study questioned if the missed diagnosis of OP was widespread. It also raised the question: “Although RECOVERY along with other cohort studies report positive effects with corticosteroids on morbidity and mortality of COVID-19, treatment approaches could be made more effective given that secondary OP often requires prolonged duration and/or careful and monitored tapering of corticosteroid dose, with ‘pulse’ doses needed for the well-described fulminant subtype.”

We reviewed the literature for use of HDPS. Sauñe et al used high-dose steroids to treat 2 desperate cases in Peru. The 2 cases were rejected by medical institutions likely due to lack of resources. The patients were treated at home with high-dose methylprednisolone, 500 mg via IV for 3 days. This resulted in a favorable outcome and resolution of most symptoms.

Mareev et al used an even higher dose. They used 1000 mg of methylprednisolone for 3 days followed by 8 mg of dexamethasone for another 3–5 days in 17 patients with severe COVID-19 pneumonia. Results
showed marked decrease in inflammatory markers. The group who received pulse steroids 1) was much sicker than the control group, 2) developed pulmonary embolism/deep vein thrombosis at a higher rate, and 3) remained hospitalized for a longer period of time. The results of the outcome must be carefully weighted given that the population of the 2 groups were different at baseline.

Edalatifard et al conducted a study in Iran where they used 250 mg of methylprednisolone via IV for 3 days in COVID-19 pneumonia cases. The authors noted marked improvement in patients who received pulse steroids, compared to the patients who did not. Sixty-eight eligible patients underwent randomization (34 patients in each group). The authors stated that: “The percentage of improved patients was higher in the methylprednisolone group than in the standard care group (94.1% versus 57.1%) and the mortality rate was significantly lower in the methylprednisolone group (5.9% versus 42.9%; p<0.001).”

Ruiz-Irastorza et al administered 250 mg of methylprednisolone via IV for 3 days in patients who remained hospitalized for a second week. Receiving methylprednisolone in the second week improved prognosis in patients with severe COVID-19 pneumonia. Of the 242 patients with COVID-19 pneumonia and elevated inflammatory markers at admission, 61 (25%) received week-2 methylprednisolone. The adjusted hazard ratios for death and death or intubation for patients in the week-2 methylprednisolone group were 0.35 (95% CI 0.11–1.06, p = 0.064) and 0.33 (95% CI 0.13–0.84, p = 0.020), respectively.

Case #1: Simple Case, Good Outcome

The patient was a 48-year-old man with a history of hypothyroidism, who was seen 4 days prior to admission for shortness of breath. He was diagnosed with COVID-19 and sent home with O₂, 6 mg of dexamethasone, and albuterol. Patient’s home O₂ saturation worsened, and he needed 6 L of O₂ at home. Patient’s symptoms included cough, loss of taste, and loss of smell. The patient came back to the emergency room (ER) with worsening shortness of breath and was admitted on January 25, 2021. The patient needed high-flow nasal cannula (HFNC) in the ER.

The patient was started on remdesivir, baricitinib, and IV antibiotics. He was started on HDPS of 500 mg of methylprednisolone via IV for 3 days on the day of admittance (day 1) and then switched back to 6 mg of dexamethasone. The patient was admitted on HFNC 30 L, FiO₂ 100% on day 1, weaned to venturi mask (VM) 15 L, FiO₂ 50% on day 3, and then discharged on nasal cannula (NC) on 4 L on day 7. He was not discharged on steroids. At 30 days follow-up, the patient was off oxygen but had a lingering cough treated with inhaled steroids.

Case #2: Accelerated Improvement

The patient was a 53-year-old woman with a history of hypertension, cholelithiasis, and medication-
induced hepatitis in 2004. She tested positive for COVID-19 6 days prior to admission, where she presented with fever and cough for 2 days. The patient was admitted on February 21, 2021 (day 1) with worsening symptoms associated with myalgias and shortness of breath.

The patient was started on dexamethasone on day 1, remdesivir on day 1, and baricitinib on day 3 along with 2 units of convalescent plasma. She started on HDPS of 500 mg of methylprednisolone via IV daily for 3 days on day 7 but only received 2 doses due to rapid improvement.

The patient was admitted on NRM and slowly improved on day 7 to HFNC 15 L, FiO$_2$ 50%. She received a computerized tomography pulmonary angiogram (CTPA) because her oxygen saturation decreased easily to low-mid 90s. CTPA was negative for pulmonary embolism. When reviewed with the radiology department, the CTPA presented as consistent with OP. The patient was started on HDPS on day 7. O$_2$ requirements improved to 3 L at rest on day 10. We are unsure if the HDPS accelerated the recovery or the patient was already on her way to recovery. The drop in oxygen requirement is not, however, easily explained by the recovery process in our subjective experience.

The patient was discharged on steroids taper. Her saturation level on 30-day follow-up visit showed oxygen saturation of 98% on room air, but she was still using oxygen at 1 L/min on exertion.

### Case #3: What is There to Lose after 10 days of Failed Treatments?

The patient was a 54-year-old woman with a history of hyperlipidemia, hypothyroid, and obesity. She was diagnosed with COVID-19 2 days prior to admission and presented to the ER on February 19, 2021 (day 1) with shortness of breath for 3 days associated with cough, fever and headache. The patient was diagnosed with COVID-19 pneumonia and was admitted to the hospital.

She was started on remdesivir via IV (days 1–5), baricitinib (for a total of 14 days), 6 mg of dexamethasone via IV (for a total of 9 days before pulse steroids), and IV ceftriaxone and IV doxycycline pending procalcitonin level (stopped 3 days later). The patient received convalescent plasma on day 2. On February 27, 2021 (day 9) CTPA pulmonary was done to rule out pulmonary embolism; it showed viral infiltrates and OP (read in retrospect). She was started on pulse steroids, ceftriaxone, and azithromycin. Her oxygen improvement is listed in Table 1.

The patient was discharged on steroids taper and required steroids inhalers on her follow-up visits. On her 30-day follow-up visit, she was still using 3 L/min of oxygen therapy.

### Table 1: Daily oxygen requirements for case #3

<table>
<thead>
<tr>
<th>Day</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>2</td>
<td>HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>3</td>
<td>HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>4</td>
<td>Use of BiPAP, FiO$_2$ = 90%</td>
</tr>
<tr>
<td>5</td>
<td>Use of BiPAP, FiO$_2$ = 90%</td>
</tr>
<tr>
<td>6</td>
<td>Use of NRM, HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>7</td>
<td>Use of NRM, HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>8</td>
<td>Use of NRM, HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>9</td>
<td>Use of NRM, HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>10</td>
<td>Day 1 of 500 mg of methylprednisolone via IV, O$_2$; Use of NRM, HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>11</td>
<td>Day 2 of 500 mg of methylprednisolone via IV, Use of NRM, HFNC = 40 L, FiO$_2$ = 100%</td>
</tr>
<tr>
<td>12</td>
<td>Day 3 of 500 mg of methylprednisolone via IV, HFNC = 40 L, FiO$_2$ = 80%</td>
</tr>
<tr>
<td>13</td>
<td>Day 1 of 250 mg of methylprednisolone via IV, HFNC = 35 L, FiO$_2$ = 60%</td>
</tr>
<tr>
<td>14</td>
<td>Day 2 of 250 mg of methylprednisolone via IV, HFNC = 30 L, FiO$_2$ = 45%</td>
</tr>
<tr>
<td>15</td>
<td>Day 3 of 250 mg of methylprednisolone via IV, HFNC = 25 L, FiO$_2$ = 35%</td>
</tr>
<tr>
<td>16</td>
<td>Day 1 of 12 mg of dexamethasone via IV, NC = 5 L; Patient progressively weaned from steroids and remained stable</td>
</tr>
<tr>
<td>19</td>
<td>Patient required 3 L of NC at rest and 5 L of NC when ambulating</td>
</tr>
</tbody>
</table>

BiPAP = bilevel positive airway pressure; FiO$_2$ = fraction of inspired oxygen; HFNC = high-flow nasal cannula; NC = nasal cannula; NRM = non-rebreather mask.
The patient was discharged on steroids taper. On the 30-day follow-up visit, the patient was off oxygen. She still had fatigue and chest tightness that was treated with inhaled steroids.

Case #5: Rapid Improvement in Milder Cases

The patient was a 42-year-old man with obesity and history of asthma. He presented with shortness of breath. The patient first developed COVID-19 symptoms on January 9, 2021, associated with fevers, cough, and shortness of breath that were progressively worsening. He checked his pulse oximeter at home, and it was 88%. The patient came to the ER and was subsequently admitted on January 22, 2021 (day 1). He needed 6 L of NC and would desaturate with minimal exertion, including eating. His CRP was higher than 380 (more than 7x normal). On day 1, the patient was started on HDPS 500 mg of methylprednisolone via IV for 3 days, in addition to remdesivir, and antibiotics (ceftriaxone and doxycycline). The patient improved markedly and was discharged on 2 L of NC on day 7. The patient was not discharged on steroids, and on his 30-day follow-up, he was off oxygen.

Case #6: Modified Protocol for Diabetic Patient with Labile Blood Sugar

The patient was a 46-year-old man with a history of type 2 diabetes, hyperlipidemia, and an ex-smoker. He presented to the ER with shortness of breath and cough; he received his first COVID-19 vaccine 12 days prior to admission. He then developed fevers and headache, which he attributed to the vaccine side effects. Nine days prior to admission, he developed a progressive worsening of cough and shortness of breath. He presented to the ER on April 19, 2021 (day 1). The patient was admitted and started on dexamethasone, remdesivir, and antibiotics. The patient received tocilizumab on day 2 while on NRM.

The patient was started on HDPS on day 8 but, given that his sugar level was very labile, the protocol was modified to 250 mg of methylprednisolone via IV twice a day for 3 days, then switched on day 11 to 125 mg via IV twice a day (the patient was improving so he only received 1 dose out of the 3 scheduled), then 10 mg of dexamethasone via IV for 2 days, and then 6 mg of dexamethasone via IV daily. The patient was started on an insulin drip for tight blood sugar control in order to prevent diabetic ketoacidosis while on HDPS. On day 9, the patient was weaned from 100% NRM to 50% VM at 15 L. On day 11, the patient was then weaned to 35% VM at 9 L. On day 12, the patient was weaned to 4 L of NC. The patient was discharged on steroids taper. Two weeks later, he was off oxygen on follow-up.

Case #7: Never too Late

The patient was a 74-year-old man with a history of hyperlipidemia who tested COVID-19 positive 6 days prior to admission. The patient developed myalgias and fever for 8 days prior to admission. He was...
admitted on April 20, 2021 (day 1) at an outside-network hospital with COVID-19 pneumonia. His presenting \( O_2 \) saturation was 81% on room air. His CRP and procalcitonin were moderately elevated, with an elevated white count of 18,000. Chest x-rays showed bilateral infiltrates. He required an NRM shortly after admission. The patient was diagnosed with acute respiratory hypoxemic respiratory failure due to COVID-19.

He was treated with 12 mg of ivermectin by mouth on day 1 and day 3; 600 mg of tocilizumab via IV on day 2; and remdesivir days 1–5. Six mg of dexamethasone was started on day 1, which was increased to 10 mg per day on day 2; doxycycline days 2–7; and piperacillin/tazobactam days 2–7. He also received zinc and vitamin D. His COVID-19 antibody was positive on day 1; therefore, the patient was not given convalescent plasma. Right peripherally inserted central catheter line was placed, and the patient was given total parenteral nutrition due to his poor nutritional status. His respiratory status deteriorated, requiring HFNC. He never required intubation. The patient signed against medical advice and came to our hospital by private transportation on day 12. His peripherally inserted central catheter line was removed prior to discharge. Chest x-rays on admission to our facility showed bilateral infiltrates (see Figure 7). No pneumothorax or effusion was observed. He was tachypneic on arrival. He required NRM, which was changed to HFNC 40 L, \( \text{FiO}_2 \) 100%. He was given piperacillin/tazobactam on admission. On day 13, his white blood cell count improved, and the procalcitonin was found to be low; therefore,
High-Dose Pulse Steroids for the Treatment of Acute Hypoxemic Respiratory Failure in COVID-19 Pneumonia

Figure 5: Chest x-ray #2 of case #4. Patient was started on high-dose pulse steroids on hospitalization day 5.

Figure 6: Chest x-ray #3 of case #4 on hospitalization day 9.
the antibiotics were stopped. He also had right-upper extremity swelling at the previous site of the peripherally inserted central catheter line. An ultrasound confirmed deep vein thrombosis. The patient was started on a full dose of subcutaneous enoxaparin 1 mg/kg twice a day. The CTPA was negative for pulmonary embolism but showed bilateral extensive ground glass opacities. The CTPA was reviewed with the radiology department in retrospect and found to be consistent with OP. The patient remained on HFNC 40 L, FiO₂ 100%.

The patient was started on HDPS on day 16 with 500 mg of methylprednisolone via IV daily for 3 days, then 250 mg via IV daily for 3 days, then 6 mg of dexamethasone via IV daily. However, he was noted to have unexplained elevation of his alanine transaminase (6x normal levels) while on HDPS, despite the troponin, CK, and hepatitis panels being negative. In light of this unexplained transaminitis, the patient was rapidly weaned from steroids. His oxygen requirement is described in Table 3.

The patient was discharged on steroids taper. On his 30-day follow-up, he was saturating 97% on room air but was complaining of protracted dizziness.

Case #8: Stuck on 15 L Venturi Mask

The patient was a 55-year-old man with a history of hypertension and stroke. He presented with fever and shortness of breath after testing positive for COVID-19, which he was tested for 14 days prior to admission. His symptoms began worsening a few days later. He developed body aches, weakness, and then a fever that got progressively worse. He became tired and short of breath with ambulation.

The patient was admitted on May 6, 2021 (day 1) with COVID-19 pneumonia, on NRM that improved to VM the next day. The patient, however, remained on 15 L 50% VM. He was started on a high-dose steroids protocol on day 5. Patient oxygen improved to 5 L NC by day 9, then he was slowly weaned to 2 L NC on day 12, the day of discharge.

The patient was not discharged on steroids taper. On his 30-day follow-up, he was still using 2.5 L/min of oxygen on exertion and during the night.
Case #9: Crash and Burn

The patient was a 64-year-old man with a history of hypertension, hyperlipidemia, and tobacco use. He was diagnosed with COVID-19 one week prior to admission on March 5, 2021 (day 1), where he presented with COVID-19 pneumonia. The patient was treated with remdesivir, dexamethasone, convalescent plasma, tocilizumab, and empiric antibiotics. He required increasing amounts of oxygen support since admission. He was treated with high-dose IV steroids on day 15. The patient desaturated while on bilevel positive airway pressure and was transferred to ICU for intubation on day 18. Standard hospital course was complicated by left-hand fifth digit ischemia felt to be due to microemboli from COVID-19, treated with therapeutic anticoagulation. He remained intubated in respiratory failure and underwent tracheostomy and percutaneous endoscopic gastrostomy placement. The patient was discharged after protracted hospitalization (more than 2 months with hospital-acquired pneumonia) to a long-term care facility, but he was readmitted shortly after for fever of unknown origin, presumed to be due to aspiration pneumonitis.

Discussion

We have presented a case series where COVID-19 pneumonias causing hypoxemia and respiratory failure were treated with HDPS. These case series are not proof that pulse steroids are the ultimate treatment for COVID-19 pneumonia. However, these cases, along with the literature review, are presented in order to raise awareness of the possibility of newer treatment protocols for COVID-19 pneumonia-related hypoxemic failure. Some patients had confirmed secondary OP from COVID-19-related infection.

It was noted in the presented case series that an improvement in oxygen requirement usually started around 72–96 hours post-HDPS, and the best improvement in oxygenation was observed 5 to 7 days later. On average, we started HDPS on the seventh day of admission. Although there was a protocol set, modification of the protocol was done to accommodate each patient. We have also subjectively observed, as did Yao et al., that D-dimer correlated with the patient’s clinical improvement but ferritin, lactate dehydrogenase, and CRP did not. Some CRP was in the typical range when HDPS was started. None of the first 8 patients had superimposed opportunistic infection.

Corticosteroid therapy is the cornerstone in treating both OP and acute fibrinous OP in dosing similar to cryptogenic OP, including methylprednisolone pulse therapy for severe cases, followed by maintaining prednisone dose (0.75 to 1.0 mg/kg daily) for 4–8 weeks. In this case, we are unsure if HDPS should be modified to include higher doses of steroids because the 6 mg of dexamethasone daily after the pulse steroids may be insufficient.

We suspect that our protocol was effective because it treated patients with OP, where steroids are the cornerstone of therapy. These findings should be used in conjunction with current protocol to control cytokine storms. Since OP develops over time, we propose that cytokine storm medications, such as tocilizumab, should be given at the time of admission, followed by CTPA a few days later if the hypoxemia is not improving (we propose 5–7 days). If the CTPA shows pulmonary embolism, the patient should be treated accordingly. If the CTPA shows OP, the patient should be treated with

<table>
<thead>
<tr>
<th>Day</th>
<th>O\textsubscript{2} CFNM: HFNC = 40 L, FiO\textsubscript{2} = 100%</th>
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</thead>
<tbody>
<tr>
<td>Day 12</td>
<td></td>
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<tr>
<td>Day 13</td>
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<tr>
<td>Day 14</td>
<td></td>
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<tr>
<td>Day 15</td>
<td></td>
</tr>
<tr>
<td>Day 16</td>
<td>Day 1 of 500 mg of methylprednisolone via IV. O\textsubscript{2} CFNM: HFNC = 40 L, FiO\textsubscript{2} = 100% (see Figure 8)</td>
</tr>
<tr>
<td>Day 17</td>
<td>Day 2 of 500 mg of methylprednisolone via IV. O\textsubscript{2} CFNM: HFNC = 40 L, FiO\textsubscript{2} = 95%</td>
</tr>
<tr>
<td>Day 18</td>
<td>Day 3 of 500 mg of methylprednisolone via IV. O\textsubscript{2} CFNM: HFNC = 40 L, FiO\textsubscript{2} = 65%</td>
</tr>
<tr>
<td>Day 19</td>
<td>Day 1 of 250 mg of methylprednisolone via IV. O\textsubscript{2} CFNM: HFNC = 40 L, FiO\textsubscript{2} = 50%</td>
</tr>
<tr>
<td>Day 20</td>
<td>Day 1 of 125 mg of methylprednisolone via IV. O\textsubscript{2} CFNM: HFNC = 40 L, FiO\textsubscript{2} = 40% (see Figure 9)</td>
</tr>
<tr>
<td>Day 21</td>
<td>Day 1 of 6 mg of dexamethasone via IV. O\textsubscript{2}: NC = 5 L, FiO\textsubscript{2} = 40%. Patient started on physical therapy</td>
</tr>
<tr>
<td>Day 22</td>
<td>Day 2 of 6 mg of dexamethasone via IV. O\textsubscript{2}: NC = 6 L, FiO\textsubscript{2} = 44%</td>
</tr>
<tr>
<td>Day 23</td>
<td>Day 3 of 6 mg of dexamethasone via IV. O\textsubscript{2}: NC = 6 L, FiO\textsubscript{2} = 44%</td>
</tr>
<tr>
<td>Day 24</td>
<td>Day 4 of 6 mg of dexamethasone via IV. O\textsubscript{2}: NC = 6 L, FiO\textsubscript{2} = 44%</td>
</tr>
<tr>
<td>Day 25</td>
<td>Day 1 of 4 mg of dexamethasone via PO. O\textsubscript{2}: NC = 5 L, FiO\textsubscript{2} = 40%</td>
</tr>
<tr>
<td>Day 26</td>
<td>Day 2 of 4 mg of dexamethasone via PO. Discharged home on 4 L of NC, FiO\textsubscript{2} = 36%</td>
</tr>
</tbody>
</table>

Table 3: Daily oxygen requirements for case #7

FiO\textsubscript{2} = fraction of inspired oxygen; HFNC = high-flow nasal cannula; NC = nasal cannula; PO = by mouth.
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Figure 8: Chest x-ray #2 of case #7. Patient was started on high-dose pulse steroids on hospitalization day 16.

Figure 9: Chest x-ray #3 of case #7 on hospitalization day 20.
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In addition, future prospective studies should investigate the role of the HDPS on admission as well as 1 week into admission. Each investigative arm should also include a rapid-tapering arm vs a slow-tapering arm for steroids.

REFERENCES


