Successful experience of using adaptive support ventilation (ASV) in the patient with suspected COVID pneumonia

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Abstract
An interesting clinical case of suspected COVID-19 pneumonia in a patient with diabetes mellitus is considered in the article. This case deserved attention of anesthesiologists, especially today, during the COVID-19 epidemic. An important role in timely diagnosis belongs to the CT scan, as the X-ray does not always diagnose viral pneumonia. In our case, we adhered to the principles of restrictive infusion therapy, early intubation, protective ventilation and early weaning of the patient from the respirator. The article describes the successful experience of using the ASV intelligent ventilation mode – from intubation to extubation. We recommend you to use ASV in patients with suspected COVID-19 pneumonia and L-type to achieve protective ventilation, rapid weaning, and low risk of complications.

Key words: COVID-19, ARDS, CT scan, early intubation, ASV, protective ventilation, early weaning


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1. Introduction
According to the World Health Organization (WHO), new forms of viral diseases continue to emerge and are a challenge for the Health Care system. Over the past twenty years, several viral epidemics have been recorded, such as Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) in 2002–2003, H1N1 influenza virus in 2009, and Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in 2012. Today, the Novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is the cause of the 2019 Pandemic Coronavirus Disease (COVID-19), which affects thousands of people worldwide. Manifestations of respiratory syndrome with 2019-nCoV virus infection can range from complete absence of symptoms to severe pneumonia with respiratory failure, which can lead to death. Studies have shown that people with underlying comorbidities like diabetes are more prone to experience adverse outcomes of COVID-19.¹²

The most common and severe complication in patients with COVID-19 is acute hypoxic respiratory failure or acute respiratory distress syndrome (ARDS) requiring oxygen and ventilation therapy.³ The Berlin definition of the 2012 announcement defines the severity of ARDS in the oxygenation index.⁴ Critically ill patients need intubation and mechanical ventilation.³⁵

In the literature there have been descriptions of two different phenotypes of the virus presentation among hospitalized patients and particularly those requiring mechanical ventilation. The H-type is characterized by high lung elastance, high weight,
and high recruitability. The L-type has high compliance, low V/Q ratio, and low lung recruitability.\(^6\)

WHO has classified patients with diabetes mellitus (DM) to the COVID-19 risk group of the severe disease, so the occurrence of pneumonia in this group of patients during the epidemic may be considered as a potential case of COVID-19.

It is still unknown whether there is a difference in the risk of patients with type 1 and type 2 diabetes. However, age, the presence of comorbidities and features of treatment play an important role in risks assessment of infectious complications in intensive care units.\(^7\)

### 2. Case report

Patient S. aged 45 years with type II diabetes mellitus was admitted to a regional hospital March 11, 2020 with complaints of 3-day subfebrile fever, cough, shortness of breath, discomfort in the chest, runny nose, fatigue. Medical and social history was unremarkable. Chest X-rays - signs of bilateral roots infiltration. (Figure 1)

![Figure 1: Chest X-rays (direct projection)](image)

In 6 days the clinical picture worsened – the temperature rose to 38.8 °C, and shortness of breath increased.

The patient was transferred to the intensive care unit (ICU). Objectively, the skin was pale pink, RR - 28 / min, SpO\(_2\) - 93%. Auscultatory - symmetrical weakened vesicular respiration. NIBP - 130/80 mmHg. Ps - 96/min, rhythmically, satisfactory and no other remarkable findings. APACHE II score was used for risk stratification – 10 points mean 15% estimated non-operative mortality.

Chest X-rays was re-performed - infiltration of roots increased (Figure 2). CITO TEST Influenza A + B - negative. Given the pandemic of Coronavirus and clinical course, the patient was suspected of viral COVID pneumonia. Unfortunately, we had no possibility to do SARS-CoV-2 testing.

The patient was started oxygen therapy through a face mask with a flow of 7 l/min. Restrictive infusion therapy (20 ml/kg/day) was started, for prevention the accession of bacterial flora - ceftriaxone 1 g was administered twice a day.

Within 2 days of treatment, the patient's condition did not improve - a lung CT scan was performed on which there were signs of viral pneumonia (Figure 3, Figure 4):

- Areas of decrease in the transparency of lung tissue by the type of frosted glass.
- Inhomogeneous areas of parenchyma consolidation.
- nodular focal shadows.

These CT findings are typical in individuals with COVID-19,\(^8\) so our suspicions were confirmed. After the examination, a correction of treatment was carried out - oseltamivir was prescribed - 75mg twice a day, azithromycin - 500 mg once a day, amikacin 500 mg - once a day, according to the microbiological passport of the department.\(^9\)
Figure 3: CT scan of the lungs (A. Direct projection and cross-section projection; B. Lateral projection)

Figure 4: CT scan with 3D lung reconstruction (A. in direct projection; B. Cross-section, C. 3D reconstruction)
Given the RR up to 32/min, SpO₂ - 92%, PaO₂ – 58 mmHg, PaCO₂ – 58 mmHg (on O₂ insufflation), increased work of breathing, alteration of consciousness it was decided not to expect further deterioration and adhere to the principle of early tracheal intubation and transfer the patient to mechanical ventilation. The patient was connected to the ventilator Hamilton C1 in Adaptive Support Ventilation (ASV) after sedation with propofol.

In this clinical case, we initially set the following ventilation parameters:
- Minute Volume – 160%;
- PEEP – 12 cmH₂O
- FiO₂ – 50%

The ventilator successfully adapted to the patient’s spontaneous breathing attempts in ASV mode. From the next day, the clinical and laboratory picture began to improve. Gradually we decreased the degree of respiratory support. Indicators of gas exchange and setting of ventilation parameters on Hamilton C1 - Table 1.

During the entire ASV ventilation period, the mean values were protective according to the ARDSnet protocol:
- Tidal volume – 6.5 ml/kg IBW (4 - 8 ml/kg IBW according to the ARDSnet protocol);
- Plateau pressure (Pplat) – 23 cmH₂O (Pplatu < 30 cmH₂O according to the ARDSnet protocol);
- Driving pressure – 9 cmH₂O (< 15 cmH₂O according to the ARDSnet protocol).

### Table 1: Gas exchange parameters and ventilator settings

<table>
<thead>
<tr>
<th>Patient gas exchange</th>
<th>1 day</th>
<th>2 day</th>
<th>3 day</th>
<th>4 day</th>
<th>5 day</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.28</td>
<td>7.32</td>
<td>7.35</td>
<td>7.37</td>
<td>7.39</td>
</tr>
<tr>
<td>PaCO₂ (mmHg)</td>
<td>52</td>
<td>47</td>
<td>45</td>
<td>43</td>
<td>42</td>
</tr>
<tr>
<td>PaO₂ (mmHg)</td>
<td>65</td>
<td>75</td>
<td>80</td>
<td>85</td>
<td>90</td>
</tr>
<tr>
<td>SaO₂ (%)</td>
<td>92</td>
<td>94</td>
<td>98</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>PaO₂/FiO₂ (mmHg)</td>
<td>130</td>
<td>187</td>
<td>200</td>
<td>284</td>
<td>300</td>
</tr>
</tbody>
</table>

### Respiratory setting

<table>
<thead>
<tr>
<th>Ventilatory mode</th>
<th>ASV</th>
<th>ASV</th>
<th>ASV</th>
<th>ASV</th>
<th>ASV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minute ventilation (%)</td>
<td>160</td>
<td>140</td>
<td>120</td>
<td>110</td>
<td>70</td>
</tr>
<tr>
<td>PEEP (cmH₂O)</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>FiO₂</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

### Respiratory mechanics

<table>
<thead>
<tr>
<th>Cstat (ml/cmH₂O)</th>
<th>48</th>
<th>46</th>
<th>45</th>
<th>44</th>
<th>42</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCexp (s)</td>
<td>0.45</td>
<td>0.48</td>
<td>0.50</td>
<td>0.53</td>
<td>0.56</td>
</tr>
</tbody>
</table>

- On the 5th day of ventilation due to the activation of spontaneous breathing and improvement of respiratory mechanics, it was decided to start weaning the patient from the respirator. We started to decrease % MinVol below 100%, PEEP down to 5 cmH₂O, FiO₂ – down to 30%. After 30 minutes of observation the patient ventilation, indices did not deteriorate, so we decided to conduct a test of spontaneous breathing with the following parameters:
  - MinVol – 25% (P sup ≈5 cmH₂O)
  - PEEP – 5 cmH₂O
  - FiO₂ – 25%

After that, the patient was attentively observed for 40 minutes - the ventilation status did not deteriorate, so it was decided to extubate the patient. Further treatment was performed according to the appointment sheet and on the 10th day of treatment the patient was transferred to a somatic hospital.

### 3. Discussion

In this clinical case, a patient with diabetes has contracted viral pneumonia. Given the COVID-19 epidemic and the fact that patients with diabetes are at risk group, CITO TEST Influenza A + B negative we followed increased safety precautions. Viral pneumonia has a wide range of clinical course - from asymptomatic carrier to severe disease, even death. A common and noticeable complication of COVID-19 pneumonia is acute hypoxemic respiratory failure requiring oxygen and ventilation therapy.

This case is evidence that if there is no clear sign of viral pneumonia on the radiograph, the diagnosis can...
be quickly and unequivocally confirmed on the CT scan. More and more patients are undergoing CT scans when there is a clinical suspicion of pneumonia with normal or questionable radiological findings.13-19 In a study of 87 patients with febrile fever and neutropenia, it was noted that CT had a pulmonary lesion that was not observed on the radiograph in 50% of patients.20 To date, the only way to confirm the COVID-19 phenotypes is through high-resolution computed tomography.21

The diagnosis of ARDS was made according to the following Berlin definition criteria: (1) presence of acute hypoxemic respiratory failure, (2) worsening respiratory symptoms; (3) bilateral opacities on chest x-ray or CT not fully explained by effusions, lobar or lung collapse, or nodules; and (4) cardiac failure not the primary cause of acute respiratory failure.

There are two phenotypes with COVID-19 ARDS. These phenotypes, known as “L-type” and “H-type”, report what appear to be two distinct presentations with drastically different management.6 We presented a case of a patient with suspected COVID-19 who approaching to L-type due to his lung compliance and CT-scan.

Conservative infusion therapy tactics should be followed in patients with ARDS.22 The use of corticosteroids should be avoided because studies have shown that influenza virus patients have increased mortality and increased hospital-acquired infections.23 - 25 However, a recent study suggests that early administration of dexamethasone may reduce the overall mortality and duration of mechanical ventilation in patients with ARDS.26

Initially, the treatment for severe respiratory failure included early intubation and invasive ventilation, as this was deemed preferable to be more effective than Non-Invasive Ventilation (NIV).27 Both NIV and HFNO are classed as an aerosol generating procedure and increase the risk of viral transmission. We had no possibility to treat patients within a negative pressure environment.

So in our case, ARDS was timely diagnosed and early intubation performed with ventilation without expecting a significant deterioration of the patient's condition. One study found that among patients with ARDS who needed intubation, survival was better in the group of patients who had an early intubation.28

Mechanical ventilation sometimes is necessary for maintaining respiration in patients with ARDS, but if it isn't protective, it may cause lung injury - ventilator-associated lung injury.29

Guides on protective ventilation of the lungs at ARDS emphasize: 1) Tidal volume - 4 - 8 ml/kg IBW; 2) RR ≤ 35/min; (3) P plateau ≤ 30 cmH2O; 4) PEEP≥ 5 cmH2O.30,31 The adequate tidal volume of each patient should be adjusted according to the plateau pressure, PEEP, thoracoabdominal compliance and respiratory effort.34 Driving pressure (P plateau - PEEP) below 12-15 cm H2O is recommended, adjusting tidal volume and PEEP in patients who do not breathe on their own.35

In our case, we decided to use ASV ventilation mode, because in this mode the machine automatically analyzes the state of pulmonary mechanics and the main parameters of external ventilation. Based on these data, it provides support for a given respiratory minute volume - with the safest ventilation parameters.36,37 In addition in ASV mode it doesn’t matter which phenotype is presented in patient with COVID-19 – in both cases the optimal ventilation parameters will be selected according to individual pulmonary compliance and resistance.

Weaning is important in the care of patients on mechanical ventilation.38 The ASV - closed-loop ventilation mode, which can ventilate in pressure-controlled ventilation and pressure-support ventilation modes, can be used for weaning in acute and chronic respiratory failure.39 Weaning in ASV mode shows good results.40 The shortened ASV weaning time in our study may be due to the automation of safe ventilation, the reduction of manipulation, and the time spent on parameters regulation.41

4. Conclusions

COVID-19 pneumonia today is a new challenge for humanity. Patients with diabetes are at increased risk. Successful treatment depends on timely diagnosis. A special place is given to CT when the conclusion of a radiograph is ambiguous. Conservative infusion therapy should be followed when treating such patients. Patients with ARDS who require mechanical ventilation should be followed by the principles of protective ventilation. In our case, we applied the ASV mode for the entire ventilation time - from intubation to extubation. It was also noted that the use of protocol algorithms for weaning from ventilation can reduce its duration compared to weaning based on the experience of a physician.
Our clinical case confirms that ASV is the mode of choice in patients with suspected COVID-19 pneumonia and L-type because it provides protective ventilation, rapid weaning, and low risk of complications.

5. Conflict of interest
None declared by the authors

6. Authors’ contribution
DD: Concept, conduct of the study, manuscript editing
KO, MM: Conduct of the study, manuscript editing
KS, DK: Manuscript editing

7. References


