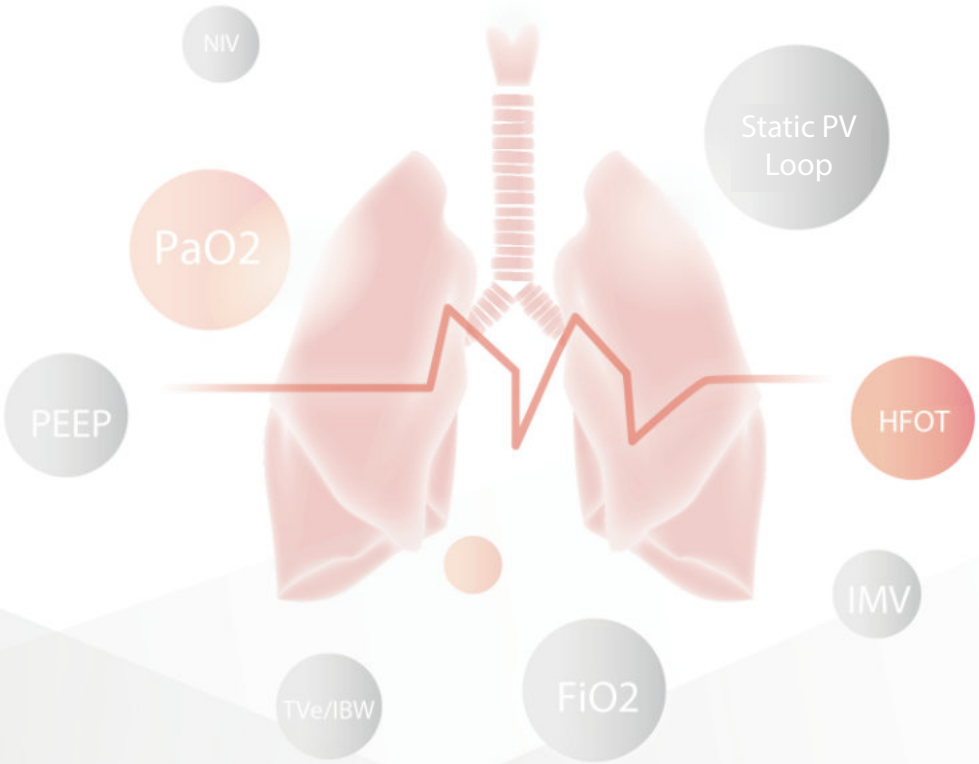
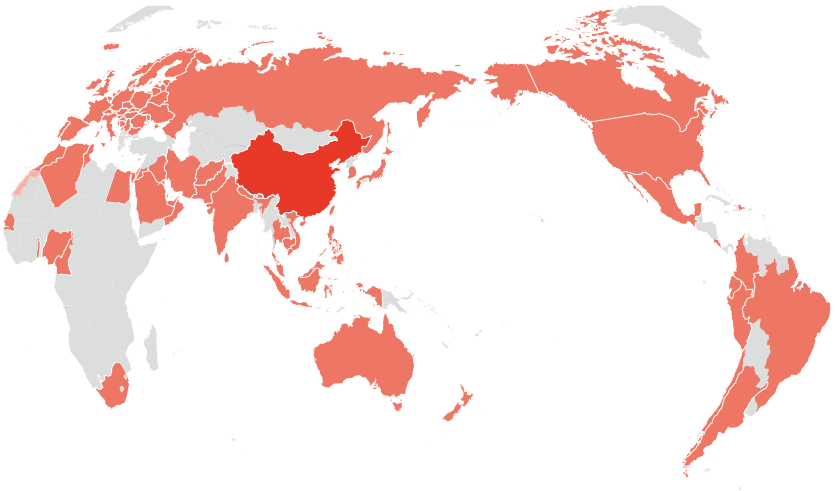
Respiratory Support Strategies For Severe COVID-19



Respiratory Support Strategies For Severe COVID-19

At this moment, over 100,000 people has been diagnosed with COVID-19. The number of confirmed cases outside the Chinese mainland has already reached over 25,000. Countries like Japan, South Korea, Italy and Iran have reported thousands of COVID-19 cases. AS the World Health Organization warned that "the window of opportunity is narrowing" to contain the deadly coronavirus.

Global Cases Reported by WHO



SITUATION IN NUMBERS
total and new cases in last 24 hours

Globally
105 586 confirmed
+3656 new

China
80 859 confirmed
+ 46 new
3100 deaths
+27 new

Outside of China
24727 confirmed
+3610 new
101 countries
+8 new
484 deaths
+71 new

WHO RISK ASSESSMENT

China	Very High
Regional Level	Very High
Global Level	Very High

Source: WHO, updated as of March 8, 2020

Among patients with COVID-19, approximately 15% to 30% are severe cases with Acute Respiratory Distress Syndrome (ARDS) [1]. This rate can be even higher in some specific areas based on the overall public health landscape. Patients categorized as severe COVID-19 cases have a high risk of death therefore, it is essential to provide appropriate treatment to this group of patients to minimize the overall mortality rate. Respiratory support, also referred to as mechanical ventilation, is one of the primary medical intervention for severe COVID-19 patients. This article will share some insights on the clinical experi- ence of Chinese experts whom been working on COVID-19 patient and the clinical guidance from WHO.

Who Are Categorized as Severe COVID-19 Cases?

Severe

Patient diagnosed with COVID-19 is categorized as severe case if they meet any of the following criteria:

1. Respiratory dyspnea with respiratory rate (RR) ≥ 30 beats/min;
2. Oxygen saturation (SpO_2) ≤ 93%, in a resting state;
3. Partial pressure of oxygen in arterial blood (PaO_2) / fraction of inspired oxygen (FiO_2) ≤ 300mmHg (i.e. PaO_2/FiO_2≤ 300mmHg).

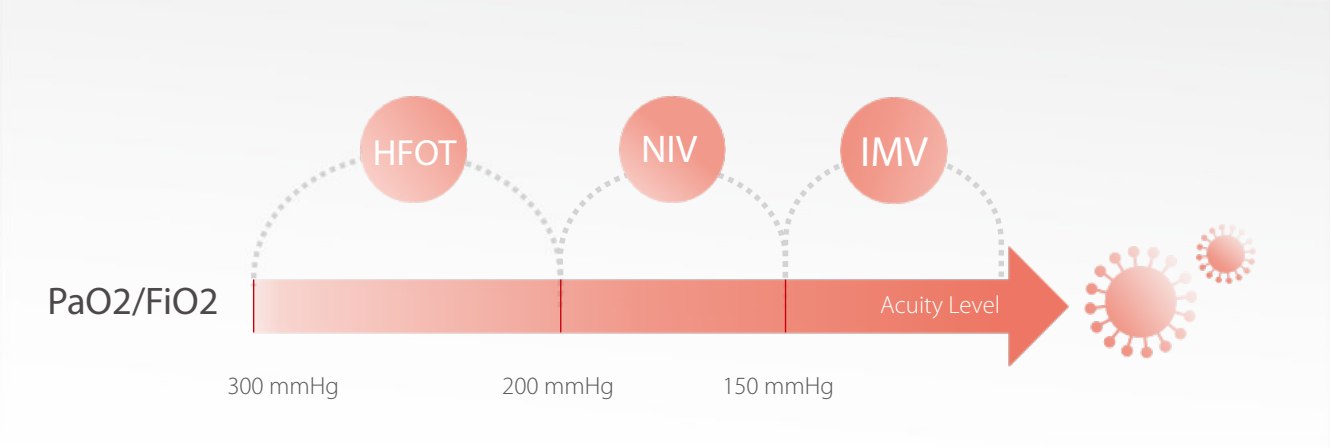
Critical

Patient diagnosed with COVID-19 is categorized as critical case if they meet any of the following criteria:

1. Respiratory failure requires mechanical ventilation (non-invasive or invasive ventilation); Shock;
2. Multiple organ failure which requires ICU monitoring and treatment.
3.

Since the difference between severe and critical cases has little influence on the actual treatment offered to the patient, clinicians generally describe them as severe.

When a COVID-19 patient has respiratory dyspnea and the oxygen therapy has failed relief the symptoms, then patient is identified as severe hypoxic respiratory failure. An ineffective oxygen therapy means that the patient is using an oxygen reservoir mask with flow of 10L-15L/min(usually at minimal flow rate to maintain bag inflation with 60%-95% FiO_2), but continues to show increasing respiratory rate with hypoxemia. Severe hypoxic respiratory failure often results in intrapulmonary shunt caused by V/Q imbalance (also referred to as ventilation-perfusion mismatch), therefore, different ventilation strate- gies should be used to adapt to the acuity level of each patient.



Invasive Mechanical Ventilation (IMV)

▸ Clinical Consensus

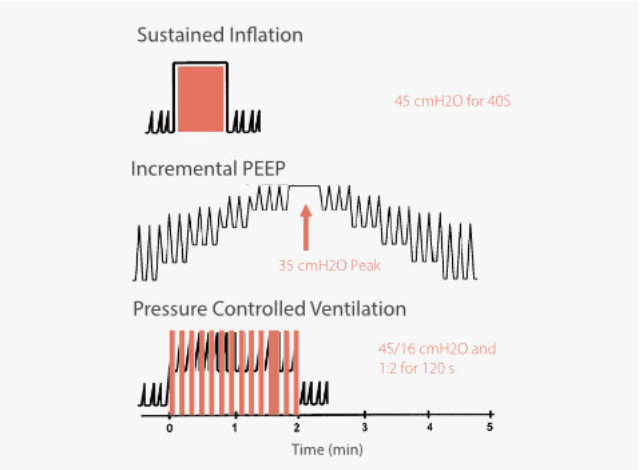
For patients with PaO2/FiO2≤ 150mmHg, IMV should be implemented as soon as possible. According to lung protection strategy, lower tidal volume ventilation is the first choice (6ml/kg PBW to 8 ml/kg PBW). It is also recommended to perform optimal positive end-expiratory pressure (PEEP) titration, appropriate lung recruitment maneuvers [4,5], and other lung protective measures.

For patients with severe ARDS (PaO2/FiO2 < 100 mmHg) who shown little effect to regular ventilation practices, particularly those with unevenly distributed lesions, it is recommended that clinicians give mechanical ventilation with prone positioning to the patient, with a minimum time of 12 hours.

Recruitment maneuvers: First, evaluate the patient's lung recruitability. Increase PEEP from 5cmH2O to 15cmH2O [6], and check whether the following is observed:

1. PaO2/FiO2 rises;
2. PaCO2 decreases;
3. Respiratory compliance improves.

If two of above is observed, the patient's lung is identified as recruitable, thus a suitable recruitment maneuvers could be implemented.



PEEP Titration: Setting the appropriate PEEP is important to maintain oxygenation of ARDS patients and to avoid lung injuries. PEEP titration is necessary to keep the lung open after recruitment. There are several PEEP titration methods commonly used by clinicians including : ARDSnet FIO2-PEEP table, Low flow P-V curve, Best Oxygenation, Stress index, PEEP Decremental, and Transpulmonary pressure.

ARDS net FiO2 - PEEP

Lower PEEP/higher FiO2														
FiO2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	5	5	8	8	8	10	10	7	14	14	14	16	18	18-24
								12						

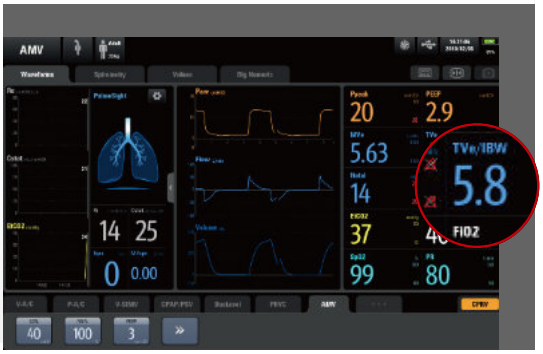
Higher PEEP/lower FiO2														
FiO2	0.3	0.3	0.3	0.3	0.3	0.	0.	0.	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	5	8	10	12	14	4	4	5	18	20	22	22	22	24
						14	16	16						

OXYGENATION GOAL: PaO2 55-80mmHg or SpO2 88-95%

Solutions for invasive ventilation

Lower Tidal Volume

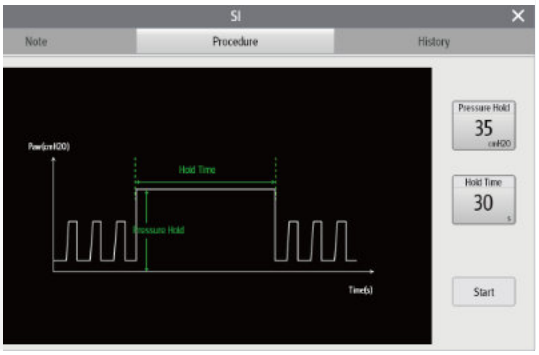
- **TVe/IBW Monitoring :** Mindray SV Series ventilator can set the default TVe/IBW strategy to its volume control mode as well as monitor it in real time during ventilation, so that clinicians can keep track of the patient's real-time expired tidal volume.



TVe/IBW Monitoring

Lung Recruitment Maneuvers

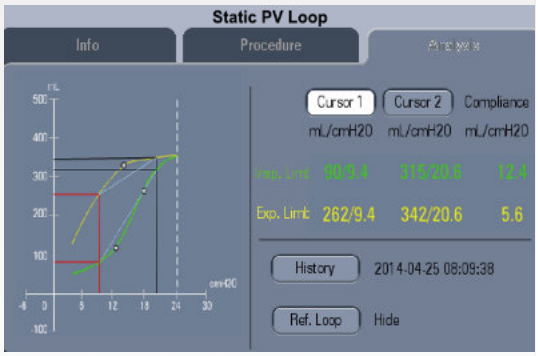
- **Sustained Inflation (SI) :** Mindray's SV Seriesventilators are equipped with lung recruitment tool: sustained infla- tion, allowing clinicians to choose the suitable tool according to the specific requirement of the patient. It is recommended that you choose the recruitment maneu- ver that you're most familiar with.



SI

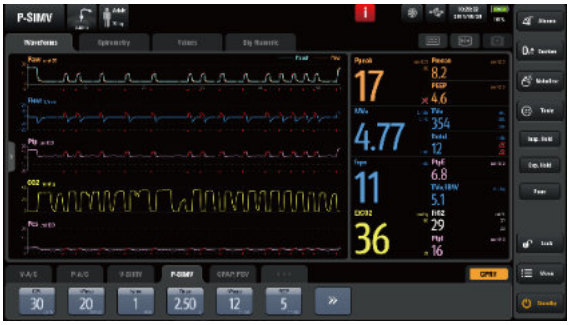
PEEP Titration

- **Static PV Loop:** Mindray ventilators can provide static PV Loop and automatically identify the inflection points. Using the low flow P-V curve method can help the doctors to find the optimal PEEP as well as guide on alarm limit set- tings and reflect the patient's current lung status.

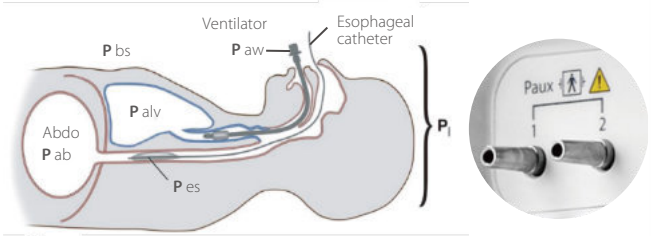


Static PV Loop

- **Esophageal Pressure Monitoring (Pes):** Mindray's ventilators can provide dual-channel auxiliary pressure monitoring, allowing one of the sensor to measure the esophageal pressure. The transpulmonary pressure can be accurately calcu- lated by esophageal pressure monitoring and thus help efficiently guide the optimal PEEP setting. In addition, another auxiliary pressure sensor can be used for measuring other indicators, such as intragastric pressure.

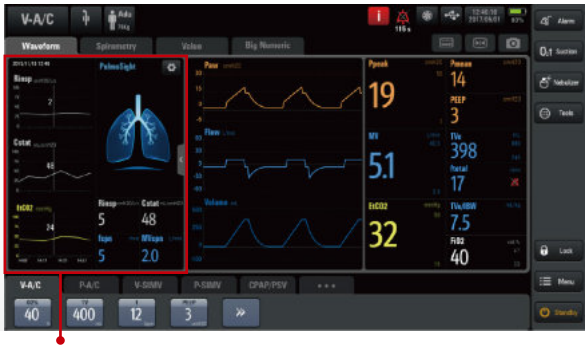


Transpulmonary pressure



Respiratory Mechanics Measurement

- **PulmoSight**: It is essential to closely monitor the changes of respiratory mechanics during PEEP titration in ARDS patients. The SV Series ventilators monitor patient's respiratory mechanics and display the data in a graphic way - PulmoSight to help display intuitive real-time feedback.



PulmoSight

Non-Invasive Mechanical Ventilation (NIV)

▸ Clinical Consensus

For severe cases of COVID-19, when the patient' s PaO2/FiO2 is between 150 mmHg and 200 mmHg, start with non-invasive ventilation. The initial NIV parameters are to be set as the following:

1. Inspiratory positive airway pressure (IPAP): 8 cmH2O to 10 cmH2O (1 cmH2O = 0.098 kPa);
2. Expiratory positive airway pressure (EPAP) : 5 cmH2O to 8 cmH2O; and
3. FiO2: 100%.

Observe for 2 hours. During this period, NIV parameters need to be adjusted according to the patient's breathing status, tidal volume (Vt) and SpO2.

1. if Vt is < 9ml/kg, RR is <30 times/min and PaO2/FiO2 is stable or improved, then continue NIV treatment;
2. if Vt is between 9 ml/kg - 12 ml/kg, PaO2/FiO2 is stable, then use NIV and observe the patient for 6 hours ;
3. during which if Vt is > 12 ml/kg or PaO2/FiO2 worsens, then immediately stop NIV and change to invasive ventilation (endotracheal intubation).

▸ Solutions for NIV

Mindray SV series ventilators support non-invasive ventilation, equipped with common non-invasive ventilation modes such as PSV-S/T, CPAP/PSV, P-A/C, etc., with the leak compensation up to 65 L/min. The ventilator is used with a dual-limb circuit with a closed non-invasive mask to support NIV. During the ventilation, VTi (insp. tidal volume), VTe(exp. tidal volume), MVleak (leaked volume in a minute) and leak% (percent of leaked tidal volume) can all be closely monitored.

When providing respiratory support for COVID-19 patients, the use of non-invasive ventilation with dual-limb circuits can greatly reduce the amount of gas exhale into the atmosphere (compared with traditional single-limb circuit expiratory valve). At the same time, with additional filter at the expiratory valve can efficiently process the exhaled air, and reduce the risk of aerosol infection to a minimal level.

NIV

Application of Mindray SV300 ventilator with dual-limb circuits for non-invasive ventilation in Wuhan Jinyintan Hospital.

High-Flow Oxygen Therapy (HFOT)

▸ Clinical Consensus

When PaO2/FiO2 is between 200 mmHg and 300 mmHg, it is advised that the patient is supported with high-flow oxygen therapy (HFOT) through nasal cannula (commonly called HFNC or HFNOT). The initial setting of HFNC can be at 40 - 50L/min with 100% FiO2. During the therapy, clinicians should closely observe the patient's vital signs and oxygenation.

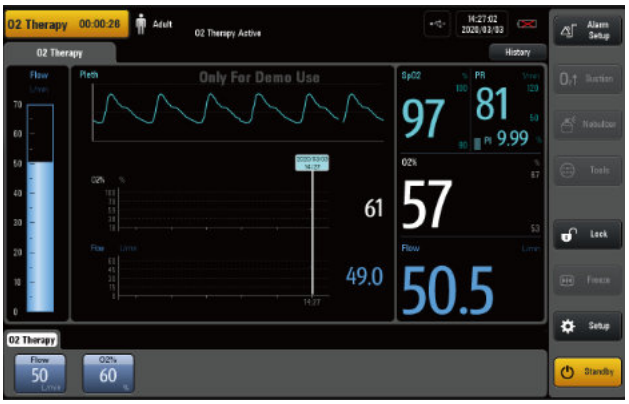
If the oxygenation deteriorates to PaO2/FiO2 < 200 mmHg, or SpO2 falls below 93%, and/or the RR is above 30 times/min, then HFNC is not likely to be effective and NIV may be a better choice in this case.

If the patient has any of the following symptom, invasive ventilation should be used instead of HFOT:

1. unconsciousness; severe arrhythmia;
2. shock (intravenous norepinephrine dosage> 0.1 μg/kgmin);
3.
4. acute respiratory acidosis (pH < 7.25); or
5. airway obstruction.

▸ Solutions for HFOT

Compared with the standard oxygen therapy, Mindray's SV Series ventilator's HFOT can provide 2 - 60 L/min flow of oxygen and up to 100% FiO2. In addition, with humidifier to actively warm and humidify the HFOT's gas flow delivered to patients, preventing mucociliary damage, sputum buildup, and other complications. Autopsy reports shown that COVID-19 lesions are concentrated in the lungs with a large amount of viscous sputum. Therefore, humidified HFOT has a great significance for patients requiring sputum clearance.



HFOT

HFOT is applied to COVID-19 patients.

Challenges of treating COVID-19 patients

- Demanding clinical environments
- Shortage of medical supplies
- Heavy workload for caregivers

What Minday can offer:

1. The comprehensive respiratory support therapy solution, including HFOT, NIV and IMV in one device, can be switched over seamlessly to meet the changing needs of the patients;
2. The lung protection strategy package is available for effective treatment of COVID-19 patients;
3. An extensive range of parameter measurement can help facilitate weaning of patient in a safe and effective way.

[1] Critical Care Committee of Chinese Association of Chest Physician, Respiratory and Critical Care Group of Chinese Thoracic Society, Respiratory Care Group of Chinese Thoracic Society. Conventional respiratory support therapy for Severe Acute Respiratory Infections (SARI): Clinical indications and nosocomial infection prevention and control.

[2] Experts' Suggestions on Clinical Management of Severe Cases of COVID-19. Chinese Journal of Critical Care & Intensive Care Medicine [e-Journal]. 2020, 06.

[3] World Health Organization. Clinical management of severe acute respiratory infection when Novel coronavirus (2019-nCoV) infection is suspected: Interim Guidance. 2020 Jan 28.

[4] Marini JJ. Recruitment maneuvers to achieve an 'open lung': whether and how? Crit Care Med 2001; 29:1647–1648.

[5] Halter JM et al. Positive End-Expiratory Pressure after a Recruitment Maneuver Prevents Both Alveolar Collapse and Recruitment/Derecruitment. Am J Respir Crit Care Med 2003; 167: 1620-1626

[6] Chen et al. Implementing a bedside assessment of respiratory mechanics in patients with acute respiratory distress syndrome. Critical Care (2017) 21:84

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