# Expert Consensus on Use and Managementof High-flow Nasal Canula for Novel Coronavirus Pneumonia Patients

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SARS-CoV-2 infection can cause Novel Corona virus Pneumonia (NCP), which may leads to several complications including hypoxemia and dyspnea in severe and critical patients. Therefore, proper respiratory support treatment is urgently needed in such cases. For acute hypoxic respiratory failure, high-flow nasal canula (HFNC) has great advantages compared to traditional oxygen therapy. It can reduce intubation rate and 90-day mortality rate , and has played an important role in the treatment of MERS-CoV pneumonia and H1N1 pneumonia. HFNC also plays a vital role in the treatment of severe and critical NCP patients. At present, the pandemic is still developing. Medical staff not from all respiratory or critical care units may not be familiar with the operation of HFNC . Training is required in the use of HFNC and subsequent disinfection treatment. The Respiratory Therapy Group of Chinese Thoracic Society has organized experts to discuss some common problems in the application of HFNC in the NCP treatment process and formed this expert consensus. This expert consensus takes the commonly used HFNC devices as examples to make explanation,

In order to enable frontline medical staff to quickly master the use and disinfection of HFNC, to benefit patients and to avoid the risk of virus transmission. This expert consensus starts with the principle and parameter setting of HFNC and the use and disinfection of different high-flow oxygen inhalation devices, aims at standardizing the use of HFNC in NCP patients and providing guiding suggestions for frontline clinical medical care.

●SARS-CoV-2 is sensitive to ultraviolet rays and heat. 56℃30 min, diethyl ether, 75% ethanol, chlorine-containing disinfectant, peracetic acid and chloroform can effectively inactivate the virus, but chlorhexidine cannot inactivate SARS-CoV-2.

●The connection and use of different HFNC devices are slightly different, but the principle and basic process are the same. Users need to pay attention to whether the machines and breathing tube are connected correctly and whether the parameters (temperature, flow rate and oxygen concentration) are set reasonably, and dynamically adjusted according to the subjective feelings, vital signs and test results of patients.

●It is recommended to use disposable breathing tube and nasal cannula, and not recommended for routine

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replacement unless there is obvious pollution. The nasal cannula should be less or equal to 50% of the diameter of patient' s nostrils. Whether the connectors are correctly worn will directly affect the diffusion distance of exhaled air. The humidification water in the humidifier of the device needs to be externally connected. The humidification water should be sterilized and distilled water. It is recommended to use automatic water injection. If the non-automatic water injection humidifier is applied, it should be replenished regularly and timely to prevent the temperature from being too high.

● In order to reduce the dispersion of aerosol and the generation of droplets, it is suggested to operate in a certain sequence: 1.Starting; 2.Setting initial parameters; 3.Wearing nasal cannula; 4.Air supply. When stopping using HFNC, shut down the machine first or lower the air flow to zero before removing the nasal cannula. When HFNC is stopped, the patient should continue oxygen supply therapy. According to the needs of the patient, required devices such as nasal catheter oxygen inhalation, non-invasive/invasive ventilator machine or tracheal intubation should be prepared in advance.

● The device failure alarm should be promptly checked and dealt with. If the failure cannot be eliminated, it is needed to replace the machine in time or apply other respiratory support methods.

● When the HFNC therapy is stopped, oxygen source should be turned off first, then shut down the HFNC machine. Disposable breathing tube, humidifier and nasal plug connectors should be destroyed as medical waste. The surface of the machine should be wiped and disinfected with 75% ethanol. The internal loop of the machine should be disinfected with a specific disinfection pipeline and the air filter cotton should be replaced.

## I The definition, principle and physiological mechanism of HFNC

HFNC refers to an oxygen therapy that continuously provides patients with adjustable and relatively constant inhalation oxygen concentration (0.21 ~ 1.0), temperature (31 ~ 37℃) and humidity through high-flow nasal plug (8 ~ 80 L/min, depending on brand and model)

HFNC mainly comprises four parts: an air-oxygen mixer, a heating and humidifying module, a connecting pipeline and a nasal plug connector. The air-oxygen mixer mixes air and oxygen in a turbine/fan according to a pre-set oxygen concentration, and the turbine accelerates to generate high-speed airflow after mixing; The heating and humidifying module warms and humidifies the high-speed airflow, then delivers the air to the patient in a constant temperature, humidity and flow rate through a connecting pipeline and a nasal plug connector, thus playing a role of breath support.(Fig.1).

HFNC has the following advantages: (1) It provides stable and higher oxygen inhalation concentration than common nasal catheter.

The oxygen inhalation concentration does not change with the change of patient's respiratory state and can meet the needs of patient for spontaneous respiration;

(2) The high-flow airflow can reach or exceed the maximum flow rate of the patient's active inspiratory, lower the resistance and workload, and reduce oxygen consumption; (3) The air can be heated and humidified to 37℃ and 44 mg/L, thus reducing the consumption of heat and water in patients with respiratory distress to keep the airway mucociliary function in an optimal state, and facilitating secretion drainage to reduce the occurrence of pulmonary infection. (4) High-flow airflow scours the dead cavity of the upper airway to reduce anatomical dead cavity and improve patient ventilation; (5) High-flow airflow provides a certain level of positive airway pressure with the functions of opening alveoli, increasing lung volume, improving ventilation, etc. (6)HFNC does not need a completely closed circuit. It has no obvious facial pressure and is convenient for eating and communication, and with high patient compliance.

## II Application timing and parameter setting of HFNC

1. Indication: Based on experiences in treatment of MERS-CoV pneumonia and H1N1 pneumonia, HFNC may be considered for NCP patients that are above the diagnostic criteria for severe NCP. Diagnostic criteria for severe NCP: (1) Respiratory distress, respiratory frequency ≥30 times/min; At rest, SpO2 ≤ 93%; (3) PaO2/ FiO2 ≤ 300 mmHg (1 mm Hg = 0.133 kPa).

It is worth noting that at present there is no unified conclusion on the indications for clinical application of HFNC. Published clinical studies have confirmed that HFNC is mainly suitable for the treatment of patients with mild to moderate hypoxic respiratory failure.

For patients with severe hypoxic respiratory failure and respiratory failure complicated with hypercapnia, HFNC should be closely monitored and oxygenation should be changed to a higher level of respiratory support as soon as possible after 1-2 hours of use.

2. Contraindications: (1) Cardiac and respiratory arrest requires emergency tracheal intubation for invasive mechanical ventilation; (2) Weak spontaneous breathing and poor protection of upper airway; (3) Severe hypoxic respiratory failure (PaO2/ FiO2 <100 mmHg) and severe ventilation dysfunction (PaCO2 > 45 mmHg and pH< 7.25); (4) Upper airway obstruction; Nasal

plug cannot be used for nasal and facial trauma; (5) Refusal to use HFNC.

3. Parameter setting observation indicators and evacuation standards

(1) Parameter setting: ① Type I respiratory failure: the initial setting of Flow is 30 ~ 40 L/min, and the flow is gradually increased to 50 ~ 60 L/min after the patient is tolerant; Adjust FiO2 to maintain pulse oxygen saturation (SpO2) at 92% ~ 96%, and dynamically adjust it in combination with blood gas analysis; If the oxygenation target is not reached, FiO2 can be gradually increased and adjusted to a maximum of 1.0. The temperature setting range is 31 ~ 37℃, appropriately adjusted according to the patient's comfort and tolerance as well as sputum viscosity. ② Type II respiratory failure: The initial setting of Flow is 20 ~ 30 L/min, which is adjusted according to patient tolerance and compliance; If the patient has obvious carbon dioxide retention, the flow rate can be set at 45 ~ 55 L/min

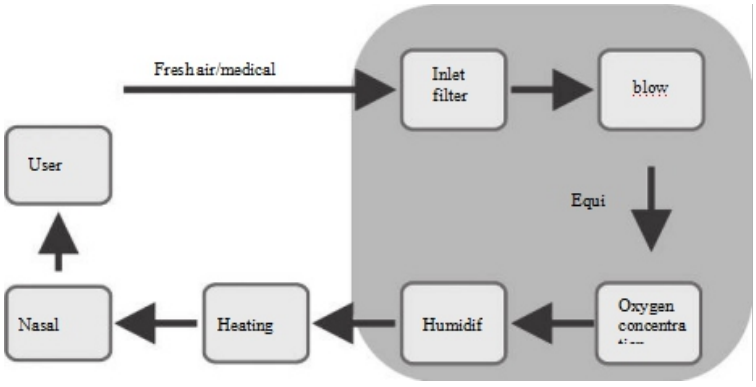



Figure 1 HFNC mode diagram

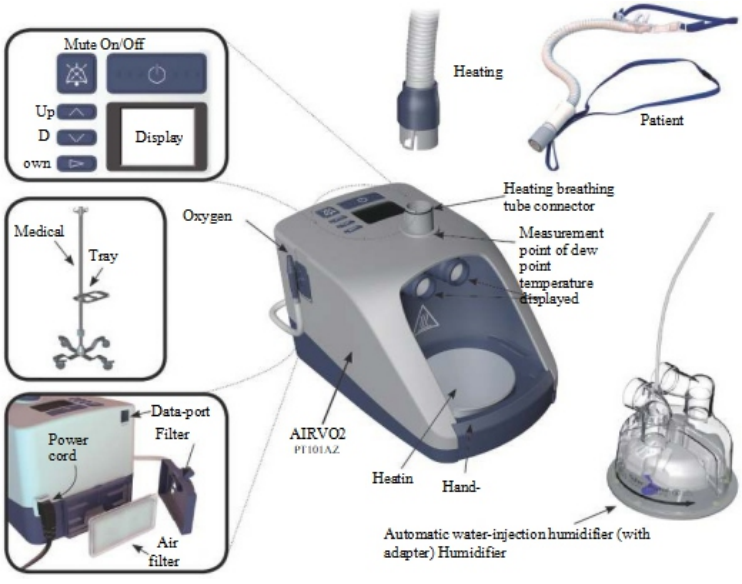



Figure 2 AIRVO2 HFNC

or even higher to reach the maximum flow rate that the patient can tolerate. Titration of FiO2 maintained SpO2 at 88% ~ 92%, and dynamically adjust it in combination with blood gas analysis. The temperature setting range is 31 ~ 37℃, appropriately adjusted according to the patient's comfort and tolerance as well as sputum viscosity.

(1)Observation indicators during use: After HFNC is used, the vital signs of the patient should be monitored, especially respiratory frequency and SpO2. If respiratory frequency decreases, SpO2 increases and FiO2 decreases within a period of time, the patient has a good response to HFNC and can continue to apply it. On the other hand, it indicates that the patient' s state is deteriorating, and it is necessary to consider increasing the flow and FiO2 and decide whether to change to a higher respiratory support mode according to clinical conditions.

(2)Evacuation criteria for patients with improvement: HFNC parameters are gradually reduced after primary disease control or improvement. Evacuation of HFNC can be considered if the following criteria are met: inspiratory flow ≤30 L/min and FiO2<0.4.

## III Use and disinfection of different HFNC devices

**1**. Airvo Series Respiratory Humidifier AIRVO2 (Fisher Paykel, New Zealand. The similar type can be referred to) (Fig2)

**1.1Machine Property** It is the first respiratory humidifier used in China. It uses a buoy type oxygen flow regulator and built-in oxygen concentration monitor. By regulating the oxygen flow to titrate the oxygen concentration (0.21-1.0), and hyperoxy alarm will occur when oxygen concentration exceeds 0.95. There are two modes for adults and children (flow rate for children is 2-25 L/min and for adults is 10-60 L/min) respectively. The temperature regulator has three gear, including 31, 34, 37 ℃.

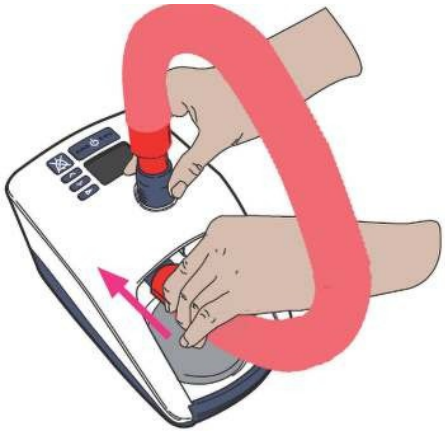
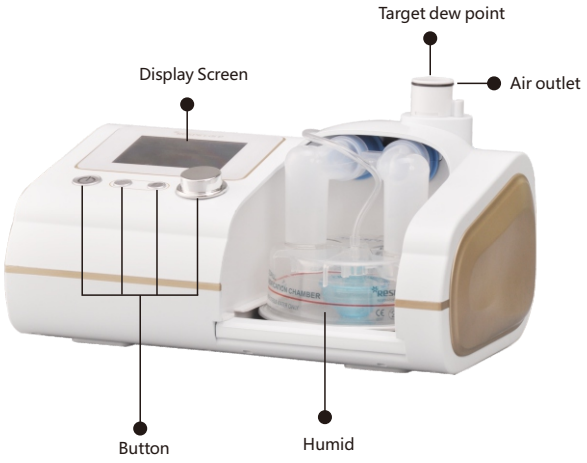


Figure 3 Internal disinfection of AIRVO2 HFNC

**1.2Start-up and parameter** setting After correctly connecting the pipe, press the button to start up the machine, then press the menu button to enter the parameter setting interface. Press the up and down buttons simultaneously for 3 s to adjust the parameters.

**1.3Disinfection and infection control** The sterilized filter cotton at the air inlet can filter bacteria and viruses (bacteria filtering efficiency is 99.999999%, virus filtering efficiency is 99.999999%), which prevent cross infection effectively during usage. After the HFNC is used, disposable breathing tube, humidifier and nasal cannula shall be discarded as medical wastes.



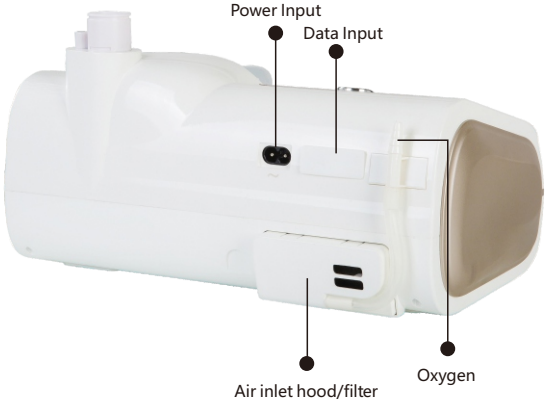




Figure 4 HFNC

## 2. Our high-flow respiratory humidifier

(The similar types can be referred to.)(Fig4)

### 2.1 Machine Property

The main property include:low flow rate mode (flow rate 2 ~ 25 L/min), high flow rate mode(10 ~ 80 L/min), three temperature options (31, 34, 37℃) ; Oxygen concentration range (21 ~ 100%).

### 2.2 Start-up and Parameter setting

After turning on the power supply and parameter setting, press the start/stop button for 3 s to start the humidifier, press the menu button to enter the parameter setting interface, select the suitable temperature and flow by rotating the shuttle, press the shuttle to confirm selection, and then press the menu button to return to the monitoring interface. This instrument is similar to AIRVO2. External oxygen source needs to enter the machine for mixing. The external oxygen flow needs to be adjusted and set to required concentration.(Fig5).

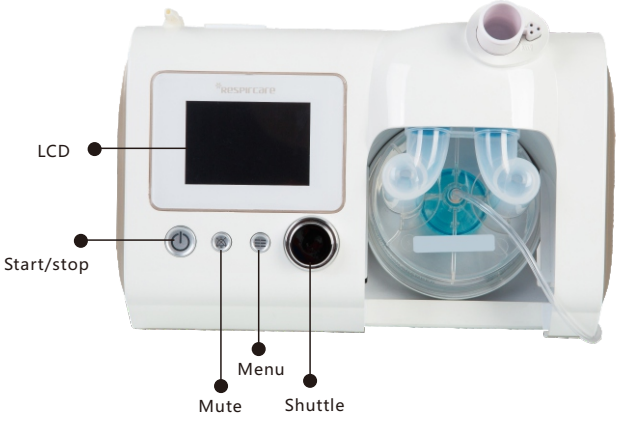



Figure 5 operation interface

### 2.3 Disinfection and infection control

After usage, disposable breathing tube, humidifier and nasal cannulashould be discarded as medical wastes. The surface should be cleaned and disinfected with 75% ethanol or chlorine-containing disinfectant. Filter cotton should be replaced and the interior of the machine shall be disinfected with a special sterilizer. (Fig6).

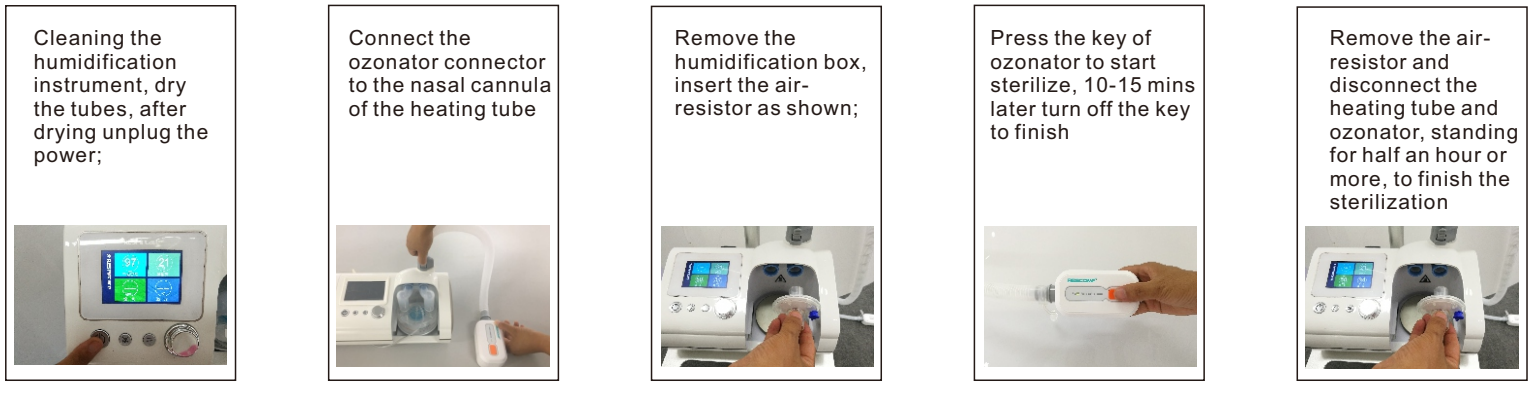



Figure 6 Internal disinfection of Hdisinfection

**3**High-flow medical air-oxygen mixer. (Fig7.8)

**3.1**System performance The high-flow air-oxygen mixer system uses a flow meter to control the flow rate (0-70 L/min) of the mixed air by adjusting the oxygen absorption concentration (21%-100%) through an air-oxygen mixer through an interface connecting central oxygen supply and compressed air, and the preset flow is sucked into the body of a patient through an active temperature and humidity device and a nasal catheter. The active heating humidifier device can be adjusted according to the target temperature. When the servo-type active heating humidifier is used, it can automatically adjust the temperature of the flow reaching the patient to 37℃, and the humidity to 44 mg/L.

**3.2**Parameter setting After connecting high-pressure air and oxygen sources, turn on the power supply of the air-oxygen mixer, rotate the knob of the mixer to select the target oxygen absorption concentration, and rotate the knob of the flowmeter to adjust the target flow rate. Open the active heating humidifier.

**3.3**Disinfection and infection control After using the instrument, discard the disposable pipeline, humidifier and nasal plug connector according to medical waste. Since the instrument does not use any internal pipelines, only 75% ethanol or chlorine-containing disinfectant is needed to wipe and disinfect the surface of the instrument. However, the temperature sensor required by the equipped active heating humidifier needs to be wiped with 75% ethanol or chlorine-containing disinfectant and then sent to ethylene oxide for disinfection.


Figure 7 maxBlend2

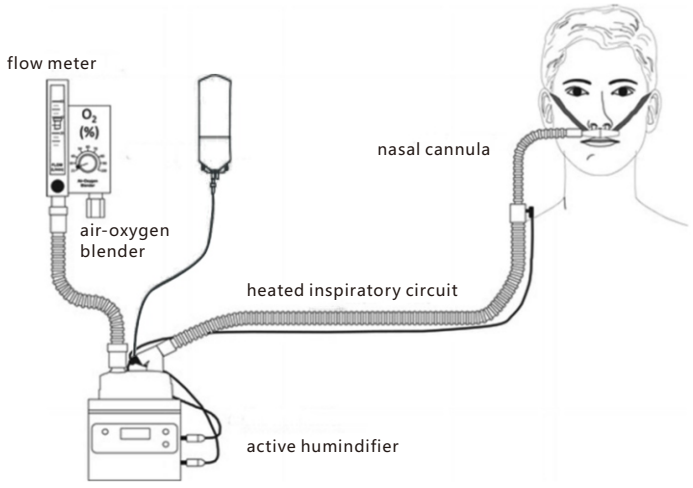



Figure 8 Schematic diagram of maxBlend2 connection location

## IV Summary

As a new oxygen therapy, HFNC provides a new choice of respiratory support for severe and critical NCP patients. Based on practicality, this expert consensus has taken widely used HFNC as examples to explain the indications, contraindications, use process and post-disinfection measures of HFNC.

Since severe and critical patients are progressing rapidly, when using the HFNC, the patient's condition should be closely monitored,and the therapy protocol should be adjusted timely in order to obtain better curative effect.

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