bellavista™ ventilators

Current recommendations for treating patients with COVID-19 related acute respiratory failure

Acute respiratory distress syndrome (ARDS)[2]

- Mild ARDS: 200 mmHg < PaO_2/FiO_2a ≤ 300 mmHg *(with PEEP or CPAP ≥ 5 cmH_2O, or non-ventilated)*
- Moderate ARDS: 100 mmHg < PaO_2/FiO_2 ≤ 200 mmHg *(with PEEP ≥ 5 cmH_2O, or non-ventilated)*
- Severe ARDS: PaO_2/FiO_2 ≤ 100 mmHg *(with PEEP ≥ 5 cmH_2O, or non-ventilated)*
- When PaO_2 is not available, SpO_2/FiO_2 ≤ 315 suggests ARDS *(including in non-ventilated patients).*

The following recommendations pertain to adult and pediatric patients who are treated with non-invasive or high-flow oxygen systems.

Clinical assessment

Closely monitor patients with COVID-19 for any signs of clinical deterioration, such as rapidly progressive respiratory failure and sepsis and respond immediately with supportive care interventions.

Treatment options for acute respiratory failure

High Flow Oxygen Therapy *(HFOT)*

Compared with standard oxygen therapy, HFOT is effective for mild to moderate hypoxemic respiratory failure.[3] HFOT reduces the need for intubation on patients with acute respiratory failure[4]

HFOT as been shown beneficial for MERS-CoV patients and might reduce nosocomial spread as well.[6]

High-flow oxygen therapy *(HFOT)* should only be used in selected patients.*

Patients treated with HFOT should never be unmonitored and always equipped with pulse oximetry and vital signs monitoring, since ventilator alarms are mostly suspended during HFOT. Only experienced, trained personnel should observe closely with short intervals while treating patients undergoing HFOT, in a controlled environment and able to perform intubation under airborne precautions. Start to treat patients with supplemental oxygen when SpO_2 is ≤ 92%.

Contraindications for HFOT:

- No respiratory drive
- Hypercapnia**
- Hemodynamic instability
- Multiorgan failure
- Agitation
- Airway obstruction
- Massive secretions
- Unconsciousness

Setup for HFOT

Recommendations for initial set up of HFOT:

- Correct sizing of prongs, prongs should not occlude the nares, only about 60%
- Start with 50 - 60 L/min for adults[7]
- 2 L/kg for infant and pediatric patients
- FiO_2 to target SpO_2 of 92-96%
- Constantly observe the patient's vital signs and oxygenation.

Abortion criteria for HFOT

Since no evidence-based guidelines are existing for treatment with HFOT, abortion criteria should be the same as for non-invasive ventilation when patient is deteriorating or not improving after an appropriate trial period *(1h)*.

If the patient fulfills at least one of the following abortion criteria, alternative means of treatment like invasive ventilation are indicated:

- PaO_2/FiO_2 < 150 mmHg
- SpO_2 < 93%
- Arrhythmia
- Hemodynamic instability
- Airway obstruction
- Respiratory distress
- Agitation
- Increasing respiratory hypercapnia
- Increasing respiratory rate *(> 30 bpm)*
- Unconsciousness
- Shock
- Respiratory acidosis *(pH < 7.25)*

*Reports on HFOT in patients infected with coronaviruses are limited[5]

**Recent publications indicate that HFOT may be suitable for patients with mild-moderate hypercapnia[4,5,6]

HFOT with bellavista

The bellavista™ ventilator offers the option of integrated High Flow Oxygen Therapy *(HFOT)* for **neonatal to adult patients** and can be used with single or dual limb breathing circuits. bellavista provides up to **80 L/min of flow*** with a FiO_2 setting up to 100%. *50 L/min for US

Non-Invasive Ventilation (NIV)

Non-invasive ventilation should be used only in selected patients with hypoxemic respiratory failure.

When applying NIV, closely monitor patients by experienced personnel to immediately identify deterioration of a patient or when the patient does not improve does after a NIV trial period *(1h)*.

Patients with following conditions should not be considered for NIV rather than options such as invasive ventilation.[5]

- No respiratory drive
- Hemodynamic instability
- Multiple organ failure
- Agitation
- Airway obstruction
- Massive secretions
- Unconsciousness

Caveat

Current guidelines do not recommend NIV in acute hypoxemic respiratory failure *(except from cardiogenic pulmonary edema and postoperative rrespiratory failure)* or pandemic viral illness *(referring to studies of SARS and pandemic influenza)*[4].

Limited data suggest a high failure rate *(>80%)* in patients with other viral infections such as MERSCoV who received NIV.[8]

Risks to take into consideration when using non-invasive ventilation

- Delayed intubation
- Excessive tidal volumes
- Injurious transpulmonary pressures.
- Increased risk of passing infection on to caregivers

Non-invasive ventilation with bellavista

bellavista NIV offers a large variety of ventilation modes, synchrony tools like **auto.sync and auto.rise** for improved patient ventilator interaction. auto. leak manages leakages up to 120 L/min. Parameters like tidal and minute volume *(Vt, MV)* are **leakage compensated** for better observation of the applied volumes. NIV in bellavista is applicable with single and dual limb circuits.

Invasive mechanical ventilation

Management of critical Acute Respiratory Distress Syndrome *(ARDS)*

The following recommendations apply to invasively ventilated adults and pediatric patients with ARDS[8,10]

- 4-8 mL/kg/PBW for adults
- 3-6 mL/kg/PBW for pediatric patients
- Plateau pressures ≤ 28-30 cmH_2O
- Driving pressures ≤ 12 cmH_2O
- Permissive hypercapnia
- Higher PEEP instead of lower PEEP in moderate to severe cases, when patient is PEEP responsive
- Consider sustained inflation recruitment maneuvers if patient is PEEP responsive
- Oxygenation PaO_2 ≥ 55-80 mmHg or SpO_2 ≥ 88-95%

Higher PEEP, lower FiO_2 ARDSnet PEEP table[12]

FiO_2	PEEP
0.3	5
0.3	8
0.3	10
0.3	12
0.3	14
0.4	16
0.4	16
0.5	16
0.5	18
0.5-0.8	20
0.8	22
0.9	22
1.0	22
1.0	24

Supporting treatments for moderate to severe cases

Application of prone ventilation is strongly recommended for moderate to severe cases, and considered for pediatric patients with severe ARDS but requires sufficient human resources and expertise to be performed safely; respective protocols are available[7,9,10]

- In adult patients with severe ARDS, prone ventilation for 12–16 hours per day is recommended[7]
- Deep sedation is recommended to control respiratory drive, prevent high transpulmonary pressures and achieve tidal volume targets
- Higher PEEP and recruitment maneuvers with sustained inflation *(RM)* are both conditionally recommended in a clinical practice guideline[11]
- A trial of inhaled pulmonary vasodilator as a rescue therapy; if no rapid improvement in oxygenation is observed, the treatment should be tapered off

bellavista invasive ventilation treatment options:

Lung Recruitment Tool

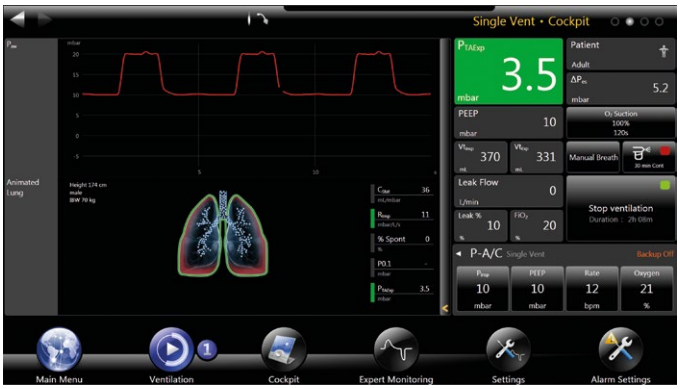
bellavistas Lung Recruitment Tool *(LRT)* provides the clinician all relevant information in a reliable, reproducible and easy way. The LRT is an **automatic maneuver** that determines recruitability and subsequent recruitment in **two steps**. The first step is to perform an assessment maneuver, to verify if the patient's lung is recruitable. After the assessment maneuver an estimation of e.g. PEEP setting or **recruitability** of the patient's lung is easy to obtain.

In a second step, the recruitment of the patient's lung with a **sustained inflation** maneuver is executed. The **recruited volume** is available as monitoring parameter.

Esophageal pressure monitoring

Esophageal Pressure Monitoring *(EPM)* has become critical in the field of ventilation, especially for the treatment of ARDS, and as a refined **lung protective ventilation strategy.** With EPM and values obtained by a balloon catheter, distending, **transpulmonary pressure** and stress applied to the lung can be verified with more detail. Further, the calculation of transpulmonary pressure gives advice where to set PEEP and inspiratory pressure, to prevent excessive **tidal pressures.**

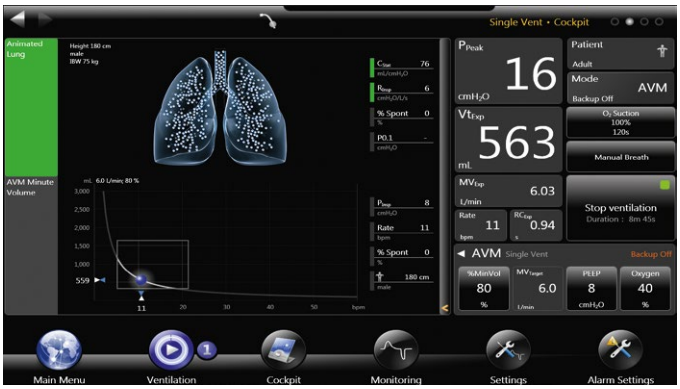
bellavista EPM provides all monitoring data to support lung protective strategies and **optimize patient ventilation.** Easy-to-understand graphics provide an immediate view to determine optimal patient ventilation and to easily monitor progress.



AVM

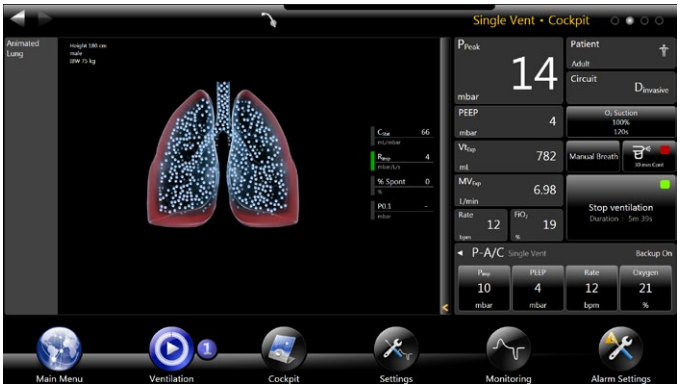
Adaptive Ventilation Mode *(AVM)* is a ventilation mode which **reduces** the number of interactions and settings, **relieving** the clinician's **workload.**

By continuously measuring patient **lung mechanics,** AVM adapts to patient activity breath by breath, whether in mechanical or spontaneous ventilation, always calculating **optimal breathing pattern** and avoiding potentially detrimental situations, while maintaining safety backup ventilation at any time. AVM supports **spontaneous breathing** of the patient at any time. AVM determines the optimal ventilation pattern throughout the entire ventilation process, **from in- to extubation.** Use AVM to ensure safe ventilation and facilitate weaning for your patients.



AnimatedLung

The AnimatedLung is a dynamic tool that visualises the mechanical state of a patient's lung and helps to detect changes of the patient's **lung condition** without constantly assessing numeric parameters. An easily comprehensible **graphic display** helps to detect at a glance any changes in static/dynamic lung compliance or inspiratory resistance as well as the patient's **spontaneous activity.**



Monitoring/Trending

bellavista offers extensive dynamic parameters for observing changes in lung condition, IBW related volumes, compliance, resistance, spontaneous activity to constantly support the caregiver in finding the best strategy for lung protective ventilation.

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