Treaton

Ventilation recommendation of COVID -19 patients for Intensive Care Ventilator Zisline MV200 based on COVID-19 clinical management dated 25th of January 2021 by World Healthcare Organization

General information on the device and its operation	Intensive care ventilator MV200 supports the modern concept of maintaining the patient's breathing function. The device operates from different sources of high and low pressure oxygen. You can launch the intensive care unit in any hospital room, which is important in the context of the COVID-19 pandemic. The ventilator does not depend on compressed air sources – it has a built-in turbine developed by Triton engineering team, with unique design and fast response time. MV200 has a wide range of ventilation modes (up to 11 modes depending on a model): - mandatory (CMV) with pressure and volume control; PCV-VG (pressure controlled and volume guaranteed mode); - synchronized intermittent ventilation with pressure control, volume control or dual control (SIMV DC); - spontaneous ventilation modes: CPAP (continuous positive airway pressure), BiStep ventilation with pressure support; airway pressure release ventilation (APRV), non-invasive ventilation NIV; - adaptive ventilation mode iSV. With MV200 you can follow the recommendations of the World Healthcare Organization (WHO) for respiratory support of patients with severe (pneumonia) and critical (ARDS – acute respiratory distress syndrome) clinical course of COVID-19. Depending on the clinical situation, modes with varying degrees of patient participation in breathing process may be required. Let’s discuss ventilation modes of MV200 for treatment of COVID-patients. You can change the ventilation mode in different ways: - Main menu – Ventilation modes - Using touch button of the mode name

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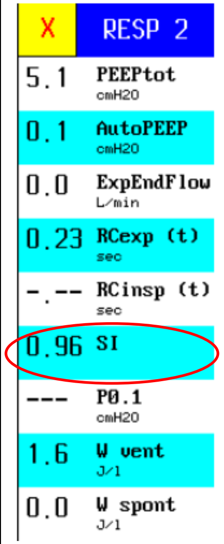
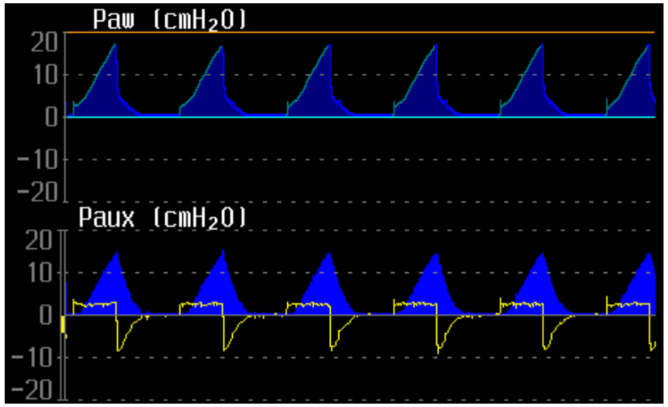
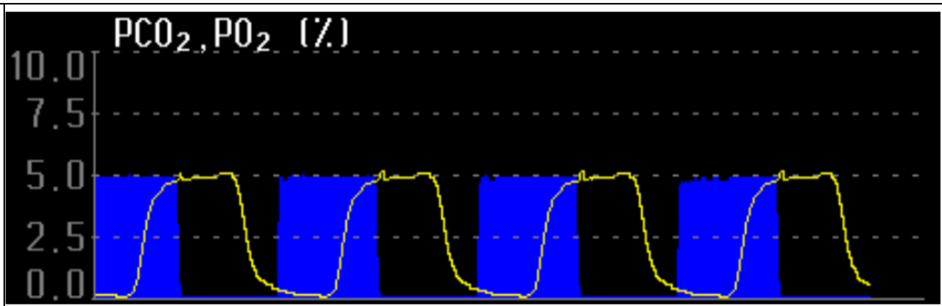
Ventilation modes	For a significant proportion of patients with severe COVID-19, the application of support ventilation modes may be sufficient. **<u>CPAP+PS</u>** The device supports a spontaneous inspiration attempt with pressure (PS). The criterion for starting an inspiratory support cycle is an inspiratory trigger (flow or pressure). **<u>BiSTEP</u>** In some clinical cases the patient needs to alternate between the high and the low airway pressure phase. BiSTEP is a spontaneous breathing mode with two levels of continuous positive airway pressure, with the pressure support. A patient can breathe through the device in both pressure phases in the circuit. *Despite the fact that when treating patients with viral pneumonia caused by COVID-19 there is always a high risk of aerolization of viral suspension in the air, sometimes it is more comfortable for the patient to breathe through the mask in the NIV mode.* *If insufficient, noninvasive support may stabilize the clinical course in mild cases, provided that the patient does not exert excessive inspiratory efforts.* *While this option is non-invasive it isn't completely benign. Patients retain some control over their breathing and large volume breaths can cause self-inflicted lung injury.* *Doctor's supervision required!* **<u>NIV</u>** This mode provides spontaneous breathing with a preset positive airway pressure (PEEP) and spontaneous inhalation support (PS) via a face mask. The difference between NIV and CPAP + PS: NIV mode always works with leakage compensation, FiO2 is set in the range of 21 - 70%. In every mode of spontaneous breathing, if there is no patient breathing activity, the ventilator switches to the APNEA (backup) mode.

	From the one side, the severe course of a disease is associated with the development of hypoxia, therefore, the delivery of a given volume of oxygen is very important (like in volume-controlled modes). At the same time, the lung tissue affected by the virus changes its mechanical properties, and the risk of baro- and volumotrauma increase, so we need to protect the lungs (like in pressure-controlled modes). Therefore, we recommend to pay a special attention to the modes with dual control. It is more effective than VCV and PCV because it combines the advantages of both, with the leveling of their shortcomings. Let's consider now the dual control modes in MV200. **PCV-VG** The PCV-VG (pressure-controlled, volume guaranteed) is a mode of mandatory ventilation with guaranteed delivery of the target tidal volume at the lowest possible pressure. The PCV-VG mode is functionally identical to the CMV / PCV mode with one exception: instead of the target inspiratory pressure, the operator sets the target inspiratory volume. The inspiratory pressure is adjusted by the device with each new breath based on the target volume. Sometimes, if the lungs are severely damaged in ARDS, it could be necessary to prevent spontaneous breathing. The clinical effectiveness of this mode is associated with more correct shape of the inspiratory pressure curve, more homogeneous mixing of air in the lungs and accurate control of the inspiratory volume. In cases where patient`s spontaneous breathing is acceptable, the SIMV-DC mode is optimal. **SIMV-DC** SIMV / DC mode is similar to SIMV / PC mode, except that hardware inspiration is performed using the dual control method like in PCV-VG mode.
Parameters	The best approach will likely vary by patient. A single approach is unlikely to work in a disease as heterogeneous as covid-19. Recommended starting parameters *(WHO about COVID-19 clinical management dated 25th of January 2021)*

	Adults: Tidal volume 4-8 ml / kg Pplat< 30 cm H2O Children: Tidal volume 3-6 ml / kg Pplat< 28 cm H2O
Optimal PEEP choosing	“To PEEP, or not to PEEP”, and how much, is another area of controversy in the management of COVID-19. Is PEEP dangerous in COVID-19 patients? Is it beneficial? The answer is “Yes” – to both questions – just like it is for any other acute respiratory distress syndrome (ARDS) patient. The tools (methods) for PEEP selection, implemented in MV200, help the doctor to make the ventilation safe and as efficient as possible for the patient.  Stress Index The coefficient characterizes the correctness of PEEP and VT choice. It is defined in CMV / VCV and SIMV / VC modes for hardware inhalation with a rectangular flow curve. SI = 1 standard value, PEEP matched correctly SI> 1 PEEP level is too high SI <1 PEEP level is too low

	<u>Paux transpulmonary pressure (option)</u> It is the difference between the alveoli pressure (PA) and the pressure in pleural cavity (Ppl). It is a measure of elastic forces in lungs that tend to decrease lung volume during any phase of respiration. To display the digital values of the auxiliary external pressure at the screen, select the Paux in the one of windows: [Menu] - [Display settings] - [Choose measured par. blocks] To display Paux curve on the screen press [Menu] [Display settings] - [Graphs]. The Paux external pressure graph shows: • graph scale (coincides with the Paw graph, set by the Pmax parameter); • curve of external pressure on the screen is in blue; • yellow Paw-Paux curve 
Capnography	Intensive care ventilator MV200 can be optionally equipped with a mainstream CO_2 sensor. Its operating principle is based on the method of measuring the infrared light absorption in the absorption spectrum of carbon dioxide. As a result of the measurement, the device displays the concentration of CO_2 at the end (EtCO2) and the beginning (FiCO2) of expiration, and capnogram (PCO2).

	 Capnography method is included in all ventilation guidelines
Volumetric capnography	Volumetric capnography (option) is important in evaluating the disease course dynamics, as it enables to assess the dead space. In addition, it could be an early symptom of pulmonary embolization. This is especially relevant with COVID-19, because one of its signs is a failure of hemostasis system and thrombus formation. The device can be equipped with a volumetric capnometry function optionally. To calculate the volume of eliminated CO2 a flow curve and a capnogram are used together. The volumetric capnography method provides information on ● elimination of CO2 per minute (VCO2) ● functional dead space (Vd); ● minute alveolar ventilation (MValv). 
Cardiac output on the Fick method	In MV200 you can monitor central hemodynamic with the cardiac output calculator (option). The relevance of this type of monitoring is undoubted, given the negative impact of mechanical ventilation on hemodynamics. Volumetric capnometry is used to calculate cardiac output in accordance with Fick method. It works together with the volumetric capnometry, since the amount of eliminated carbon dioxide must be known to calculate cardiac output.

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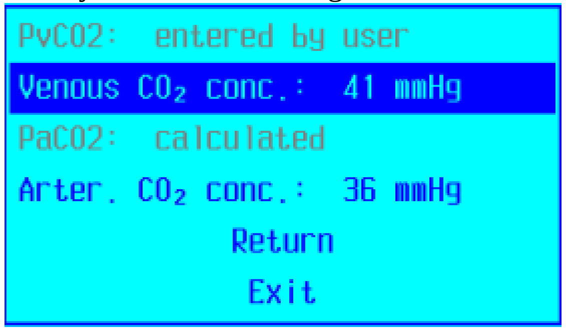
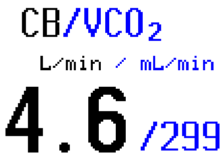
	To use this function, select the CO / VCO in: [Menu] - [Display settings] - [Choose measured par. blocks]: For that click on the digital window "CO/ VCO2" or go to the menu of additional functions: [Main Menu] - [Additional Functions] - [Cardiac Output by Fick]. Then you need to enter figures of venous and arterial CO2 concentration.  Use in vitro values of venous (PvCO2) and arterial (PaCO2) CO2 concentration. If you have only one of this analysis, the second is calculated automatically. $CB = \frac{VCO_2 * P_{v\_CO2}}{(P_{v\_CO2} - P_{a\_CO2}) * k_r}$,  After that cardiac output will be calculated and displayed on the screen. If PvCO2 and / or PaCO2 values have not been updated for more than 4 hours, or EtCO2 value changed more than 30% from EtCO2 measured during cardiac output calculation, the message “Update PaCO2/PvCO2” appears on the screen.
Weaning from ventilator	Many physicians note that it can be difficult to wean a patient from a ventilator with atypical pneumonia caused by COVID-19. Several advanced respiratory monitoring parameters may be helpful in this case. The device calculates the breathing work of a patient and the ventilator separately. So it is possible to assess the increase in the patient's respiratory activity in dynamics.

	P01 measures the inspiratory effort. P0.1 - the amount of airway pressure decrease in the first 100 msec of the patient's spontaneous breathing attempt when the breathing circuit is occluded. This indicator normally in a healthy person ranges from -2 mbar to -4 mbar or -2 / -4 cm of water column. If it is below normal, then a patient is not ready for weaning from the ventilator. RSBI (Rapid Shallow Breathing Index) is the ratio of respiratory rate to the tidal volume. This parameter is measured in CPAP, BiSTEP, APRV modes. If RSBI value is less than 100, a patient can be extubated, with an 80-95% chance of being able to spontaneously breathe without complications. At RSBI> 120, a patient will need continued respiratory support Press the extended monitoring touch button to display the specified parameters.
Additional functions	Sanitation During prolonged mechanical ventilation, it is very important to sanitize the airways in time. To prevent a FiO_2 decrease, the device has a sanitation function with 100% pre- and post-oxygenation Nebulizer An important component in treatment of patients with COVID-19 is the use of drugs inhalation through a nebulizer. This is especially required for patients who had respiratory problems before COVID-19. It is possible to use different types of nebulizers with the MV200 ventilator. • Set the required nebulizer run time in [Menu] - [Additional functions] - [Nebulizer run time] (0 - 60 min). • Turn on the nebulizer by pressing the encoder
Metabolism evaluation module	In case of prolonged ventilation, also it is necessary to conduct metabolic monitoring (option) to provide proper nutritional support. Remember that both poor and excessive nutrition could be dangerous for a patient. The device can be equipped with the metabolism evaluation module, measuring by indirect calorimetry method The essence of this method is to calculate a resting energy expenditure(REE), respiratory quotient (RQ) and a ratio of eliminated CO_2 to consumed O_2 per time unit. Direct measurement: VO_2, O_2 consumption VCO_2, CO_2 elimination

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Calculation:

REE, resting energy expenditure

RQ, respiratory quotient

The respiratory quotient RQ is calculated by the formula: RQ = VCO2 / VO2 (pop-up window)

The calculation of the resting energy expenditure REE is calculated by modified Weir’s indirect calorimetry formula

REE (kcal/day) = (3,941 x VO2 + 1,106 xVCO2) x N (pop-up window)

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