ACER BIOMEDICALS

SAFETY • RELIABILITY • COMFORT

Intensive Care Ventilator MV200

MV200 is multifunctional mechanical ventilator that effectively provides all necessary functions for reliable and safety respiratory support of all patient groups: adults, children and infants.

MV200 includes large number of innovative functions that were developed in close cooperation with leading Russian medical experts. The device provides continuous monitoring of gas exchange and evaluation of metabolic needs and has mode of intellectual adaptive ventilation. MV200 provides invasive mandatory and assisted as well as non-invasive ventilation.

Friendly, intuitive interface allows using the device by medical personnel of different qualification.

Extended respiratory monitoring

- SI – stress index.
- P0.1 – respiratory effort index.
- Wspont – work of the patient's breathing.
- Rexp – resistance to exhalation.
- Cdyn – dynamic compliance.

Integrated functions

- Alveolar recruitment maneuver – short-term PEEP increasing to the set level.
- Leak compensation – full automatic leakage compensation in the circuit (if leak is too high and cannot be compensated, disconnection alarm is triggered).
- Tube resistance compensation – providing the airway pressure taking into account the resistance of the intubation tube.
- 100% oxygenation.
- Standby mode.
- Suction maneuver.
- Manual breath (manual ventilation).
- "Freezing" / analysis of graphs.
- Screen lock.
- Nebulizer.
- Mode of the deepen sigh.

Trends

Saving and viewing of trends of the main monitoring parameters during 240 hours.

12 ventilation modes

MV200 provides a wide range of mandatory and assisted modes of invasive ventilation.

Mandatory ventilation: CMV/VCV, CMV/PCV, PCV-VG.
Synchronized intermittent mandatory ventilation: SIMV/VC, SIMV/PC, SIMV/DC.
Modes of spontaneous breathing: CPAP, BiSTEP, APRV.
Non-invasive ventilation: NIV.
Intelligent ventilation: iSV.
Apnea backup.

Advanced patient monitoring

- Mainstream CO_2.
- Volumetric CO_2.
- Evaluation of patients metabolic needs.
- Auxiliary pressure.
- SpO_2.
- Respiratory mechanics.
- Cardiac output by Fick method.

Built-in turbine

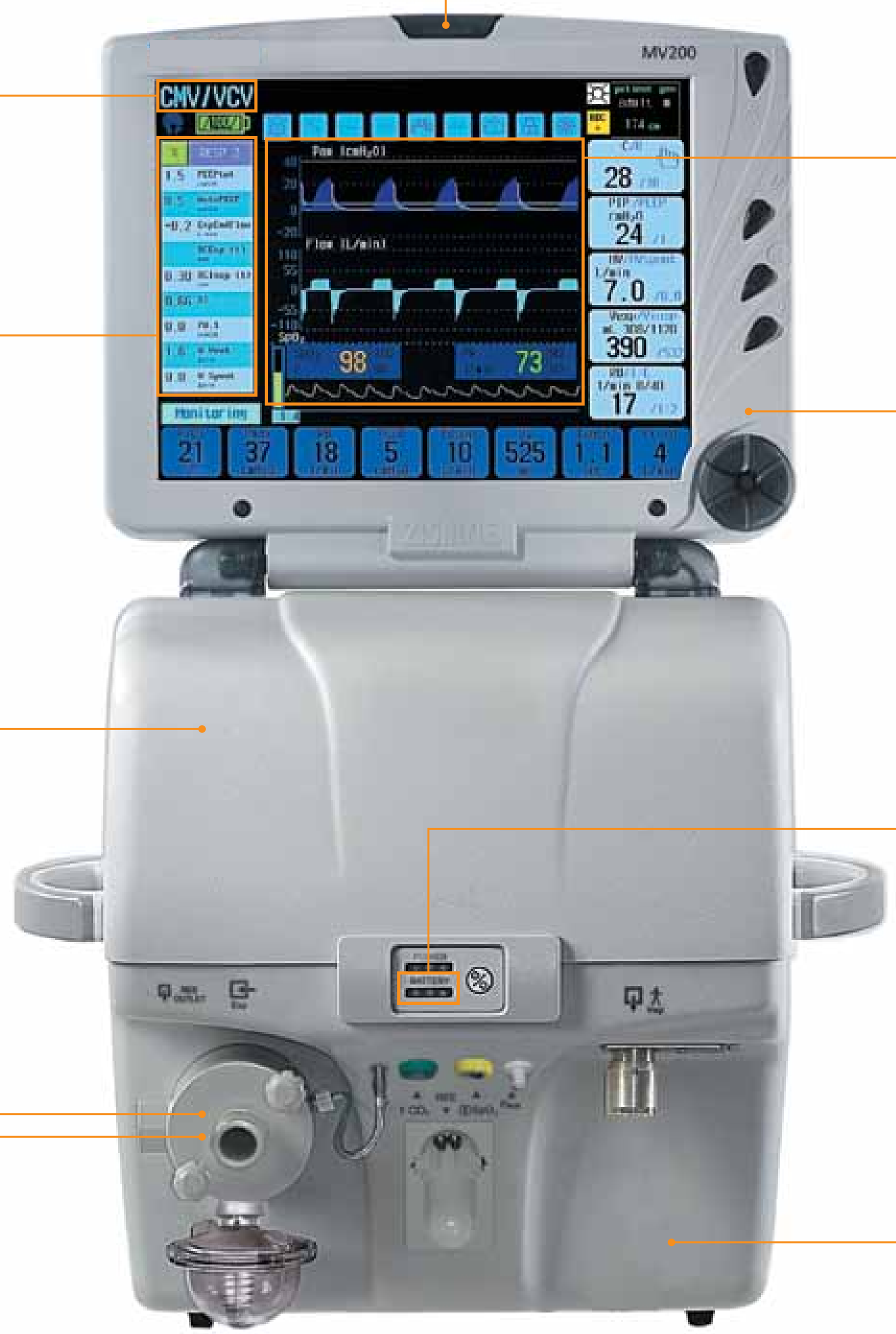
MV200 is independent from compressed air sources due to built-in turbine. Its unique design does not require special maintenance and ensures the operation of the device for 10 years or 40 000 hours.

Reliable autoclavable exhalation valve

MV200 is equipped with exhalation valve, which can be easily disconnected from the device and processed in autoclave. Number of sterilization cycles is unlimited.

Integrated exhalation flow sensor

Does not require any maintenance during the life time.



Alarm with viewing angle of 360°.

Simultaneous display of up to three curves and up to two loops at the user's choice.

Graphs:
P_{aw} (pressure), Flow (flow), Vol (volume).

Loops:
volume/flow V-F, volume/pressure V-P, flow/pressure F-P, V/P_{aux}, with reference loops.

Advanced graphs:
PCO_2 (in mmHg or %), PO_2 (oxigram in %), SpO_2, iSV, VCO_2 (volume capnogram), P_{aux}.

12.1" full-color touch LCD display allowing to adjust the viewing angle. Display can be fully folded for easy transportation.

Up to 6 h back-up battery

Prolonged operation without mains power ensures high level of patient safety. The rechargeable battery allows doctor to continue ventilation in desired mode up to 6 hours.

Operation of the device is guaranteed from any sources of compressed oxygen:

central O_2 pipeline, cylinders, oxygen concentrator even with very low O_2 pressure less than 0.5 bar.

Intelligent Support Ventilation – iSV mode

The intelligent support ventilation (iSV) mode provides the target volume of minute ventilation at any level of patient's spontaneous respiratory activity. iSV automatically adjusts the support pressure level in each respiratory cycle, depending on the changes in the parameters of the bronchopulmonary system. The parameters of iSV are determined extremely simply – by the patient's height and gender.

Advantages of adaptive ventilation iSV:

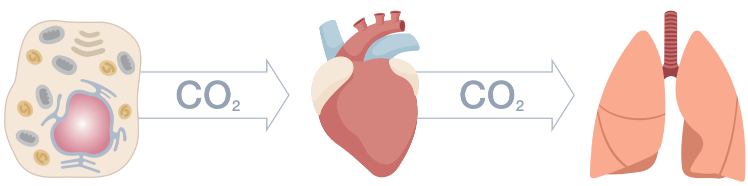
- automatically adjusts the I:E ratio in real time in accordance with the respiratory mechanics of the patient;
- prevents AutoPEEP and protects the patient;
- automatically calculates the static and dynamic limits of safe ventilation for V_t, RB and I:E, ensures strict compliance of ventilation parameters with specified limits.

The adaptive ventilation mode does not exclude the participation of a doctor in the adjustment of the ventilation parameters, but significantly simplifies his work and minimizes the optimization time of the ventilation parameters.

The mode is optimal for rapidly changing respiratory needs of the patient, e.g. during weaning from the ventilator.

Capnometry and volumetric capnometry (VCO_2 + $ETCO_2$)

Measurement and graphical display of CO_2 concentration in exhaled gas has become standard practice in anesthesiology and resuscitation. Capnography reflects the ventilation adequacy, gas exchange, elimination of CO_2 and the cardiac output.



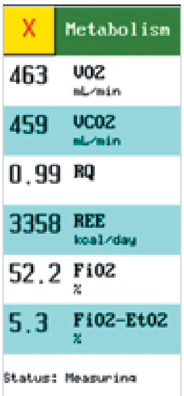
This monitoring method is recommended for use in intensive care units and operating rooms to improve patient safety.

Capnography allows to assess the endotracheal tube location, the resuscitation effectiveness. This type of monitoring is necessary for patients with increased intracranial pressure.

Volumetric capnometry has additional capabilities:

- allows to assess the alveolar ventilation;
- tracks the change in physiological dead space at the artificial ventilation.

Evaluation of patient‘s metabolic needs



The peculiarity of patients in intensive care and resuscitation units is metabolic instability caused by the severity of the condition, artificial lung ventilation, sedation, analgesia and extracorporeal detoxification methods. Therefore, metabolic monitoring for such patients is of great importance.

The method of indirect calorimetry used in the MV200 is considered the “gold standard” of metabolic monitoring. In addition to directly measuring the actual resting energy expenditure (REE), this method calculates the respiratory quotient (RQ) – the ratio of carbon dioxide release rate to oxygen consumption rate and assess the contribution of each macronutrient to the total metabolism.

The built-in metabolic module is convenient and easy to use because requires minimal user effort.

The principle of the metabolic needs evaluation is based on measuring the volume of carbon dioxide released, the volume of oxygen absorbed and the subsequent calculation of energy costs using the Weir equation.

Experience has shown that the individualized program of nutritional support for 3–4 days of treatment in ICU using the metabolic module significantly reduces:

- frequency of nosocomial infections;
- consumption of antibacterial drugs;
- duration of artificial ventilation.

Parameters	Empirical nutritional support (n = 36)	Nutritional support using metabolic module (n = 74)
Frequency of pneumonia	28%	6.76%
Frequency of pressure sores	25%	10.8%

(N. Sh. Gajieva – Candidate of Medical Sciences, Neuroresuscitator; I. N. Leiderman – MD, Professor; A. A. Belkin – MD, Professor. Intensive Therapy, 2008)

Metabolic monitoring is used in programmes of early and resuscitation rehabilitation of patients. Its use makes it possible to shorten the time of rehabilitation and minimize complications after suffering strokes, spinal cord injuries, brain injuries, muscular dystrophies, etc.

Deficiency of calories in critical states can cause:

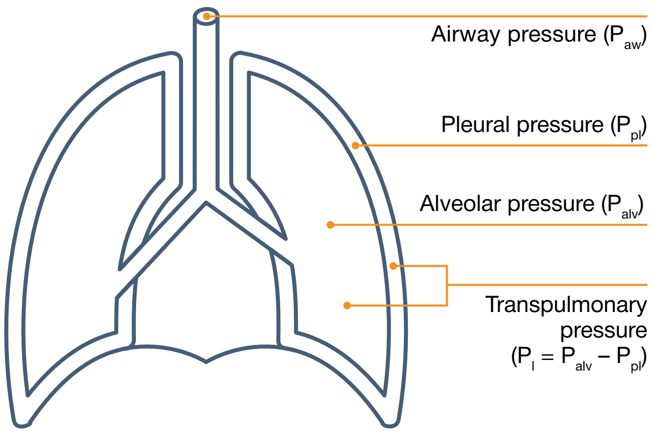
- postoperative wound suppuration, failure of anastomoses;
- dysfunction of the respiratory musculature and diaphragm;
- hospital-acquired infections (tracheobronchitis, VAP, etc.);
- high consumption of antibiotics;
- greater consumption of blood components (FFP, albumin);
- pressure sores, anemia;
- prolonged bed rest in ICU and inpatient department.

Excess calories in critical states lead to:

- hyperglycemia;
- growth of CO_2 production;
- desynchronization with the ventilator;
- hyperthermia;
- aggravation of ALI/ARDS;
- fatty hepatosis.

Auxiliary pressure P_{aux}

Chest pressure scheme



An auxiliary pressure channel allows to the health practitioner to obtain valuable practical information. The doctor can measure the pressure directly in the trachea and esophagus. The pressure in esophagus is equal to the intrapleural pressure.

Among the main principles of protective artificial lung ventilation the PEEP is considered to be an important component for the prevention of atelectotrauma.

P transpulmonary = P alveolar – P pleural.

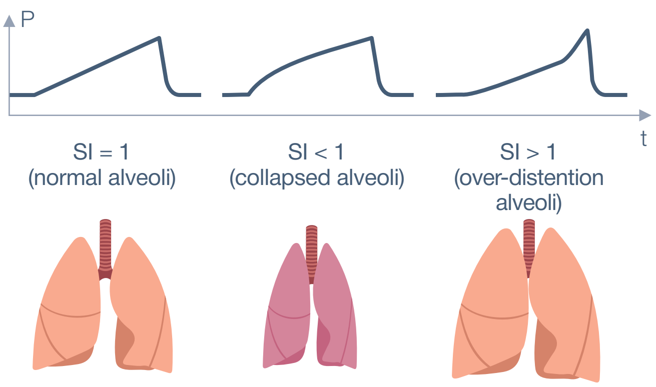
Transpulmonary pressure is the only objective criterion for setting up PEEP. Its monitoring allows reducing or eliminating lung injuries during the ventilation.

Advanced Respiratory Monitoring

Advanced respiratory monitoring allows to set comfortable and safe ventilation parameters in accordance with the respiratory needs of the patient.

Advanced respiratory monitoring includes:

Stress index is an indicator of the correct choice of PEEP and the inspiration volume V_t. Its deviation from “1” shows non-optimal choice of ventilation parameters.

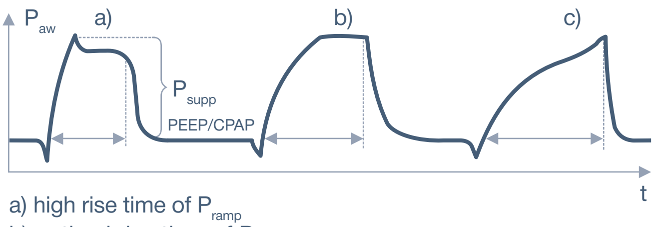


RSBI (rapid shallow breathing index) indicates the adequacy of spontaneous ventilation under pressure support (CPAP with PS) and is used to assess patient‘s readiness for weaning from respiratory support.

AutoPEEP monitoring. In some cases, the selection of parameters for effective and safe ventilation without AutoPEEP monitoring is not possible, e.g. for patients with bronchial obstruction and an increased time constant.

P_{ramp} – rate of inspiratory pressure rise. Setting up P_{ramp} allows adapting the device to the respiratory needs of the patient.

Influence of P_{ramp} to the inspiration pressure waveform



a) high rise time of P_{ramp}
b) optimal rise time of P_{ramp}
c) low rise time of P_{ramp}

Technical Specification

Power: AC 100–250 V, 50/60 Hz. Built-in battery provides from 4 h of independent operation.
Input oxygen pressure: 0.15–0.6 MPa (1.5–6 bar). It is allowed to use low-pressure oxygen sources with operating pressure range: 0.05–0.15 MPa (0.5–1.5 bar).

Operation from a low pressure oxygen sources (optional): 0–0.005 MPa (0–0.05 bar).
Active expiration valve ensures free breathing of the patient during mandatory breaths. Sensitivity: ± 0.2 cmH_2O (mbar).
Maximum (peak) flow on inspiration: 180 lpm.

Ventilation parameters

Tidal volume, V_t	10–3000 ml
Minute volume, MV	0–60 lpm
Rate of breathing, RB	1–120 1/min
Frequency of mandatory breaths at SIMV, RB	1–60 1/min
Form of gas flow in volume-controlled modes, FormFlow	Rectangular, decreasing
I:E ratio	1:99–60:1
Plateau time, T_{plat}	0–5 sec 0–70% from inspiratory time
Support pressure of spontaneous breath, PS	0–80 cmH_2O (mbar)
Positive end-expiratory pressure, PEEP	0–50 cmH_2O (mbar)
Inspiratory pressure, P_i	0–100 cmH_2O (mbar)
Inspiratory time, T_{insp}	0.2–10.0 sec
Trigger window, TrigWnd	0–100% (0.5–4 sec)
Flow trigger sensitivity, F_{trig}	0.5–20 lpm
Criterion of spontaneous inspiration volume exceeding of 25 ml	Available
Pressure trigger sensitivity, P_{trig}	0.5–20 cmH_2O (mbar)
Expiration trigger sensitivity, ETS	5–80%
Fractional concentration of inspired oxygen, FiO_2	21–100%
Rate of the pressure rise (inspiration pressure increase phase), P_{ramp}	5–200 cmH_2O/sec
Flow acceleration, F_{acc}	10–100%
Maximum acceptable inspiratory pressure, P_{max}	105 cmH_2O (mbar)
Support flow (base flow), F_{supp}	0–30 lpm
Factor of increasing/decreasing of target MV in the iSV mode, % MV	25–300%
Function of MV adaptation it the iSV mode, Adapt.MV	Available
Limiting pressure in the breathing circuit in iSV mode, P_{limit}	0–72 cmH_2O (mbar)
Minimum support pressure of spontaneous breaths, P_{min}	3–50 cmH_2O (mbar)
Endotracheal tube compensation, ETC	0–100%
Apnea time, T_{apnea}	10–60 sec

Alarms

High, medium and low priority alarms: disconnection, apnea, occlusion, low/high V_{exp}, low/high minute volume, low PEEP, low PIP, low/high O_2 concentration, maximum pressure is reached, low/high RB, low/high input O_2 pressure, no mains voltage, low/high $EtCO_2$ (option), low pulse signal (option), low/high SpO_2 (option), low/high PR (option).
Diagnostic messages at technical malfunctions of the device.
Log of alarms and events (up to 1000 messages).

Interfaces

Ethernet for connection to PC, USB.

Digital monitoring

Peak inspiratory pressure	PIP
Mean pressure for the respiratory cycle	P_m
Positive end-expiratory pressure	PEEP
Residual pressure level in lungs	AutoPEEP
Minute volume of breathing	MV
Minute volume of spontaneous breaths	MV_{spont}
Expiratory volume	V_{exp}
Inspiratory volume	V_{insp}
Respiratory rate	RB
Inspiratory:expiratory ratio	I:E
Fractional concentration of inspired oxygen	FiO_2
Oxygen consumption (option)	dO_2
Frequency of spontaneous breaths	f_{spont}
Leakage flow from the breathing circuit	Leak
Static compliance	C_{st}
Static resistance	R_{st}
Dynamic compliance/resistance	C, R (LSF)
Concentration (partial pressure) of CO_2 in the inhaled and exhaled gas mixture (option)	$FiCO_2$, $EtCO_2$
Oxygen saturation of arterial blood hemoglobin (option)	SpO_2
Plateau pressure	P_{plat}
Peak inspiratory flow	FlowPeak
Elimination of CO_2 per minute (option)	VCO_2
Minute alveolar ventilation, alveolar ventilation (option)	MV_{alv}, V_{alv}
Functional dead space (option)	V_d
Cardiac output according to Fick (option)	CB
Auxiliary external pressure (option)	P_{aux}
Transpulmonary pressure (option)	P_{tp}
True pressure level in lungs at the end of expiration	$PEEP_{tot}$
Flow at the end of expiration	ExpEndFlow
Expiratory time constant	RC_{exp}
Inspiratory time constant	RC_{insp}
Stress index	SI
Respiratory effort index	P0.1
Work of the patient breathing	W_{spont}
Work of the ventilator breathing	W_{vent}
Inspiratory time (including spontaneous)	T_{insp}
Factor of breathing cycle filling	T_{insp}/T_{tot}
Factor of spontaneous breathing	MVe_sp/MVe
Resistance to the exhalation	R_{exp}
Elasticity of respiratory ways (elastence)	E
Resistance of the breathing circuit	R_{circ}
Compliance of the breathing circuit	C_{circ}
Compliance of lungs	C_{dyn}
Rapid shallow breathing index	RSBI

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