Low-Resistant Stabilized Mini-Vaporizers IN and OUT of the Breathing Circuits

(manuscript 2010)

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A number of inhalation anesthesia problems (sophisticated and bulky equipment, non-stability of the well-known draw-over vaporizers and delayed change of anesthetic concentration during low- or mini-flow anesthesia) may be solved by using a more advanced vaporizer that would be accurate as a plenum vaporizer, simple and low-resistant as a draw-over one **[1-3, 5]**.

Due to the low resistance and virtual independence from fresh gas flow rate, temperature, and ambient pressure, MINIVAP vaporizers **(Fig. 1)** are instantly adaptable to needs of both on-site emergency surgery and more sophisticated demands of a general hospital.

Fig. 1

Fig. 2

A modular format of the MINIVAP Anesthesia Kit give an opportunity of the user to custom-build an anesthetic system (from draw-over to semi-closed) optimally suited to the prevailing situation.

Field conditions

The MINIVAP Anesthesia Kit may be used in military surgery, urgent situations and remote areas, at district hospitals, and in veterinary anesthesia (at spontaneous breath and artificial respiration with air or oxygen, including Oxygen Concentrator; with CO_2 absorber).

The simplest modification (**Fig. 2**) is the pocket vaporizer MINIVAP-20 (MV-20, mass less 0.5 kg) that can be connected directly to a facemask or a tracheal tube by means of a non-rebreathing valve. MV-20 may be used with self-inflating (Ambu) bag or any ventilator (**Fig. 3**) and in semi-closed systems during mini- or low-flow anesthesia (**Fig. 4**).

Hospital conditions

At hospital conditions MINIVAP vaporizers may be used OUT of a breathing circuit (VOC) instead of any other plenum vaporizer (**Fig. 5**) at fresh gas flow from **0.2**! to 10 l/min.

Fig. 3

Fig. 4

One may be installed IN a breathing circuit (VIC) of any anesthesia machine (**Fig. 6**). There is instant change of inspired concentration $\mathbf{C_I}$ (**Fig. 7**) that will be much higher than the scale one $\mathbf{C_S}$ at high ratio of minute ventilation **MV** to fresh gas flow $\mathbf{F_G}$ **[2 - 3]:** $\mathbf{C_I \approx C_S}$ **MV/**$\mathbf{F_G}$.

There is opportunity of switching over IN to OUT position of MV-20 with the special valve.

The concentration delivered by MV-20 vaporizers is virtually independent of flow rate (continuous and intermittent), temperature, pressure and positions (vertical and overturned).

There is a minimum anesthetic wick waste after drainage: 3 ml of the MV-20 compared with 60 ml of the popular analogs.

Consumption of liquid anesthetic by MINIVAP vaporizer at high fresh gas flow (6 L/min) is about 20 ml/hour; while during mini- or low-flow anesthesia (0.5-1 L/min) it does not exceed 5-10 ml/hour, and in a closed system it is about 1-3 ml during 1-5 hours.

Fig. 5

Fig. 6

"MINIVAP" vaporizers have been successfully tested in 3 leading Moscow hospitals (more than 100 operations of adults and children 2-14 years) with different anesthesia machines (Drager Primus, STEPHAN Artec, Datex-Ohmeda S/5 Avance, Ru PMT Xena-010).

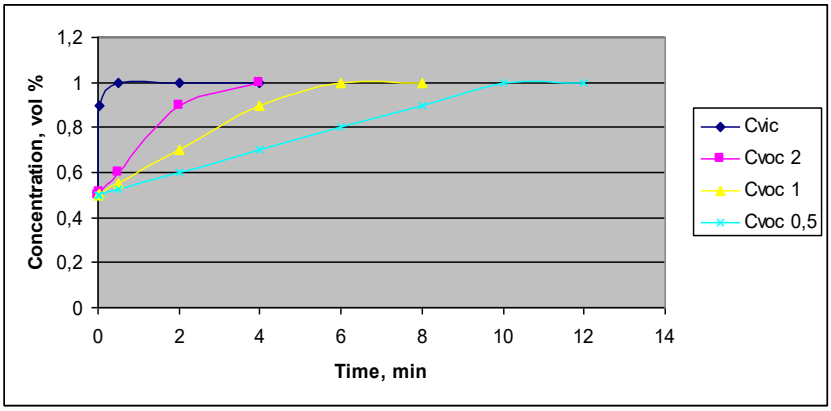

Fig. 7. Time of inspire anesthetic concentration change (delay) from 0,5 to 1 vol % in semi-closed circles after alteration of the vaporizer setting ("patient" – bag or bellow)
C_{VIC} – inspired concentration with VIC (MINIVAP-20, MV = 5 L/min, V_T = 0.4 L); **$C_{VOC\ 2}$, $C_{VOC\ 1}$, $C_{VOC\ 0,5}$** - inspired concentrations with VOC (V_C = 5 L, F_G = 2; 1 and 0,5 L/min accordingly).

Table

Novel Low-Resistance Vaporizers and its Plenum and Draw-Over Analogs

Parameters	**Vapor 2000** Drager Germany	**Delta** Penlon UK	**OMV**	**MV-100** "MINIVAP" Ltd. Russia	**MV-20**
Gas flow range, L/min	0,25 – 15	0,2–15	3-15	0,2-15	0,2-10
Temperature range, °C	10 – 40	15– 35	18-22	5 - 35	
Atmospheric pressure, kPa	100 ± 5	100 ± 5		70 - 110	
Anesthetic volume, mL	360	250	50	150	40
Wick volume (waste), mL	60	60	10	5	3
Pressure drop at 10 L/min, mm H_2O	1100	1000	10	≈100	≈10
Angle of tilt, degrees	30	10	30	90	180
Weight, kg	6,5 – 8,5	5,7	2	1,5	<0,5

Current state

Vaporizer & Anesthesia Machine Certificates RU № FSR 2010/06696 from 01.02.2010 (indefinite) and №0126447 from 04.03.2010 up to 03.03.2013 (were received together with RU manufacture company "MITC-M" Ltd).

50 items were manufactured together with RU companions "MITC-M" and "AMNTC "UNION" this year, next year – about 400 items.

Anesthetic concentration ranges of manufacture samples are from 0 to 4 % vol. Sevoflurane concentration range of new experimental samples MV-20 and MINIVAP-100 (MV-100 is developed together with "UOMZ" plant) is from 0 to 8 % vol.

References

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