Automated versus physician-directed weaning from mechanical ventilation after off-pump coronary artery bypass grafting

Fot EV, Izotova NN, Yudina AS, Smetkin AA, Kuzkov VV, Kirov MY

Department of Anaesthesiology and Intensive Care Medicine, Northern State Medical University, Arkhangelsk, Russian Federation

Background & Goal

The process of weaning from mechanical ventilation in the postoperative period may take a long time and involves intensive work by the healthcare team. The goal of our study was to assess the efficacy and safety of automated weaning from mechanical ventilation after off-pump coronary artery bypass grafting (OPCAB).

Methods

During year 2015, 40 adult patients undergoing elective OPCAB were enrolled into a prospective study. The study design and the informed consent form were approved by the Ethical Committee of the Northern State Medical University (Arkhangelsk, Russian Federation). Exclusion criteria were: age < 18 and > 80 years and morbid obesity with body mass index (BMI) > 40 kg/m². For respiratory support in the Intensive Care Unit (ICU) we used a G-5 ventilator (Hamilton Medical, Switzerland). Patients were randomised into two groups: automated weaning (*n* = 20) using Adaptive Support Ventilation (INTELLiVENT®-ASV mode) with quick-wean option and physician-directed weaning (*n* = 20) using conventional Synchronized Intermittent Mandatory Ventilation (SIMV) + Pressure Support (PS) mode. The inspiratory pressure, respiratory rate, and inspired oxygen fraction (FiO₂) were adjusted to maintain tidal volume 6–8 mL/kg of predicted body weight, EtCO₂ 35–40 mm Hg, and SpO₂ ≥ 94%, respectively. In the INTELLiVENT®-ASV group the weaning processes as well as spontaneous breathing trial (SBT) were performed automatically. In the SIMV+PS group, we decreased inspiratory pressure by 2–4 cm H₂O and mandatory respiratory rate by 2–4/min every 30 minutes. In both groups, patients were extubated immediately after successful SBT. The patients were monitored with ECG, invasive arterial pressure, cardiac index (CI) and blood gases. All these parameters were registered after transfer to the ICU, as well as after SBT and at 2, 6, 12, and 18 hrs after extubation. After extubation, all the values were measured without supplemental oxygen (FiO₂ 0.21). In addition, we assessed the duration and incidence of unacceptable respiratory support that was defined as a tidal volume greater than 12 or smaller than 6 ml/kg PBW, Pplateau above 35 cm H₂O, EtCO₂ below 25 or above 50 mm Hg, and SpO₂ below 90% for a minimum of 30 sec.

Table 1. Key clinical characteristics of the patients.			
Characteristics	Automated weaning (<i>n</i> =20)	Physician-directed weaning (<i>n</i> =20)	<i>p</i>
Age, years	63 (54–70)	60 (55–71)	NS
BMI, kg/m ²	30 (28–33)	29 (27–31)	NS
EuroScore II, points	1.24 (0.75–1.56)	1.15 (0.81–1.60)	NS
EF before surgery, %	60 (53–64)	57 (47–66)	NS
Duration of surgery, min	218 (178–260)	205 (155–160)	NS

Data are presented as median (25th–75th percentile). BMI, body mass index; EF, ejection fraction; NS — non-significant.

Table 2. The changes of the studied parameters during weaning and after extubation.			
Characteristics	Automated weaning (<i>n</i> = 20)	Physician-directed weaning (<i>n</i> = 20)	<i>p</i>
PaO ₂ /FiO ₂ after SBT, mm Hg	324 (246–356)	338 (281–353)	NS
PaO ₂ /FiO ₂ 2 hrs after extubation, mm Hg	318 (305–354)	346 (309–385)	NS
PaO ₂ /FiO ₂ 12 hrs after extubation, mm Hg	314 (276–350)	324 (290–362)	NS
PaCO ₂ after SBT, mm Hg	38 (37–42)	36 (32–40)	NS
PaCO ₂ 2 hrs after extubation, mm Hg	39 (35–39)	37 (34–38)	NS
PaCO ₂ 12 hrs after extubation, mm Hg	37 (35–39)	35 (32–39)	NS
MAP after SBT, mm Hg	86 (80–95)	95 (83–104)	NS
MAP 2 hrs after extubation, mm Hg	87 (78–96)	90 (81–94)	NS
MAP 12 hrs after extubation, mm Hg	78 (70–91)	80 (70–87)	NS
Heart rate after SBT, 1/min	75 (70–90)	77 (69–84)	NS
Heart rate 2 hrs after extubation, 1/min	82 (74–91)	76 (70–88)	NS
Heart rate 12 hrs after extubation, 1/min	77 (71–83)	73 (67–83)	NS

Data are presented as median (25th–75th percentile). SBT, spontaneous breathing trial; MAP, mean arterial pressure. NS, non significant.

* — Mann–Whitney test, *p* < 0.05.

* — Mann–Whitney test, *p* < 0.017.

* — Mann–Whitney test, *p* < 0.05; RS, respiratory support.

Additionally, we performed the retrospective analyses of 135 patients (standard weaning), who underwent OPCAB and matched all inclusion and exclusion criteria. For respiratory support of these patients the ICU staff also used conventional SIMV+PS mode, but decision to decrease inspiratory pressure and mandatory respiratory rate, as well as conduction of SBT were made without any protocol. Data are presented as median (25th–75th percentiles) and analyzed using Mann–Whitney *U*-test or χ^2 -test where appropriate.

Results & Discussion

Key demographic and preoperative characteristics of the patients are presented in Table 1. Haemodynamics and gas exchange during the study did not differ between two groups (Table 2). The automated weaning protocol required adjustment of the respiratory settings only in two patients vs. 6 per patient in the physician-directed weaning group (*p* < .05). The FiO₂ during SBT was significantly lower in the automated weaning group: 30 (30–35)% vs. 40 (40–45)% in the physician-directed weaning group (*p* < 0.01) (Figure 1). The average time until tracheal extubation did not differ in the automated weaning and the physician-directed weaning groups, but was significantly longer in the standard weaning group (Figure 2). Both the duration and incidence of unacceptable respiratory support were reduced by means of the automated weaning approach (Figure 3). Length of the ICU stay did not differ between the groups. All patients were successfully weaned from ventilator and survived Day 28 of the study.

Conclusions

Automated weaning from mechanical ventilation after OPCAB is safe, reduces the load on medical staff and does not prolong the duration of ventilation.

Acknowledgements

We thank the personnel of the Cardiosurgical ICU., Municipal Hospital #1 of Arkhangelsk.

Corresponding author:
Eugenia V. Fot, MD
E-mail: ev_fot@mail.ru