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ORIGINAL

Effect of FiO_2 in the measurement of VO_2 and VCO_2 using the E-COXV metabolic monitor☆

M. Ferreruela, J.M. Raurich*, J.A. Llompart-Pou, A. Colomar, I. Ayestarán

Servei de Medicina Intensiva, Hospital Universitari Son Espases, Palma de Mallorca, Spain

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KEYWORDS
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Reproducibility of results

Abstract
Objective: We evaluated the effect of changes in FiO_2 on the bias and accuracy of the determination of oxygen consumption ($\dot{V}O_2$) and carbon dioxide production ($\dot{V}CO_2$) using the E-COVX monitor in patients with mechanical ventilation.
Design: Descriptive of concordance.
Setting: Intensive Care Unit.
Patients or participants: Patients with mechanical ventilation.
Interventions: We measured $\dot{V}O_2$ and $\dot{V}CO_2$ using the E-COVX monitor. Values recorded were the average in 5 min. Two groups of 30 patients. We analyzed: 1) the reproducibility in the measurement of $\dot{V}O_2$ and $\dot{V}CO_2$ at FiO_2 0.4, and 2) the effect of the changes in FiO_2 on the measurement of $\dot{V}O_2$ and $\dot{V}CO_2$. Statistical analysis was performed using Bland and Altman test.
Variables of main interest: Bias and accuracy.
Results: 1) FiO_2 0.4 reproducibility: The bias in the measurement of $\dot{V}O_2$ and $\dot{V}CO_2$ was 1.6 and 2.1 mL/min, respectively, and accuracy was 9.7 to −8.3% and 7.2 to −5.2%, respectively, and 2) effect of FiO_2 on $\dot{V}O_2$: The bias of $\dot{V}O_2$ measured at FiO_2 0.4 and 0.6 was −4.0 mL/min and FiO_2 0.4 and 0.8 was 5.2 mL/min. Accuracy between FiO_2 0.4 and 0.6 was 11.9 to −14.1%, and between FiO_2 0.4 and 0.8 was 43.9 to −39.7%.
Conclusions: The E-COVX monitor evaluates $\dot{V}O_2$ and $\dot{V}CO_2$ in critical patients with mechanical ventilation with a clinically acceptable accuracy until FiO_2 0.6.

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* Corresponding author.
E-mail address: joan.raurich@ssib.es (J.M. Raurich).

PALABRAS CLAVE
Consumo de oxígeno;
Dióxido de carbono;
Intercambio pulmonar de gases;
Ventilación mecánica;
Paciente crítico;
Reproducibilidad de resultados

Efecto de la FiO_2 sobre la medición del VO_2 y la VCO_2 con el monitor metabólico E-COVX

Resumen

Objetivo: Valorar el efecto de la FiO_2 sobre el sesgo y la precisión en la medición del consumo de oxígeno (VO_2) y la producción de dióxido de carbono (VCO_2) con el monitor E-COVX en pacientes con ventilación mecánica.

Diseño: Descriptivo de concordancia.

Ámbito: Unidad de Cuidados Intensivos.

Pacientes o participantes: Pacientes con ventilación mecánica.

Intervenciones: Se midieron el VO_2 y la VCO_2 con el monitor E-COVX. Los valores de VO_2 y VCO_2 fueron el promedio de 5 min. Dos grupos de 30 pacientes. Se analizó: 1) la reproducibilidad de la medición del VO_2 y la VCO_2 con una FiO_2 de 0,4, y 2) el efecto de los cambios en la FiO_2 sobre el VO_2 y la VCO_2. Análisis estadístico por el método de Bland y Altman.

Variables de interés principales: Sesgo y precisión.

Resultados: 1) Reproducibilidad a una FiO_2 de 0,4: los sesgos en la medición del VO_2 y la VCO_2 fueron de 1,6 y 2,1 mL/min, respectivamente, y los errores en la precisión fueron de 9,7 a −8,3% y de 7,2 a −5,2%, respectivamente, y 2) efecto de la FiO_2 sobre el VO_2: el sesgo del VO_2 medido a una FiO_2 de 0,4 y 0,6 fue de −4,0 mL/min y a FiO_2 de 0,4 y 0,8, de 5,2 mL/min. La precisión entre FiO_2 de 0,4 y 0,6 fue de 11,9 a −14,1%, y entre FiO_2 de 0,4 y 0,8, de 43,9 a −39,7%.

Conclusiones: El monitor E-COVX mide el VO_2 y la VCO_2 en pacientes críticos con ventilación mecánica con un sesgo y una precisión clínicamente aceptables hasta una FiO_2 de 0,6.

Introduction

The main interest of measuring oxygen consumption (VO_2) and the production of carbon dioxide (VCO_2) in critical patients subjected to mechanical ventilation (MV) is to calculate energy expenditure by applying the formula of Weir.[1] Recent studies have shown that a calorie supply capable of compensating the losses resulting from energy expenditure shortens the duration of mechanical ventilation, reduces the nosocomial infection rate, facilitates physical recovery and reduces mortality.[2–5] The measurement of VO_2 and VCO_2 also has other applications, however. In effect, the measurement of VO_2 allows us to assess the relationship between oxygen transport and VO_2[6] or determine the respiratory effort of a given ventilatory mode with respect to some other mode.[7] The measurement of VCO_2 in turn allows us to measure the physiological dead space.[8]

However, the precise measurement of VO_2 and VCO_2 in the critical patient subjected to mechanical ventilation poses a series of problems including the need for a fraction of inspired oxygen (FiO_2) above that of room air, particularly in the acute phase of the disease; airway gas leakage due to the positive pressure of the ventilator; and the presence of water vapor in the expired gas.[1,9–11] Of these problems, FiO_2 is the most important, since error in the measurement of the concentrations of inspired and expired oxygen in order to determine VO_2 is amplified when FiO_2 is incremented.[12]

The measurement of respiratory gas exchange in patients under mechanical ventilation has been facilitated by the development of automated systems capable of measuring VO_2 and VCO_2 on a breath-to-breath basis. In this regard, some studies have reported that the M-COVX and E-COVX monitors can be used in patients subjected to mechanical ventilation and with a need for high FiO_2 (<0.85), with an error acceptable to clinical practice.[13–15]

The present study was carried out to evaluate the effect of FiO_2 upon precision in the measurement of VO_2 and VCO_2 using the E-COVX metabolic monitor in critical patients subjected to mechanical ventilation.

Material and methods

Patients

The study included patients admitted to the Intensive Care Unit (ICU), intubated and subjected to mechanical ventilation, who were receiving sedatives (midazolam or propofol) and/or analgesics (morphine or fentanyl) in continuous perfusion. Measurements were made of VO_2 and VCO_2, with the calculation of resting energy expenditure (REE). The study was carried out in the morning, with the patient under resting conditions, the headrest raised 30 degrees, and after two or more days of mechanical ventilation. All the patients were ventilated in volume control mode with $FiO_2 \leq 0.4$. Before indirect calorimetry measurement, we checked the pressure of the balloon of the endotracheal tube and the absence of air leakage. Indirect calorimetry measurement was carried out during the administration of enteral, parenteral or mixed nutrition, with a calorie supply of 15–30 kcal/kg/day. The nutrition was