Validation of a new indirect calorimeter for critically ill children in laboratory setting

Project: 401

Jacques Cotting, PD & MER, Médico-chirurgicaux de Pédiatrie
Centre Hospitalier Universitaire Vaudois CHUV-BH0, 1011 Lausanne

Background: In critically ill patients, energy needs must be carefully assessed in order to avoid both under and over-nutrition that are associated with poor outcomes. The gold standard method for the determination of energy needs is the measurement of energy expenditure by indirect calorimetry. Until recently, the majority of intensive care units have used the Deltatrac II (Datex-Ohmeda, Helsinki, Finland) that has been extensively studied and validated in critically ill adults and children. Nevertheless, this device has not been manufactured anymore and a new calorimeter must be validated for measurements in patients on mechanical ventilation. The aim of this study was to evaluate the accuracy of the M-COVX (Datex-Ohmeda, Finland) using a ventilated lung model that simulates paediatric conditions and to compare the results with the Deltatrac II.
Methods: The simulation of oxygen consumption (VO2) and carbon dioxide production (VCO2) was achieved by the burning of ethanol. Based on the stœchiometric equation of pure ethanol (high grade purity, 99.97%), a respiratory quotient of 0.66 must be measured by the indirect calorimeter. We used a lung test, integrated between the burning kit and the ventilator in a closed circuit, to collect gas exchange in respiratory mode. In order to assess the range of energy expenditure values in children, we used a syringe pump of high precision (Hamilton TLL, Model 1011) to inject the ethanol in the burning kit at chosen rate. The values measured by the M-COVX were compared with theoretical values expected according to the stoechiometric equation of ethanol and with the values measured by the Deltatrac II. Measurements were performed with a rate flow of ethanol of 2.5, 3 and 3.5 ml/h, corresponding to 319, 382 and 446 kcal/d. We performed the same measurement at different FiO2: 0.25 and 0.4. Each series of measurement lasted 40 minutes.
Results: The measurements by the M-COVX of VO2 and VCO2 performed at 3 different flows of ethanol of 2.5, 3.0 and 3.5 ml/hr and a FiO2 of 25% and 40% showed differences ranging between 20 and 40% with the theoretical values and the values measured by Deltatrac II. These differences reached statistical significance. In consequence, the measurements of energy expenditure by M-COVX, showed a difference with theoretical values ranging between 28% and 39% except for measurements performed at a rate of 3.5 ml/h and a FIO2 of 25% for which the difference was 15%. Energy expenditure measurements performed with the M-COVX, with a 40% FiO2 rate, were systematically lower than those performed with a 25% FIO2 rate. In contrast, Deltatrac II values of energy expenditure were systematically higher in the same conditions.
Conclusion: We evaluated the accuracy of the M-COVX, using a ventilated lung model that simulates paediatric conditions (newborn to 10 kg child). The measurements of VO2 and VCO2 performed with the M-COVX were systematically lower than expected and the biases deteriorated for the lower flow rate of ethanol that mimics newborn and infant. These values showed an important deviation from theoretical values and Deltatrac II values. Therefore, the M-COVX in its current design should not be used for metabolic measurements in newborns and infants, and these results will be used to orient the future activities of the engineers responsible for the development of the M-COVX. This underlines the necessity of careful evaluation of new devices.

Contact: Jacques.cotting@chuv.ch