

Contents

Spontaneously Breathing Subjects 1

Mechanically Ventilated Patients 2

Quark RMR

Spontaneously Breathing Subjects

A Test of Validity of a New Open-Circuit Indirect Calorimeter.

Ashcraft CM, Frankenfield DC. JPEN J Parenter Enteral Nutr. 2014 Mar 10.

BACKGROUND: Indirect calorimetry is an accurate way to measure resting metabolic rate. The Deltatrac Metabolic Monitor is considered a criterion standard but is no longer manufactured. New-generation indirect calorimeters have been introduced, but there are limited published validation data comparing these devices to criterion instruments.

METHODOLOGY: A prospective, observational, N-of-1 trial was conducted to validate a new-generation indirect calorimeter against a gold standard device. This design was chosen to minimize and define the degree of biological variation, thus focusing on variation due to the devices. Measurements of gas exchange using both indirect calorimeters were conducted daily for 10 consecutive days. Another set of measurement pairs was conducted using just the criterion device for 10 days. Ninety-five percent confidence intervals of differences were used to test for bias. Precision was defined as repeat measures with one device falling within 5% of the other at least 90% of the time.

RESULTS: There were no statistically significant differences between the devices for any measured or calculated parameter. Interdevice differences were no larger than intradevice differences using the criterion instrument. The values obtained from the new device were precise and unbiased compared with the values obtained from the gold standard device.

CONCLUSIONS: The new indirect calorimeter measures gas exchange in a reliable and accurate manner compared with a gold standard device. The two devices are equivalent.

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A new indirect calorimeter is accurate and reliable for measuring basal energy expenditure, thermic effect of food and substrate oxidation in obese and healthy subjects

Emilie Blond, Christine Maitrepierre, Sylvie Normand, Monique Sothier, Hubert Roth, Joelle Goudable, Martine Laville. e-SPEN, the European e-Journal of Clinical Nutrition and Metabolism Volume 6, Issue 1, February 2011, Pages e7–e15

PURPOSE: The objectives of the study were to validate accuracy and reliability of the QUARK RMR, an indirect calorimeter versus the DELTATRAC II™, a well-established reference system which is no longer available, in resting and post-prandial conditions.

METHODOLOGY: A crossover, randomized study was performed in 30 subjects for two consecutive days. Resting metabolic rate (RMR) was measured for three 45 min periods using alternating calorimeters. Means of RMR were then compared with Pearson's test and Bland and Altman plot. Thermic effect of food (TEF) and substrate oxidation were assessed for 3 h with each calorimeter, 15 min after meal ingestion, and were compared by longitudinal analysis.

RESULTS: Means at rest of VO₂, VCO₂, RMR and substrate oxidation were not significantly different with both devices. The variability of VO₂, VCO₂ and RMR measurements, at rest, for each device, on two consecutive days, was similar to that measured with QUARK RMR and DELTATRAC II™ the same day, under standardized conditions. Longitudinal analysis of TEF and post-prandial substrate oxidation was equivalent with the two devices.

CONCLUSIONS: The QUARK RMR calorimeter seems to be a valid system to measure energy expenditure in resting and post-prandial conditions in obese and healthy subjects.



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Mechanically Ventilated Patients

Indirect Calorimetry in Mechanically Ventilated Patients: A Prospective, Randomized, Clinical Validation of 2 Devices Against a Gold Standard

Matilde Jo Allingstrup, Jens Kondrup, Anders Perner, Poul Lunau Christensen, Tom Hartvig Jensen, and Steen Winther Henneberg. JPEN J Parenter Enteral Nutr August 3, 2016

BACKGROUND: The 2 currently available indirect calorimeters, CCM Express Indirect Calorimeter (MedGraphics, St Paul, MN) and Quark RMR ICU Indirect Calorimeter (COSMED, Rome, Italy), have not been validated against a gold standard in mechanically ventilated patients. Our aim was to do so using a gold-standard, modified Tissot bell-spirometer method in mechanically ventilated patients who were hemodynamically, respiratory, and metabolically stable.

METHODOLOGY: We studied 30 patients undergoing general anesthesia and major gynecological surgery. We measured oxygen consumption (Formula O₂) and resting energy expenditure (REE) in a randomized, sequential, crossover design with double determination of each device.

RESULTS: Compared with the modified Tissot bell-spirometer, the CCM Express Indirect Calorimeter demonstrated a mean Δ -REE of +361 kcal/d, corresponding to a 31% overestimation of energy requirements. Bland-Altman analysis for REE showed a mean (SD) bias of 384 (124) with limits of agreement 142–627 kcal/d. QUARK RMR ICU demonstrated a mean Δ -REE of 81 kcal/d, corresponding to a 7% overestimation of energy requirements. Bland-Altman plot analysis showed a mean (SD) bias of 77 (167) with limits of agreement –249 to 404 kcal/d.

CONCLUSIONS: The QUARK RMR ICU Indirect Calorimeter compared better with the gold standard for values of Formula O₂ and REE than did the CCM Express Indirect Calorimeter in mechanically ventilated patients who were circulatory and respiratory stable. Both indirect calorimeters had low precision. Although precision and accuracy could be further improved, measurements of REE using the QUARK RMR ICU Indirect Calorimeter may be of value, because the alternative (eg, equations) is likely to be less precise.

Indirect calorimetry in mechanically ventilated patients. A systematic comparison of three instruments.

Sundström M, Tjäder I, Rooyackers O, Wernerman J. Clin Nutr. 2013 Feb;32(1):118-21. doi: 10.1016/j.clnu.2012.06.004. Epub 2012 Jul 3.

BACKGROUND: Indirect calorimetry is the gold standard in determining energy expenditure to dose nutritional therapy for critically ill patients. The most commonly used system for indirect calorimetry in the ICU setting (Deltatrac Metabolic Monitor) is no longer in production. The aim of this study was to compare two new instruments for IC (Quark RMR, CCM Express) to the Deltatrac in mechanically ventilated patients.

METHODOLOGY: Sequential measurements with all three instruments were performed in randomized order on 24 mechanically ventilated ICU patients. Resting energy expenditure (REE), respiratory quotient (RQ), oxygen consumption and carbon dioxide production were recorded during a stable 10–30 min period.

RESULTS: There was no difference in mean REE measurements between Deltatrac, 1749 \pm 389 kcal/24 h and Quark RMR, 1788 \pm 494 kcal/24 h ($P = 0.166$). CCM Express produced 64% higher mean REE values (2876 \pm 656 kcal/24 h) than Deltatrac ($P < 0.0001$). All instruments registered different values for RQ and expiratory minute volume.

CONCLUSIONS: Available instruments for indirect calorimetry give conflicting estimates of energy expenditure in mechanically ventilated patients. Whilst the Quark RMR compares better with the Deltatrac than CCM Express, the mechanisms behind this difference needs to be further explored.

Influence of Ventilatory Settings on Indirect Calorimetry in Mechanically Ventilated Patients

S. Cecchini, E. Schena, R. Cuttone, M. Carassiti, and S. Silvestri. 33rd Annual International Conference of the IEEE EMBS Boston, Massachusetts USA, August 30 - September 3, 2011

PURPOSE: With the aim to assess metabolic monitor's suitability to the use in mechanically ventilated patients, a method, based on the comparison between the measurements performed by the monitor and the ventilator, is here described. In particular, the effects of positive end-expiratory pressure and oxygen inspiratory fraction (FiO₂) on the metabolic measurements in presence of bias flow are investigated.

METHODOLOGY: In this study a metabolic monitor is used to estimate the energy expenditure of 10 mechanically ventilated cardiothoracic patients at different positive end-expiratory pressure, FiO₂ and two different modes of ventilation, with bias flow. The influence of the ventilatory settings on the parameters measured by the monitor is here quantified: a slight decrease of respiratory quotient and a slight increase of resting energy expenditure are observed with the increase of FiO₂.

RESULTS: This study shows a good agreement between the measurements of the two devices: FiO₂, expiratory volume (mean difference lower than 3%), and respiratory frequency (mean difference lower than 1%).

CONCLUSIONS: This also demonstrates the capability of the metabolic monitor to reject the effect of the bias flow.

Uncertainty Evaluation of a Calibration Method for Metabolic Analyzer in Mechanical Ventilation

Cecchini, S. ; Schena, E. ; Di Sabatino Di Diodoro, M.N. ; Silvestri, S. Medical Measurements and Applications Proceedings (MeMeA), 2011 IEEE International Workshop

PURPOSE: A calibration methodology for metabolic analyzer to be used with mechanically ventilated patients is described.

METHODOLOGY: The associated uncertainty is evaluated by means of both standard and Monte Carlo methods, the effects of pulmonary ventilator bias flow are considered. An experimental set-up composed of a burning unit, for the combustion of ethanol, a mechanical ventilator and a test lung has been used to generate respiratory patterns, with known CO₂ production and respiratory quotient. Trials with and without bias flow at different oxygen fractions and positive end expiratory pressure levels have been carried out with two mechanical ventilators.

RESULTS. An average uncertainty of 7% has been estimated for the CO₂ volume produced, whereas an average uncertainty of about 4% for the respiratory quotient has been obtained.

CONCLUSIONS: Furthermore, the results obtained by application of Monte Carlo method are in agreement with standard method of uncertainty evaluation.