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Q-NRG

Mechanically Ventilated Subjects

The clinical evaluation of the new indirect calorimeter developed by the ICALIC project

Oshima T, Delsoglio M, Dupertuis YM, Singer P, De Waele E, Veraar C, Heidegger CP, Wernermann J, Wischmeyer PE, Berger MM, Pichard C. Clin Nutr. 2020 Jan 31. pii: S0261-5614(20)30040-6. [Epub ahead of print]

BACKGROUND & AIMS: The ICALIC project was initiated for developing an accurate, reliable and user friendly indirect calorimeter (IC) and aimed at evaluating its ease of use and the feasibility of the EE measurements in intensive care unit (ICU).

METHODS: This was a prospective unblinded, observational, multi-center study. Simultaneous IC measurements in mechanically ventilated ICU patients were performed using the new IC (Q-NRG®) and currently used devices. Time required to obtain EE was recorded to evaluate the ease of use of Q-NRG® versus currently used ICs and EE measurements were compared. Conventional descriptive statistics were used: data as mean ± SD.

RESULTS: Six centers out of nine completed the required number of patients for the primary analysis. Mean differences in the time needed by Q-NRG® against currently used ICs were 32.3 ± 2.5 min in Geneva (vs. Deltatrac®; p<0.01),32.3±3.1 in Lausanne (vs. QuarkRMR®; p<0.05),33.7±1.4 in Brussels (vs. V-Max Encore®; p < 0.05), 26.4 ± 7.8 in Tel Aviv (vs. Deltatrac®; p < 0.05), 28.5 ± 3.5 in Vienna (vs. Deltatrac®; p < 0.05), and 0.3 ± 1.2 in Chiba (vs. E-COVX®; p ¼ 0.17). EE (kcal/day) measurements by the Q-NRG® were similar to the Deltatrac® in Geneva and Vienna (mean differences ± SD: 63.1 ± 157.8 (p ¼ 0.462) and 22.9 ± 328.2 (¼0.650)), but significantly different in Tel Aviv (307.4 ± 324.5, p < 0.001). Significant differences were observed in Lausanne (Quark RMR®: 224.4 ± 514.9, p ¼ 0.038) and in Brussels (Vmax ®: 449.6 ± 667.4, p < 0.001), but none was found in Chiba (E-COVX®; 55.0 ± 204.1, p ¼ 0.165).

CONCLUSION: The Q-NRG® required a much shorter time than most other ICs to determine EE in mechanically ventilated ICU patients. The Q-NRG® is the only commercially available IC tested against mass spectrometry to ensure gas accuracy, while being very easy-to use.

In vitro validation of indirect calorimetry device developed for the ICALIC project against mass spectrometry

Oshima T, Dupertuis YM, Delsoglio M, Graf S, Heidegger CP, Pichard C. Clin Nutr ESPEN. 2019 Aug;32:50-55.

BACKGROUND: Accurate evaluation of the energy needs is required to optimize nutrition support of critically ill patients. Recent evaluations of indirect calorimeters revealed significant differences among the devices available on the market. A new indirect calorimeter (Q-NRG®, Cosmed, Roma, Italy) has been developed by a group of investigators supporting the international calorimetry study initiative (ICALIC) to achieve ultimate accuracy for measuring energy expenditure while being easy to use, and affordable. This study aims to validate the precision and the accuracy of the Q-NRG® in the in-vitro setting, within the clinically relevant range for adults on mechanical ventilation in the ICU. Mass spectrometry is the reference method for the gas composition analysis to evaluate the analytic performances of the Q-NRG®.

METHODS: The accuracy and precision of the O2 and CO2 measurements by the Q-NRG were evaluated by comparing the measurements of known O2 and CO2 gas mixtures with the measurements by the mass spectrometer (Extrel, USA). The accuracy and precision of the Q-NRG® for measurements of VO2 (oxygen consumption) and VCO2 (CO2 production) at clinically relevant ranges (150, 250 and 400 ml/min STPD) were evaluated by measuring simulated gas exchange under mechanically ventilated setting at different FiO2 settings (21-80%), in comparison to the reference measurements by the mass spectrometer-based mixing chamber system.

RESULTS: The measurements of gas mixtures of predefined O2 and CO2 concentrations by the Q-NRG® were within 2% accuracy versus the mass spectrometer measurements in Passing Bablok regression analysis. In a mechanically ventilated setting of FiO2 from 21 up to 70%, the Q-NRG® measurements of simulated VO2 and VCO2 were within 5% difference of the reference mass spectrometer measurements.

CONCLUSIONS: In vitro evaluation confirms that the accuracy of the Q-NRG® indirect calorimeter is within 5% at oxygen enrichment to 70%; i.e. maximum expected for clinical use. Further recommendations for the clinical use of the Q-NRG® by will be released once the ongoing multi-center study is completed.

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Spontaneously Breathing Subjects

Evaluation of the accuracy and precision of a new generation indirect calorimeter in canopy dilution mode

Delsoglio M, Dupertuis YM, Oshima T, van der Plas M, Pichard C. Clin Nutr. 2020 Jun; 39(6): 1927-1934

BACKGROUND: Indirect calorimetry (IC) is the only way to measure in real time energy expenditure (EE) and to optimize nutrition support in acutely and chronically ill patients. Unfortunately, most of the commercially available indirect calorimeters are rather complex to use, expensive and poorly accurate and precise. Therefore, an innovative device (Q-NRG®, COSMED, Rome, Italy) that matches clinicians' needs has been developed as part of the multicenter ICALIC study supported by the two academic societies ESPEN and ESICM. The aim of this study was to evaluate the accuracy and intra- and inter-unit precision of this new device in canopy dilution mode in vitro and in spontaneously breathing adults.

METHODOLOGY: Accuracy and precision of oxygen consumption (VO2) and carbon dioxide production (VCO2) measurements were evaluated in vitro and in 15 spontaneously breathing healthy adults by interchanging three Q-NRG® units in a random order. In vitro validation was performed by gas exchange simulation using high-precision gas mixture and mass flow controller. Accuracy was calculated as error of measured values against expected ones based on volume of gas infused. Respiratory coefficient (RQ) accuracy was furthermore assessed using the ethanol-burning test. To evaluate the intra- and inter-unit precisions, the coefficient of variation (CV% = SD/Mean*100) was calculated, respectively, from the mean ± SD or the mean ± SD of the three mean values of VO2, VCO2, RQ and EE measured by each Q-NRG® units. In vivo accuracy measurement of the Q-NRG® was assessed by simultaneous comparison with mass spectrometry (MS) gas analysis, using Bland-Altman plot, Pearson correlation and paired t-test (significance level of $p = 0.05$).

RESULTS: In vitro evaluation of the Q-NRG® accuracy showed measurement errors <1% for VO2, VCO2 and EE and <1.5% for RQ. Evaluation of the intra- and inter-unit precision showed CV% ≤1% for VO2 and EE and CV% ≤1.5% for VCO2 and RQ measurements, except for one Q-NRG® unit where CV% was 2.3% for VO2 and 3% for RQ. Very good inter-unit precision was confirmed in vivo with CV% equal to 2.4%, 3%, 2.8% and 2.3% for VO2, VCCO2, RQ and EE, respectively. Comparison with MS showed correlation of 0.997, 0.987, 0.913 and 0.997 for VO2, VCO2, RQ and EE respectively ($p \leq 0.05$). Mean deviation of paired differences was 1.6 ± 1.4% for VO2, -1.5 ± 2.5% for VCO2, -3.1 ± 2.6% for RQ and 0.9 ± 1.4% for EE.

CONCLUSIONS: Both in vitro and in vivo measurements of VO2, VCO2, RQ and EE on three Q-NRG® units showed minimal differences compared to expected values and MS and very low intra- and inter-unit variability. These results confirm the very good accuracy and precision of the Q-NRG® indirect calorimeter in canopy dilution mode in spontaneously breathing adults.