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ORIGINAL ARTICLE

Reproducibility of indirect calorimetry in underweight patients with chronic obstructive pulmonary disease

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Prediction equations

Summary
Background & aims: Studies have shown that reproducibility of indirect calorimetry in healthy subjects is high, but none have studied this in chronic obstructive pulmonary disease. The aim was to examine the reproducibility of indirect calorimetry in chronic obstructive pulmonary disease patients and to compare measured resting metabolic rate to prediction equations of resting metabolic rate.
Methods: Resting metabolic rate was assessed twice the same week and was also predicted using four different equations in 41 (30 women, 11 men) underweight patients with stable chronic obstructive pulmonary disease.
Results: There was no statistical significant difference between the two measurement occasions. The mean between-day coefficient of variation was 4.1%. The difference between occasions of indirect calorimetry was 50 kJ with limits of agreement −740–640 kJ. The prediction equation assessing the largest part (68.3%) of the patient group within 90%–110% of measured resting metabolic rate was based on fat free mass.
Conclusions: Reproducibility of indirect calorimetry to assess resting metabolic rate in chronic obstructive pulmonary disease is high and prediction of resting metabolic rate shows poor

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agreement with measured resting metabolic rate. This finding underlines the importance of follow up of nutritional care.

Introduction

Malnutrition and weight loss are common findings in patients with chronic obstructive pulmonary disease (COPD). Studies have shown prevalence of malnutrition in between 20 and 40% of cases.[1,2] Low body weight in COPD have been shown to be associated with increased mortality.[1,3,4] Even a low fat free mass (FFM) is associated with reduced survival in COPD.[5] A variety of factors has been suggested to cause weight loss or loss of skeletal muscle mass in COPD such as anorexia,[6] dietary problems,[7] and increased energy requirement.[8–10] We have earlier shown that energy requirements in COPD patients is inadequately assessed by prediction equations of resting metabolic rate (RMR).[11] A recent study in hospitalised patients showed that the best prediction equation failed by more than 10% in up to one third of the patients.[12] With the aim of achieving a better estimate of patients' energy requirement, measurement of RMR by indirect calorimetry is therefore suggested.[13]

Studies have shown that the reproducibility of indirect calorimetry in healthy subjects is high. In an overview of 14 different studies, Bader et al showed that the coefficients of variation (CV) were between 1.3 and 6.0%.[14] Seven of the included studies showed a CV <3%. A study in elderly subjects reported a CV of 3.6% for males and 2.5% for females.[15] It has been shown that anxiety could increase RMR in male students.[16] Measurement with indirect calorimetry in a ventilated, but enclosed, hood-system might lead to anxiety, especially in dyspnoeic COPD patients, being afraid of not getting enough air. Anxiety might also produce an increased breathing pattern. It has been shown that COPD patients have a higher energy cost of breathing.[17] A hypothesis could therefore be that COPD patients have a lower RMR during a second measurement, due to familiarisation with the measuring environment. The only study in COPD patients studying reproducibility of RMR was performed in 12 patients with two months between the measurements.[18] No statistical significant differences in RMR between the two measurements were found. However, two months is a too long time period to observe reproducibility, so the aim of the current study was to examine the reproducibility of indirect calorimetry in malnourished COPD patients. A secondary aim was to compare measured RMR to prediction equations of RMR.

Subjects and methods

Study design

RMR was assessed by indirect calorimetry twice in the same week, with a minimum of 48 h between each measurement.

Subjects

Forty-one underweight patients (11 men and 30 women) with stable COPD not having experienced any infection the last 14 days were included in this study. Severe COPD was diagnosed as forced expiratory volume in one second (FEV_1) <60% predicted, or FEV% less than normal −2SD as determined by criteria from The European Respiratory Society.[19] Underweight was defined as having a body mass index (BMI) <21 kg/m^2,[20] or involuntary weight loss of >5% during the last month or >10% the last three months. All patients were recruited consecutively from the outpatient COPD-unit at the Department of Respiratory Medicine, Sahlgrenska University Hospital, Göteborg, Sweden. Exclusion criteria were need of constant oxygen treatment, cancer, diabetes mellitus, hypothyreoidism, heart failure, and kidney failure or other major diseases. The patients were instructed to abstain from the factors known to increase RMR, such as food intake and physical activity, before the measurement occasions. Participants were also told to continue current medication as usual during the time of the measurements.

The patients were informed of the nature and purpose of the study and gave written informed consent. The study was approved by the Ethics Research Committee of Göteborg University.

Pulmonary function tests

Spirometry was performed on a spirometer SensorMedics model 922 (SensorMedics Co, Palm Springs, USA) except the last patient where a spirometer Jaeger Masterscope (VIASYS, Hoechberg, Germany) was used. The European Coal and Steel Community (ECSC) reference values were used for prediction.[21] Arterial blood gases (partial pressure of oxygen (PO_2) and partial pressure of carbon dioxide (PCO_2)) were measured in all patients.

RMR

RMR was measured by indirect calorimetry using a ventilated-hood system. The equipment used was a Deltatrac™ II Metabolic Monitor (Datex, Helsinki, Finland). The equipment was calibrated with Quick Cal™ calibration gas (Datex-Ohmeda, Helsinki, Finland) constituting of 95% O_2 and 5% CO_2 according to the manufacturer's instructions before each measurement. The subjects were instructed to limit their physical activity the evening before the measurement. All subjects were measured after an overnight fast and they arrived from their home by car or public transport. After a 30 min rest in the supine position, RMR was measured during 30 min when the subjects were awake in the supine position. The measurements were performed in an environmental temperature between 22–23 °C. The presented mean RMR for each patient is based on the last 25 min of the measurement. RMR was assessed by indirect calorimetry twice in the same week, with a minimum of 48 h between each measurement.