Comparative Analysis of Energy Expenditure Equations in Overweight and Underweight Adult Hospitalized Patients

Kyle J. Hampson, Pharm.D., BCNSP, CNSC; Rachel Leong, Pharm.D.; Vivian M. Zhao, Pharm.D., BCNSP, FASPEN; Daniel P. Griffith, R.Ph., BCNSP; Nisha J. Dave, Pharm.D., BCNSP; John R. Galloway, MD; Thomas R. Ziegler, MD

Introduction: Providing optimal nutrition support therapy mandates the provision of an appropriate amount of calories for each patient. Measurement of the resting energy expenditure (REE) through indirect calorimetry is the gold standard for determining energy needs. This method may not be able to be performed on all patients and therefore predictive mathematical equations have been designed that estimate REE based on patient parameters. Little data exists regarding the use of these equations in underweight and overweight individuals. This study compares indirect calorimetry with some commonly used energy expenditure equations in obese and underweight patients.

Methods: This study is a retrospective chart review that includes patients with a body mass index (BMI) <18.5 and >30 who were admitted to Emory University Hospital and had an indirect calorimetry performed between January 1, 1990 and June 30, 2013. Patients were excluded if they were under 18 years of age, receiving supplemental oxygen, if their mechanical ventilation was leaking, if they had any amputations, spinal cord injury, or underlying chronic pulmonary disease. The results of indirect calorimetry studies were compared to several predictive energy expenditure equations, including the Harris-Benedict equation, Penn State and Modified Penn State Equations, and the Mifflin-St. Jeor equation and were stratified by patient weight category (obese vs. underweight) and location (ICU vs. floor). A comparison of the efficacy of the equations to predict energy requirements in floor and critically ill patients was conducted.

Results: The only equation that was not significantly different from indirect calorimetry for obese patients located on the floor was the Harris-Benedict equation adjusted for 50% BM (p=0.013; 95% PI: -710 to 1079). Both the Penn State and modified Penn State equations were not statistically different from indirect calorimetry in obese ICU patients (p=0.824; 95% PI -805 to 777 and 0.096; 95% PI -694 to 912, respectively). When underweight patients located on the floor were assessed, the Harris-Benedict equation was the only equation that was not significantly different from indirect calorimetry (p=0.72; 95% PI -459-482). When these equations were investigated for underweight patients in the ICU, both the Penn State and modified Penn State equations were not statistically different from indirect calorimetry (p=0.233; 95% PI -465 to 648 and 0.375; 95% PI -516 to 657, respectively).

Conclusion: This data suggests that the PSU and mPSU equations may provide results more similar to indirect calorimetry in both obese and underweight critically ill patients. In patients on the floor, this data suggests that the HBE be used in underweight patients and the HBE adjusted for 50% BM be used or obese patients. Further studies are needed to confirm these results.

Keywords: Indirect calorimetry, metabolic rate, metabolism, caloric requirements, resting energy expenditure

References:

1. Ahmad, A, et. al. An evaluation of resting energy expenditure in hospitalized, severely underweight patients. Nutrition. 1999; 15: 384-388.
2. Bursztein, Simon. et. al. "Methods of Measurement and Interpretation of Indirect Calorimetry." *Energy metabolism, indirect calorimetry, and nutrition*. Baltimore: Williams and Wilkins, 1989. 173-209.
3. Choban, P, et. al. ASPEN Clinical Guidelines: Nutrition support of hospitalized adult patients with obesity. JPEN 2013; 37(6): 714-744.
4. Campbell, CG, et. al. Predicted vs. measured energy exposure in critically ill, underweight patients. Nutr Clin Pract. 2002; 17: 38-42.
5. Frankenfield DC. Validation of an equation for resting metabolic rate in older obese, critically ill patients. JPEN 2011 35: 264-9.
6. Frankenfield, DC, et. at. Prediction of resting metabolic rate in critically ill patients at the extremes of body mass index. JPEN 2013 37: 361-7.
7. Frankenfield DC, et. al. Analysis of estimation methods for resting metabolic rate in critically ill adults. JPEN. 2009; 33: 27-36.
8. Ireton-Jones, Carol. "Nutrition Therapy Specialist/Consultant." *Ireton Jones Equations*. <www.carolireton-jones.com>.
9. Kross EK, et. al. A comparison of predictive energy expenditure and measured energy expenditure in critically ill patients. J Crit Care. 2012 June ; 27(3): 321.e5–321.e12.
10. McClave, SA, et. al. “Guidelines of the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient” JPEN 2016; 40(2): 159-211.
11. Petros S, Engelmann L. Validity of an abbreviated indirect calorimetry protocol for measurement of resting energy expenditure in mechanically ventilated and spontaneously breathing critically ill patients. Intensive care medicine. 2001; 27: 1164-1168.