

Comparison of a Handheld Indirect Calorimetry Device and Predictive Energy Equations Among Individuals on Maintenance Hemodialysis

Ellis A. Morrow, DCN, MS, RDN, LD,^{*,†} Andrea Marcus, PhD, MPH,[†] and Laura Byham-Gray, PhD, RD[†]

Objectives: Practical methods for determining resting energy expenditure (REE) among individuals on maintenance hemodialysis (MHD) are needed because of the limitations of indirect calorimetry. Two disease-specific predictive energy equations (PEEs) have been developed for this metabolically complex population. The aim of this study was to compare estimated REE (eREE) by PEEs to measured REE (mREE) with a handheld indirect calorimetry device (HICD).

Methods: A prospective pilot study of adults on MHD (N = 40) was conducted at 2 dialysis clinics in Houston and Texas City, Texas. mREE by an HICD was compared with eREE determined by 6 PEEs using Bland-Altman analysis with a band of acceptable agreement of $\pm 10\%$ of the group mean mREE. Paired t-test and the intraclass correlation coefficient were also used to compare the alternate methods of measuring REE. A priori alpha was set at $P < .05$.

Results: The mean (\pm standard deviation) age was 56.7 ± 12.9 years, 52.5% ($n = 21$) were female, and 85% ($n = 34$) were African American. Body mass index (BMI) ranged from 18.1 to 47.1 kg/m^2 , 67.5% were overweight ($\text{BMI} \geq 25 \text{ kg/m}^2$) and 50% were obese ($\text{BMI} \geq 30 \text{ kg/m}^2$). The Maintenance Hemodialysis Equation-Creatinine version (MHCD-CR) was the most accurate PEE with 52.5% of values within the band of acceptable agreement, followed by the Mifflin-St. Jeor Equation and the Vilar et al. Equation at 45.0% and 42.5%, respectively.

Conclusion: When compared with mREE by the HICD, the MHDE-CR was more accurate and precise than other PEEs evaluated; however, this must be interpreted with caution as mREE was consistently lower than eREE from all PEEs. Further research is needed to validate the MHDE-CR and other practical methods for determining REE among individuals on MHD.

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Introduction

PROTEIN-ENERGY WASTING (PEW) among individuals receiving maintenance hemodialysis (MHD) is defined as a state of decreased body stores of energy fuels and protein.¹ The consequent sequelae of PEW are associated with adverse clinical outcomes including increased hospitalizations and mortality.¹⁻⁵ The prevalence of PEW, previously described as comprising of protein-energy malnutrition, malnutrition-inflammation complex syndrome, uremic malnutrition, and/or uremic (renal) cachexia, is high among individuals receiving MHD estimated to range from 17% to 75%.^{1,2,6-9} PEW is

diagnosed based on 4 established criteria, requiring any 3 of them to be present for diagnosis: abnormal biochemical markers, low protein and energy intake, a decrease in muscle mass, weight loss, or reduced total body fat and low body weight.¹ Treatment and prevention of PEW require a comprehensive approach that includes nutrition intervention since inadequate dietary energy and protein intake are recognized etiologic factors.^{1,2,6} Optimal dietary intake is essential for mitigating any complications associated with such deficits, thereby promoting weight (WT) maintenance and neutral nitrogen balance.^{9,10}

Determining energy requirements for individuals on MHD is challenging because of their metabolic complexity. Indirect calorimetry (IC) is recognized as the “gold standard” for measuring resting energy expenditure (REE) in clinical settings.¹¹ However, the use of IC is not practical due to the need for specially trained personnel, expensive equipment, the time required to complete the procedure and the burden of the procedure on the patient.¹²⁻¹⁴ Thus, there is a need for an easier and reasonably precise method for determining REE in this population. Two potential methods for determining REE in this population are predictive energy equations (PEE) and handheld IC devices (HICDs).

^{*}Department of Human Services and Consumer Sciences, Texas Southern University, Houston, Texas.

[†]Department of Nutritional Sciences, Graduate Programs in Clinical Nutrition, Rutgers University, School of Health Professions, Newark, New Jersey.

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Address correspondence to Ellis A. Morrow, DCN, MS, RDN, LD, Department of Human Services and Consumer Sciences, Texas Southern University, 3100 Cleburne, CS Lane Room 116, Houston, Texas 77004. E-mail: morrowea@tsu.edu

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PEEs are simple and practical methods for estimating REE in settings when IC is not feasible.¹⁵ As of date, only 2 disease-specific PEEs are available for individuals on MHD: the MHD equation (MHDE) and the Vilar et al equation (VE).^{16,17} Because of the metabolic derangements present in MHD, many of the PEEs developed for the general population do not provide accurate estimates of REE in this unique population.^{16,18-21} There remains a gap in the knowledge regarding the accuracy and precision of disease-specific PEEs for estimating REE in individuals on MHD.

HICDs are also an alternative method for measuring REE in clinical settings in which IC is not practical.²² The MedGem (MG; Microlife Medical Home Solutions, Inc. Golden, CO) is an HICD that measures inspired and expired airflow oxygen using a dual-channel florescent quenching sensor.²³ Results of studies comparing the MG to IC have been mixed.^{22,24-30} The reliability of the MG for measuring REE is not clear, it may provide acceptable measurements of REE among healthy adults, but may be less reliable in cancer or in conditions of excessive WT.^{22,24-30} No known large-scale studies have

investigated the use of HICDs among individuals on MHD. The results of a small pilot study demonstrated that the mean measured REE (mREE) from the MG and IC were not statistically nor clinically significantly different in a sample ($N=17$) of individuals on MHD.³¹ The aim of this study was to assess the level of agreement between mREE by the MG and estimated REE (eREE) using each of 6 PEEs among a sample of individuals receiving MHD.

Methods

Study Sample and Study Design

Using a prospective, cross-sectional design, patients receiving MHD 3 times weekly between May and July 2016 were recruited from dialysis clinics in Texas City and Houston, Texas. Adults aged ≥ 18 and < 90 years on MHD were recruited directly by the primary investigator. One hundred thirty-two patients were screened for inclusion (Fig. 1). Patients were excluded if they were < 90 days dialysis vintage, had a nonhealing wound or an active infection, had been hospitalized or undergone any elective or surgical procedures within the previous 30 days, were

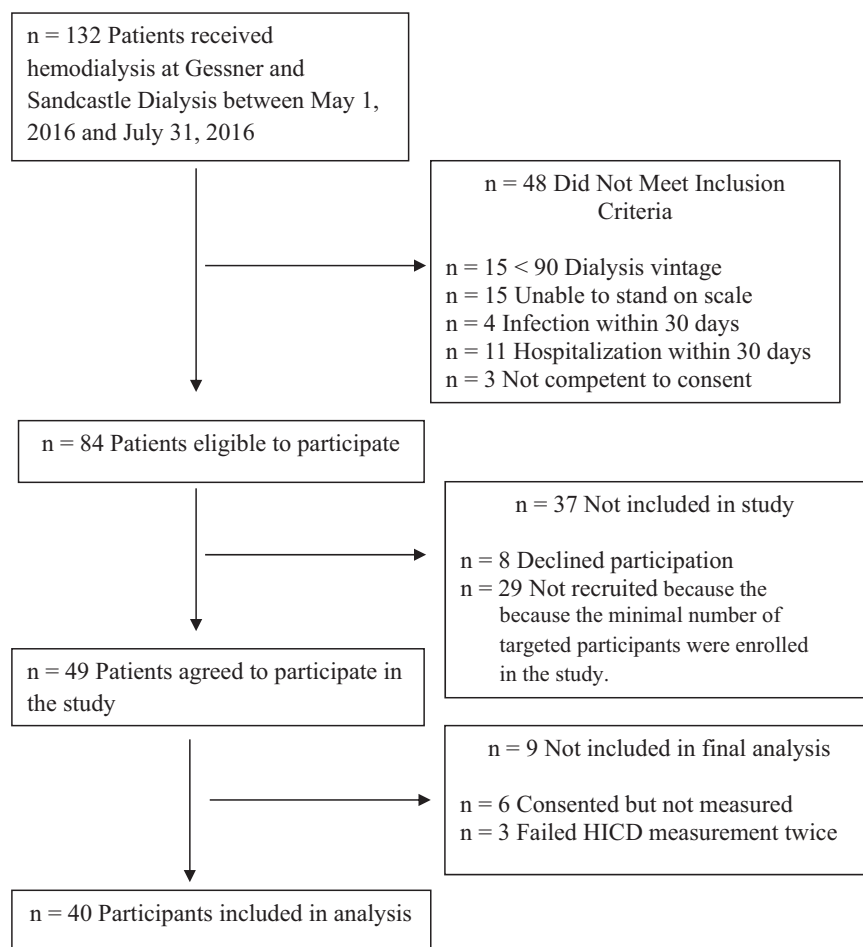


Figure 1. Selection of participants from 2 dialysis clinics in Southeast Texas to participate in a study comparing a handheld indirect calorimetry device to predictive energy equations for determining resting energy expenditure.

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