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Brief Reports

BEDSIDE ESTIMATION OF PATIENT HEIGHT FOR CALCULATING IDEAL BODY WEIGHT IN THE EMERGENCY DEPARTMENT

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□ **Abstract—Background: Ideal body weight (IBW), which can be calculated using the variables of true height and sex, is important for drug dosing and ventilator settings. True height often cannot be measured in the emergency department (ED). Objectives: Determine the most accurate method to estimate IBW using true height-based IBW that uses true height estimated by providers or patients compared to true height estimated by a regression formula using measured tibial length, and compare all to the conventional 70 kg male/60 kg female standard IBW. Methods: Prospective, observational, double-blind, convenience sampling of stable adult patients in a tertiary care ED from September 2004 to April 2006. Derivation set (215 patients) had blinded provider and patient true height estimates and tibial length measurements compared to gold-standard standing true height. A validation set (102 patients) then compared the accuracy of IBW using true height calculated from the regression formula vs. IBW using gold-standard true height. Regression formula for men tibial length-IBW (kg) = 25.83 + 1.11 × tibial length; for women tibial length-IBW = 7.90 + 1.20 × tibial length; $R^2 = 0.89$, $p < 0.001$. Inter-rater correlation of tibial length was 0.94. Results: Derivation set: percent within 5 kg of true height-based IBW for men/women = Patient: 91.1%:/85.7%; Physician: 66.1%/45.1%; Nurse: 65.7%/ 47.3%; tibial length: 66.1%/63.7%; and 70 kg male/60 kg female standard 46%/ 75%. Validation set: tibial length-IBW estimates were within 5 kg of true height-ideal body weight in only 56.2% of men and 42.2% of women. Conclusions: Patient-reported height is the best bedside method to estimate true height to calculate ideal body weight. Physician and nurse estimates of true height are substantially less accurate, as is true height obtained from a regression formula that uses measured tibial length. All methods were more accurate than using the conventional 70 kg male/60 kg female IBW standard. © 2011 Published by Elsevier Inc.**

□ **Keywords—ideal body weight; drug dosing; ventilator volume settings; medical error**

INTRODUCTION

Background

Knowledge of a patient's ideal body weight (IBW) can be important for drug dosing and for calculating initial ventilator volume settings in the Emergency Department (ED). Lung capacity correlates best with lean body mass, which is a function of height, rather than actual body weight. Ventilator volume settings calculated using actual weight, particularly in obese patients, can result in excess ventilatory volumes, barotrauma, and hemody-

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namic compromise (1). Although most medications are dosed using actual, true body weight, some medications are best dosed using IBW, or a combination of IBW and actual body weight, particularly in obese patients (2–4). Although drug dosing and ventilator volume settings initiated in the ED are based on preliminary estimates and later adjusted based on the patient's response, the goal should always be to initiate drug dosing and ventilatory settings as close as possible to the patient's physiological requirements.

Multiple studies have demonstrated that ED health care providers cannot accurately or reliably predict actual body weight, and that the best bedside method to estimate a patient's actual body weight is to simply ask the patient (5–10). In a small sample of intensive care unit patients, Bloomfield et al. found that 18 of 20 bedside estimates were within 15% of true height and the majority were within 10% (11). No studies, however, have evaluated the ability of health care providers to estimate true height (TH), and by extraction, IBW in a large ED sample of patients. Furthermore, critically ill patients often are unable to communicate their TH due to altered mental status, language barriers, or actual lack of knowledge of their precise true height. Measuring TH is often impractical in an emergent setting; it is important therefore, to know the most accurate and precise method to estimate TH and subsequent IBW to reduce the risk of complications associated with over- and under-ventilation and drug-dosing errors.

We performed a prospective study to determine which bedside method best predicts TH and IBW: bedside estimates by physicians or nurses, bedside anthropomorphic measurement or height as stated by the patient, or to simply use the conventional 70 kg male/60 kg female IBW standard. Based on research in the fields of nutrition and forensic anthropology, we selected tibial length as the bedside anthropomorphic measurement for use in a regression model to predict TH and IBW (12). We also chose to test this method, as it seemed to be the most easily and rapidly accessible anthropomorphic measurement, short of measuring the actual height itself.

METHODS

Study Design, Setting, and Participants

This was a prospective, double-blinded, observational study. Before implementation, the local Institutional Review Board approved the study. Informed written consent was obtained for all enrollees. The study took place in an urban, tertiary care, military ED, with an annual census of approximately 62,000 visits and an Emergency Medicine residency training program. The patient population is diverse in both age and ethnicity and includes active duty service members, dependents (children, parents, spouses, and other relatives), and retirees. Patients were enrolled on a convenience basis if they were visiting the ED on a day when an investigator was available. All medically stable patients in the ED ages 18 years or older who were able to stand for height measurement and who were able to provide oral and written consent were considered eligible for enrollment. Patients with amputations, altered mental status, inability to speak English, or with a paralysis of any kind were excluded. Enrollment in the study did not influence the patient's medical care.

Methods of Measurement and Data Processing

Tibial length (TL) was measured in centimeters with a standard measuring tape from the medial malleolus to the tibial tuberosity using a modification of the method described by Pelin and Duyar (12). The patient was asked to stand barefoot on a standard balance beam scale while his/her height was measured in centimeters. A pool of 15 attending physicians, 39 residents, and 44 nurses were selected on a convenience basis to estimate the patient's height while the patient was lying supine on a gurney. Data were collected in sequential order to ensure blinding of physicians, nurses, patients, and the investigators performing the measurements. During the derivation phase, physician, nurse, and patient estimates of TH and measurement of TL were performed, whereas only TL and TH were measured during the validation phase. When two investigators were available, as was the case for 49 patients, a second blinded tibial length measurement was done to evaluate inter-rater agreement.

Primary Data Analysis and Outcome Measures

IBW was calculated for each patient's gold-standard measured TH and for estimated TH using the Devine formula (13):

$$\text{Male IBW (kg)} = 50 + 2.3 \times [(\text{TH in cm}/2.54) - 60]$$

$$\text{Female IBW (kg)} = 45 + 2.3 \times [(\text{TH in cm}/2.54) - 60]$$

IBW based on tibial length, TL-IBW, used simple linear regression with TL (independent) to predict TH-based IBW (TH-IBW) (dependent). The final regression models from the derivation set were then prospectively tested in a final independent group of 102 patients. We chose 5 kg and 10 kg as clinically meaningful, practical, and easily referenced cutoffs for purposes of comparing the various methods. Simple correlation was used to deter-