Caloric Requirements in Patients with Inflammatory Bowel Disease

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Measured resting energy expenditure (REE) was compared to predicted basal energy expenditure (BEE) in 35 consecutive patients with nonseptic inflammatory bowel disease (IBD) and 20 healthy volunteers. Patients with IBD were groups greater or less than 90% ideal body weight (IBW). The BEE in kcal/day was found to be equivalent to the measured REE in both patient groups. It is suggested that the BEE be used to determine caloric requirements in nonseptic patients with inflammatory bowel disease. Patients less than 90% IBW had significantly higher measured energy expenditure (26.4 ± 1.0) per kg body weight than either controls (21.2 ± 0.7) or patients ⩾ 90% IBW (21.2 ± 0.8), $p < 0.001$. It is suggested that this increased expenditure is due to a combined effect of weight loss and intrinsic disease.

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THE APPLICATION OF INDIRECT CALORIMETRY to clinical populations has demonstrated consistent changes in energy expenditure with different disease states. Long et al.[1] has shown increases in energy expenditure above predicted levels following surgery, trauma, and burn injuries. These are clinical situations commonly associated with metabolic stress and acute nitrogen losses.[2] Relatively less information is available concerning the effect of chronic disease combined with protein-calorie malnutrition on claoric requirements. Starvation alone appears to decrease energy requirements[3] concomitant with a decrease in body cell mass.[4] The effects of disease superimposed on malnutrition relative to energy expenditure is still uncertain. A preliminary study of energy expenditure in 12 patients with inflammatory bowel disease from this institution suggested that resting energy expenditure (REE) measured by indirect calorimetry did not differ significantly from the predicted basal energy expenditure (BEE) in the absence of sepsis.[5] The purpose of this follow-up study was to further characterize energy expenditure in inflammatory bowel disease with and without weight loss relative to a normal control population and to provide guidelines for the rational use of TPN in these patients.

Patients and Methods

Thirty-five consecutive patients with inflammatory bowel disease referred to the Nutrition Support Service of the Hospital of the Unversity of Pennsylvania were evaluated. There were 20 males, 6 with ulcerative colitis and 14 with Crohn's disease. There were 15 females, all with diagnoses of Crohn's disease (Table 1). The reason for referral in all cases was exacerbation of disease or fistulization requiring bowel rest. None of the patients had intra-abdominal abscesses or clinical evidence of sepsis at the time of the study. In addition to the patient population, 20 normal volunteers, 8 males and 12 females, were included as a control group (Table 2).

In addition to routine nutritional indices that included usual weight, current weight, and ideal body weight determined by Metropolitan Life standard tables, each individual had energy expenditure determined by both indirect calorimetry and a standard anthropometric formula. Predicted basal energy expenditure (BEE) was calculated from the Harris-Benedict formulas.[6] Resting energy expenditure (REE) was measured by a single examiner from values for $\dot{V}O_2$ and $\dot{V}CO_2$ provided by the Beckman Metabolic Measurement Cart. With the patient relaxed and at bedrest, direct measurements of $\dot{V}O_2$ and $\dot{V}CO_2$ were taken at one-minute intervals until equilibration occurred, which was usually between 5 to 15 minutes. Average values of the data points were then used in the modified Weir formula [1440 min/day (3.9 $\dot{V}O_2$ + 1.1 $\dot{V}CO_2$] to yield

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kcal/day.[7] The control group was studied at least two hours after their last meal, and the patient population received a variable amount of intravenous glucose.

The 35 patients were divided into two groups based upon percentage of ideal body weight (IBW), with IBW of <90% constituting a signficant depletion in body weight (Table 3). Means and standard deviation were used to calculate p values by the Student's t-test.

Results

Significant differences in per cent ideal body weight were evident when those patients less than 90% IBW were compared to normal volunteers or patients with IBD who had not undergone chronic weight loss (Fig. 1). The control group was 105.9 ± 1.6% of IBW, which was similar to the patients > 90% IBW (107.2 ± 2.6%) but significantly greater than the patients with long-term weight loss (76.9 ± 2.0%, $p < 0.0005$). There were no significant differences in daily energy expenditure measured by indirect calorimetry between the control and patient populations (Fig. 2). When the measured REE was compared to the predicted BEE, there were significant differences only in the control group. Mean BEE was 1557.3 (55.3) kcals/day compared to REE of 1393.7 (50.6) kcal/day, a difference of 10.5% ($p < 0.002$) (Fig. 3). when energy expenditure is normalized to a unit weight basis, the patients less than 90% IBW had significantly higher measured energy expenditure per kilogram (26.4 ± 1.0) than either the controls (21.2 ± 0.7) or patients < 90% IBW (21.2 ± 0.8), $p < 0.001$ (Fig. 4). This represents a 24% increase in energy expenditure per kilogram of body weight over both the patients who had maintained their weight and the control group. Finally, when the expected energy expenditure per unit weight was compared to the measured energy expenditure per unit weight, the 10% difference normally present was absent in patients < 90% IBW (Fig. 5).

Discussion

Optimal nutritional support for both maintenance and restoration of normal body composition is dependent upon the provision of adequate calories and nitrogen. Various methods of estimating or measuring these requirements in the clinical setting have been proposed. Anthropometric formula based upon simple measurements of age, sex, weight, and height[6] or body surface area[8] have been used. However, these formulas assume a normal body composition that may not be true for the individual patient due to the effects of disease. Significant erosion of body cell mass relative to other body compartments may cause an overestimation of caloric requirements by these formula. The wide variability in measured resting energy expenditure as compared to the Harris-Benedict predictive formulas has been noted in other studies.[9] Several clinical studies have demonstrated that the Harris-Benedict formula can be used as a basis for estimating daily caloric requirements with some modification. Rutten et al.[10] demonstrated that a caloric intake of 1.76 × BEE (via Harris-Benedict equation) would result in positive nitrogen balance in mild to moderately catabolic surgical patients receiving total parenteral nutrition. Similarly, Long et al.[1] correlated nitrogen dynamics with both REE and metabolic rate in patients following minor surgery, multiple trauma, and severe burns. They recommended that daily caloric requirements be based upon 1.20 × BEE for minor operations, 1.6 × BEE for major sepsis, and 2.10 × BEE for severe thermal burns. However, in certain situations where multiple stress factors are combined with acute changes in nutritional status, indirect calorimetric measurements of the actual energy expenditure would be perferable. Indirect calorimetry, although now more easily adapted to the hospital setting, may not be feasible for each individual requiring a nutritional prescription. Those patients with exceptional or altered nutritional requirements need to be selected out for more specific examination.

In the present study, patients with inflammatory bowel disease were evaluated by both indirect calorimetry and standard formulas. For these nonseptic patients, the BEE based upon Harris-Benedict formula was found to be statistically equivalent to the REE

TABLE 1. *Patient population*

	No.	UC*	Crohn's	Age (yrs)	Wt (kg)
Male	20	6	14	40.3 (4.3)	61.6 (2.9)
Female	15	—	15	40.6 (3.8)	50.9 (2.3)
Total	35	6	29	40.4 (3.0)	57.0 (2.1)

* UC = ulcerative colitis.

TABLE 2. *Control Group*

Sex	No.	Age (yrs)	Wt (kg)
Male	8	27.8 (1.5)	77.5 (6.7)
Female	12	27.8 (3.0)	58.9 (4.4)
Total	20	27.8 (2.2)	66.4 (10.7)

TABLE 3. *Patient Groups Based Upon Per Cent Ideal Body Weight*

	No.	Male	Female	Age (yrs)	Wt (kg)
>90% IBW	18	10	8	40.8 (3.7)	65.0 (2.2)*
<90% IBW	17	10	7	40.0 (4.7)	48.5 (2.2)*

* $p < 0.001$.

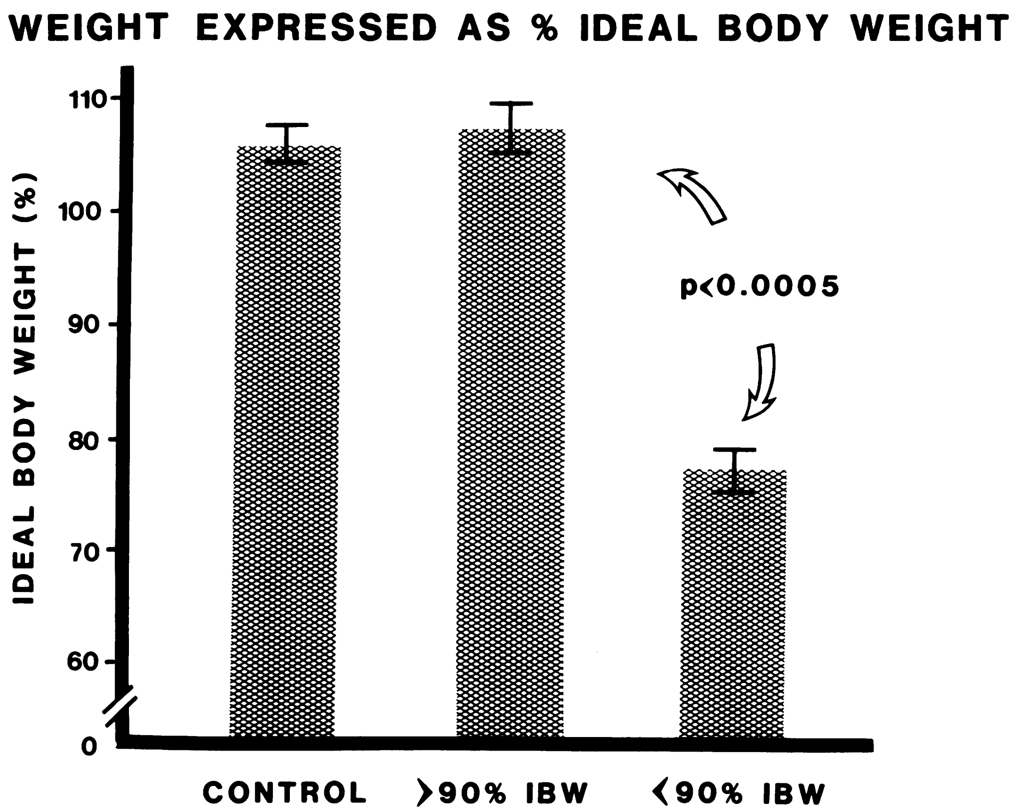

FIG. 1. Per cent ideal body weight (mean ± SEM) of the three study groups.

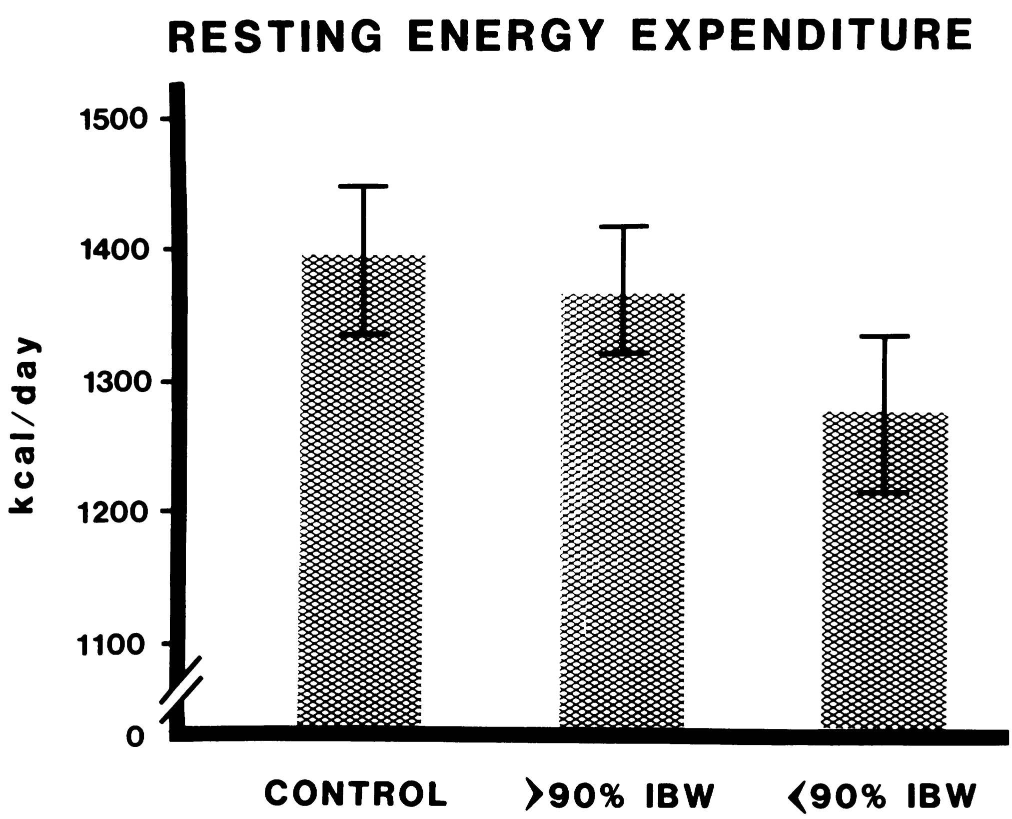

FIG. 2. Resting energy expenditure measured by indirect calorimetry for each group (mean ± SEM).

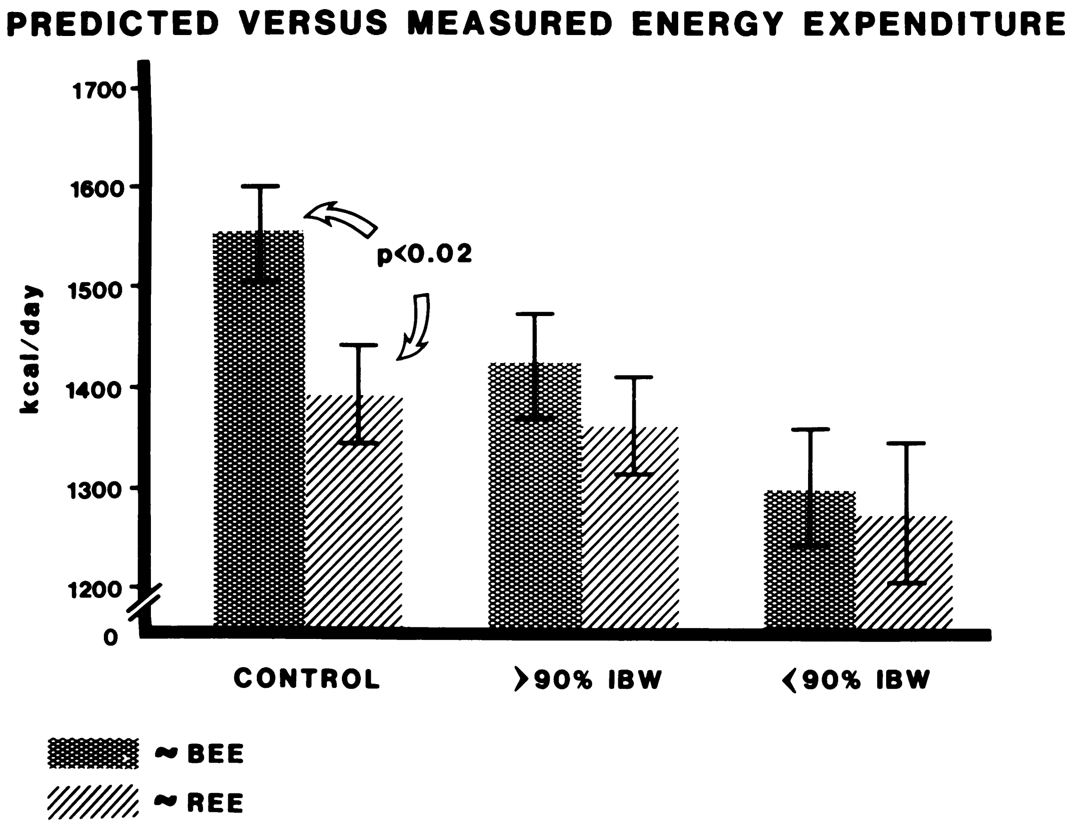

FIG. 3. Resting energy expenditure compared to the Harris-Benedict predicted energy expenditure for each group (mean ± SEM).

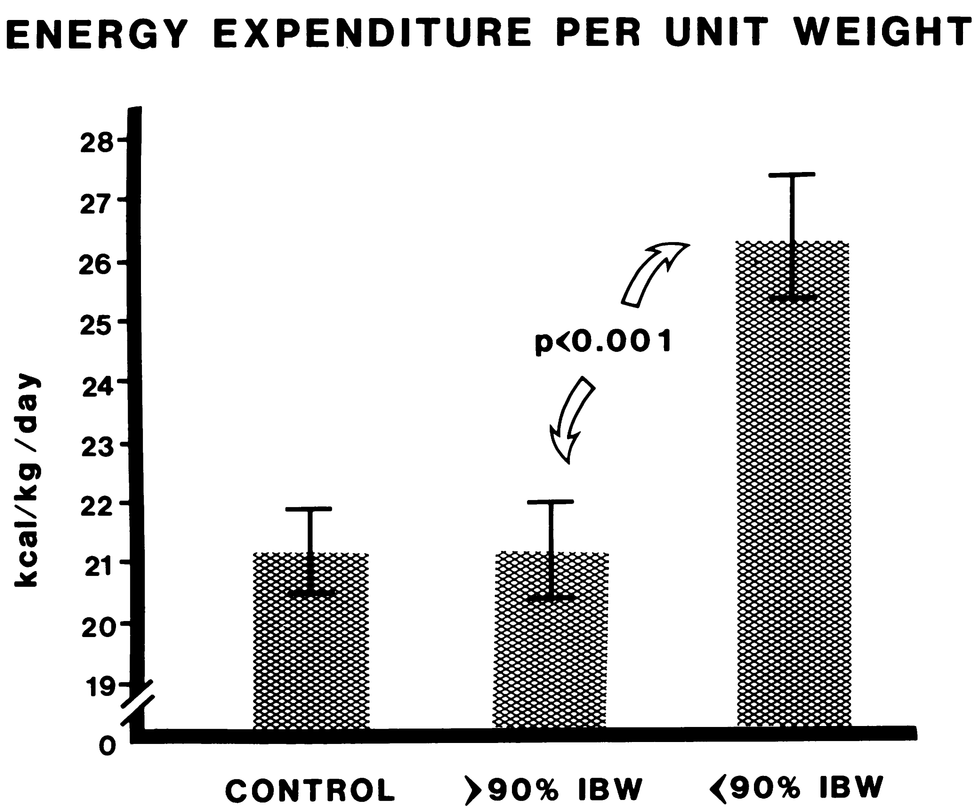

FIG. 4. Measured resting energy expenditure normalized to a unit weight basis for each group (mean ± SEM).

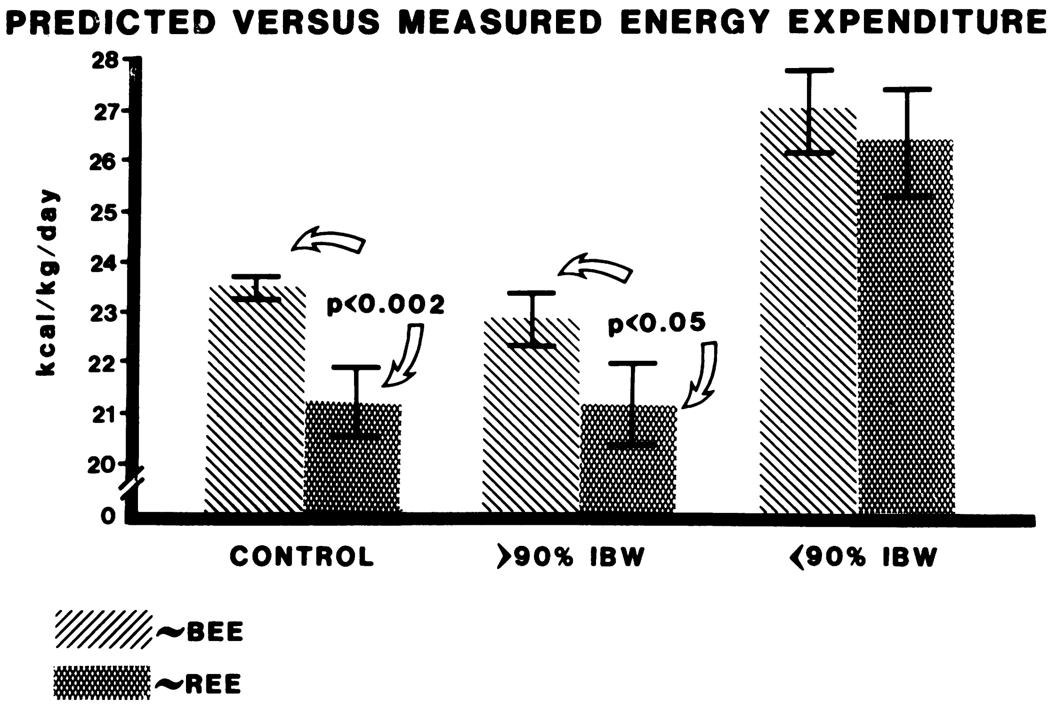

FIG. 5. Comparison of measured and predicted energy expenditures on a per unit weight basis (mean ± SEM).

measured by indirect calorimetry. In general, caloric requirements for these patients based upon 1.75 × BEE can be expected to result in anabolism.

Examination of the resting energy expenditure also gives some insight into the interaction of the disease process with host metabolism. One might expect that a chronic inflammatory process would increase energy expenditure above basal levels as is seen in sepsis or burns. However, when the patients with IBD who have maintained their weight are compared to a control population, there are no differences in energy expenditure per day or on a unit weight basis. This suggests that in the absence of significant erosion of body cell mass or sepsis, inflammatory bowel diesase does not significantly alter basal metabolism.

In those patients < 90% IBW in whom there has been a longstanding decrease in body weight, there is a significantly higher measured energy expenditure per unit weight. However, this increase can also be predicted by using the Harris-Benedict formulas in these patients, implying that body composition is relatively normal. The 10% difference in BEE and REE that is found in the controls and the patients with IBD who are >90% is not observed in the patients with weight loss. This may indeed be due to a combined effect of the intrinsic disease and weight loss that results in elevation of REE. Overall, however, this effect is small and can probably be ignored when calculating daily caloric requirements. Indirect calorimetry should be used to more accurately determine the caloric requirements of patients with IBD after operation, when septic, or when they fail to show the expected improvement in nutritional indices while receiving a presumably adequate nutritional regimen. In uncomplicated situations, determinations of BEE combined with appropriate activity and repletion factors should be sufficient to predict daily caloric requirements.

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