

Original Article

Total energy expenditure in patients with advanced solid tumors: a preliminary report

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ABSTRACT: Objectives: The measurement of total energy expenditure (TEE) plays an important role in planning correct nutritional support for cachectic cancer patients. Its measurement, however, remains problematic, and the available knowledge on this subject is almost nil. The aim of this communication was to report our preliminary findings regarding TEE as measured through a portable device, the BodyMedia SenseWear armband.

Methods: TEE was measured in 14 patients (6 women and 8 men) over a 3-day period, using the SenseWear armband (BodyMedia, Inc., Pittsburgh, PA, USA). Recording was from midnight on day 0 to midnight on day 3 (72 hours consecutively). Patients baseline characteristics were (mean \pm SD) age 65 ± 9 years, body mass index 21 ± 3 (calculated as kg/m^2), weight loss $18\% \pm 13$. All patients were affected by advanced cancer, mainly from the gastrointestinal tract.

Results: The resting energy expenditure (REE) according to the Harris-Benedict equation was 22 ± 3 Kcal/kg per day. Mean daily TEE measured through the armband was 28 ± 3 Kcal/kg per day. The TEE/REE ratio was only 1.27, which indicates that the energy requirement of these patients is rather low because of reduced physical activity.

Conclusions: Preliminary data suggest that the TEE of cachectic cancer patients is lower than usually expected, because of low levels of physical activity. If these data are confirmed in a larger series of patients, it will be possible to plan the nutritional support of advanced cancer patients more accurately. (Nutritional Therapy & Metabolism 2008; 26: 45-7)

KEY WORDS: Calorie requirements, Cancer patients, Energy expenditure, Resting energy expenditure, Total energy expenditure

INTRODUCTION

The first studies investigating energy expenditure in cancer patients date back to the 1980s (1, 2) and were mainly addressed to understanding whether an excessive resting energy expenditure (REE) could account for the progressive weight loss of advanced cancer patients. On the whole, the data showed that a mild hypermetabolism (approximately $> 15\%$) was a common finding (3), and, if not compensated for by an increased energy intake for a period of several weeks, it could account for the ongoing deterioration of the patients' nutritional status (4). From a clinical perspective, however, oncologists and nutritionists are more interested in estimating the total energy expenditure (TEE) of patients, because meeting the total calorie requirement through adequate administration of nutritional substrates remains the cornerstone of the nutri-

tional rehabilitation of wasted patients.

Data concerning the TEE of advanced cancer patients are very scarce and refer to very small series of patients who were studied in metabolic wards for a very limited period of time (5). We report here our preliminary experience with 14 advanced cancer patients in which TEE was measured for 72 consecutive hours through a recently available portable armband device.

PATIENTS AND METHODS

Fourteen consecutive adult wasted and weight-losing patients admitted to our hospital in Prato and suffering advanced metastatic solid tumors (9 colorectal, 3 gastric, and 2 pancreatic) were considered eligible for the study if they had an expected hospital stay of at

least 3 days, they had no evidence of endocrine disease and no major impairment of organ function, they were not febrile and were not receiving steroids or any nonsteroidal antiinflammatory drugs. No patient was in a postoperative state or had an infectious complication. The presence of edema or pleural or peritoneal effusions disqualified the patient for this investigation and was assessed through a clinical examination and a total body computed tomography scan that was an obligatory part of the oncologic staging. Eleven patients were investigated during the diagnostic work-up, and 3 during the interval between 2 cycles of chemotherapy. Food intake was grossly quantified as either normal (i.e., similar to that prior to the disease), low, or very low (i.e., almost nothing) on the basis of a specific inquiry directed to the patient and/or the attending nurses.

The portable armband (SenseWear armband; BodyMedia, Inc., Pittsburgh, PA, USA) uses a 2-axis accelerometer, a heat flux sensor, a galvanic skin response sensor, a skin temperature sensor, and a near-body ambient temperature sensor to capture data. These data, as well as height, body weight, and handedness, are used to calculate the TEE.

The procedure was explained to the patients who agreed to have the armband placed on the upper right arm (on the triceps and at the midhumerus point) for at least 72 consecutive hours and to remove it only for

bathing purposes or any activity involving water.

Finally, data were downloaded, and the software (InnerView Research, version 5.1; BodyMedia, Inc.) then provided percentages of on-body time. Main characteristics of the series are reported in Table I.

RESULTS

All 14 patients wore the armband for a period of at least 3 consecutive days while in the medical oncology unit of the hospital in Prato. Data were calculated for 72 hours consecutively (from midnight on day 0 to midnight on day 3), with the armband worn on the body effectively for $94\% \pm 10\%$ (range 68%-100%) of the time. They spent 20 ± 11 hours (range 9-40) (that is 28% of the period) sleeping, while the remaining time they lay in bed or underwent modest physical activity (settled at 2.5 metabolic equivalents [METs] by default) which mainly consisted of walking in the ward, 0.28 ± 0.47 hours (range 0-2.59) (2%).

Analysis showed that patients had a TEE of 28 ± 3 Kcal/kg per day (range 22-34). This value exceeded by 21% the calorie consumption estimate provided by the Harris-Benedict equation of a REE of 22 ± 2 Kcal/kg per day (range 19-26).

DISCUSSION

Although these results have been achieved in a small number of patients and require further confirmation in a larger series, we have to consider that there is little information in the literature regarding the TEE of cancer patients. To our knowledge only Gibney et al (5) has measured TEE: in 8 free-living patients with small cell lung cancer for 1 or 2 days, and they reported a 6% elevation in basal energy expenditure and a TEE/REE ratio of only 1.36. They concluded that the energy requirements of these cancer patients were not increased, because their mild basal hypermetabolism was overbalanced by decreased physical activity. Our findings of an energy requirement of approximately 28 Kcal/kg per day are in keeping with the recommendations of the recent literature for wasted cancer patients receiving home parenteral nutrition (6).

One should ask how accurate the estimate achieved through the armband is, and several investigators are actively working to validate the instrument. Quite recently St-Onge et al (7) compared daily energy expenditure determined through an armband with that determined using the doubly labeled water method in free-

TABLE I - MAIN CHARACTERISTICS OF PATIENTS

Number of patients	14 (8 men, 6 women)
Age, years (range)	65 ± 9 (50-79)
Primary tumor	
Colorectal	9
Gastric	3
Pancreatic	2
Stage	
III	12
IV	2
Chemotherapy ongoing	3
Usual body weight, kg (range)	70 ± 15 (50-104)
Present body weight, kg (range)	57 ± 9 (40-70)
Percentage weight loss, body mass index (range)	18 ± 13 (1-46)
	21 ± 3 (16-25)
Nutrient intake	
Normal	2
Low	8
Very low	4
REE, Kcal/kg per day (range)	22 ± 2 (19-26)

Data are means \pm SD (range), or number, as indicated.

REE = resting energy expenditure calculated by the Harris-Benedict equation.

living individuals and found a reasonable concordance, with an underestimation of less than 5%. Such a small discrepancy might be of concern in metabolic investigations, but it is unlikely to be significant in the clinical context. As a consequence, if these data are confirmed in a larger series of patients, it will be possible to take a more tailored approach to the nutritional support of cancer patient.

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