Body composition and dietary intake in neoplastic disease\textsuperscript{1, 2}


ABSTRACT Changes in body composition in 37 cancer patients were studied over a period of 6 months. Total body nitrogen was measured by prompt \(\gamma\) neutron activation; total body potassium by whole body counting, and total body water with the use of the tritium isotope. The nitrogen balance of patients with neoplastic diseases varied from marked negative to positive. Initially, the patients were divided into two groups: those who lost body weight (over 10\%) and those who maintained or gained body weight before the study. Analysis of body composition indicated that patients who lost body weight had caloric and protein intakes markedly below "normal" levels at the beginning of the study. There also appears to be a direct relationship between the protein intake and the total body potassium/total body water ratio in the cancer patients. At the end of the 6-month study, the patients were again placed into two groups on the basis of weight loss or gain (and maintenance). Changes in body composition over the period were analyzed in terms of lean body mass, its protein constituent, water, and fat. Weight loss was found to reflect primarily the loss of fat, water, lean body mass (potassium), and only to a minor extent the protein component of lean body mass (nitrogen). Further, on the basis of the values of the ratios of total body nitrogen/total body potassium/total body water, it was possible to ascertain the relative normalcy of the body tissue gained or lost in the 6-month period. The results of the present study suggest that the ratio total body nitrogen/total body potassium may serve as the best indicator of recent or ongoing catabolism or anabolism of the neoplastic process. By means of the application of the techniques used in this study for the determination of body composition, it should be possible to assess regimes of hyperalimentation for cancer patients who lose body weight. \textit{Am. J. Clin. Nutr.} 34: 1997–2004, 1981.

KEY WORDS Body composition, total body nitrogen, total body potassium, total body water, neutron activation, whole body counting, lean body mass, protein intake, caloric intake, neoplastic disease

Introduction

Body composition of 60 patients with hematological neoplasms, lung, gastrointestinal (GI) or head-neck cancers was recently studied (1). A basic four component model was used: total protein, lean body mass (LBM), fat, and water. In the present study, measurements of body composition of 37 of the above mentioned 60 patients were made over a 6-month period. The patients differed in type and duration of the disease process, administration of chemotherapy, and dietary intake. Analysis of this heterogeneous group of cancer patients is thus exceedingly complex.

The first objective of the study was to determine whether a relationship exists between the nutritional status (in terms of initial body composition) and dietary intake. For the nutritional assessment, both the energy intake and the protein intake were estimated at the start of the study. The initial analysis...


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of body composition reflects the results of weight loss (or gain) before the start of the present study.

Recently, Hill et al. (2) described a technique for analyzing body composition of critically ill surgical patients. A four compartment model consisting of fat, minerals (reflecting bone), protein, and water (the latter two compartments reflecting lean soft tissue mass) was used. The changes in these components were used to assess the effects of certain therapeutic programs for surgical patients with metabolic or nutritional problems.

The second objective of the present study was to apply Hill's approach to quantify the changes in body composition in cancer patients over a 6-month period. The patients were placed, for analysis, in two groups: those losing over 10% of their "normal" body weight (group B) and those maintaining or gaining body weight (group A).

Four basic components of body composition were measured: protein, fat, lean body mass, and total body water (TBW). The protein was determined by measurement of total body nitrogen (TBN) via prompt γ neutron activation analysis. Total body potassium (TBK), an index of lean body mass, was measured by whole body counting, and TBW by tritium labeled water.

The third objective of the present study was to analyze the changes in body composition over the 6-month period in terms of the ratios of TBN/TBK/TBW. Given that the ratios of the three components of body composition are constant in normal fat-free tissue, it should be possible to determine whether the lean tissue remains normal despite weight gain or loss. It is important to ascertain whether a loss of body weight reflects a decrease in body cell mass or merely decreased water retention.

The application of these three experimental approaches should provide a rational basis for the future evaluation of the efficacy of dietary supplementation by means of a quantitative assessment of nutritional status in terms of body composition.

Methods

Patient selection procedures

1) Thirty-seven of 60 patients of a previous study conducted jointly by Brookhaven National Laboratory and Long Island Jewish-Hillside Medical Center were selected. All the patients selected for this study had histologically verified cancer. Patients with the following types of cancer were included in the study: hematological neoplasms (acute and chronic myeloid leukemia, chronic lymphocytic leukemia, and lymphoma), GI, lung, and head and neck cancer.

2) All of the patients were ambulatory and volunteered to participate in the study. Assignment was based on the patient's clinical status and functional capacity to participate in the study.

3) Patients were treated on an outpatient basis, with periodic hospitalization as necessitated by their clinical condition. The patient population studied by this protocol was under the care of oncologists in the Long Island Jewish-Hillside Medical Center. All aspects of the clinical management, such as chemotherapy, were at the discretion of the patient's oncologist.

4) A brief clinical summary of the cancer patients is presented in Table 1. The mean weight loss before this study, the stage of the disease, and the tumor burden in each category is presented.

5) None of the 37 patients selected had any major complications other than those directly associated with the patient's malignancy. There were no deaths among the patients in the selected group during the 6-month study period.

6) The assignment of the patients into the two study groups (B: weight loss, >10%; A: gain or maintenance of weight) was performed in a nonrandomized manner. The grouping for the 6-month study was set up in retrospect and was designed to include patients with little or no change in body weight as well as those presenting significant changes. Among the former group of patients were those with hematological neoplasms, and among the latter, patients with solid tumors in stages III and IV.

7) The experimental procedures for this study were reviewed by the Human Studies Committees of both Brookhaven National Laboratory and Long Island Jewish Hospital to ascertain that they were in accord with the ethical standards of the Committee on Human Experimentation of the National Institutes of Health and in accord with the Helsinki Declaration as updated in Tokyo, Japan in 1975. A fully informed consent was obtained from each patient.

Dietary assessment

Dietary protein and caloric intakes were assessed in 22 of 37 or a little more than half of the patients in each of the categories of cancer patients and in eight control subjects as well. No dietary assessments were performed on patients while on chemotherapy. At the time of the first evaluation of body composition, patients were interviewed by a dietician and their food intake quantified over a representative 4-day period. The dietician recorded a 24-h recall dietary assessment and, in addition, explained the detailed dietary diary which the patient was to fill out over 2 weekdays and 2 weekend days. The mean daily intake of food reported in the diary was then converted into caloric and protein intake, with the use of Handbook 456, USDA, "Nutritive Value of American Foods". The dietician underwent special training at NIH-NCI in Washington in order to standardize this technique with that of other participants in the national study. Further, to ensure accurate dietary reporting, a sample of the coded diary data was periodically reviewed by the Diet, Nutrition and Cancer Program Clinical
Studies support group in Washington. The average error rate for coding the dietary data in this assessment was less than 1%.

The data were coded according to the manual prepared by Environ Control, Inc., for Diet, Nutrition and Cancer Program Clinical Studies, 1978. This coded information was then transferred to a computer based system at the NIH-NCI Diet and Nutrition Group (3). Protein and caloric intakes were calculated for these patients and for the group of eight normal individuals studied at the same time. The caloric and protein intakes expressed in absolute amounts and also normalized for body size (ratio of intake to lean body mass) are presented in Table 2.

Other experimental techniques used

The new technique of prompt γ neutron activation analysis was used for the measurement of TBN in these patients. The prompt γ neutron activation facility measures TBN with an accuracy and precision of ±3% in an anthropomorphic phantom. A detailed description of the prompt γ neutron activation technique for absolute measurement of whole body nitrogen has been presented (4).

The advantage of the prompt γ technique is that errors resulting from differences in irradiation and detection conditions, as well as from differences in the size and shape of the patient, are minimized. This reduction in error makes sequential nitrogen measurements very reliable, particularly when the weight of the patient changes significantly, as does that of cancer patients. The total irradiation time is less than 20 min, and the dose delivered to the body in this procedure is 26 mrem (skin dose).

The unique 54 detector Brookhaven whole body counter was used for the absolute measurement of TBK (5, 6). With its on-line computer facility, the counter has a response which is relatively invariant with respect to both the size of the individual and to the internal location of the radionuclide.

Another index of body composition was measured in this study. Total body water was determined from a plasma sample taken 4 h after oral administration of tritiated water. The precision of this technique was better than 1% (7).

Results

A summary of the clinical data for the 37 cancer patients at the time of the first body composition measurement is presented in Table 1. Body weight loss before the first evaluation is listed in the first column. Patients with solid tumors had sustained mean losses ranging from 3.1 to 22.8% of body weight. The stage of cancer for each category of patients was between 3 and 4, on an ascending scale of 1 to 4.

An attempt was made to quantify the level of the tumor burden by the method of DeWys and Walters (8). The involvement of organ systems was scored as 0 to 3 for the solid tumor groups; the technique is not applicable for the group with hematological tumors. It was very difficult to quantify the level of the tumor burden of the neoplastic disease; pres-

<table>
<thead>
<tr>
<th>Cancer type</th>
<th>n</th>
<th>ΔBWT*</th>
<th>Stage</th>
<th>Tumor burden</th>
<th>Incidence of anorexia</th>
<th>Chemotherapy†</th>
<th>No. of patients on therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematology</td>
<td>18</td>
<td>0.8</td>
<td>3-4</td>
<td>N.A.‡</td>
<td>0</td>
<td>Leukeran, Pred CTX, Chlorambucil</td>
<td>14/18</td>
</tr>
<tr>
<td>Head-neck</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A§</td>
<td>2</td>
<td>-4.5</td>
<td>3</td>
<td>2</td>
<td>25</td>
<td>BLM, CMF</td>
<td>1/2</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>-22.8</td>
<td>4</td>
<td>1-2</td>
<td>25</td>
<td>BLM, CTX, MTX, 5Fu</td>
<td>4/4</td>
</tr>
<tr>
<td>Lung</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td>-3.1</td>
<td>3</td>
<td>1-2</td>
<td>0</td>
<td>None</td>
<td>0/1</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>-10.1</td>
<td>3-4</td>
<td>0-1</td>
<td>66</td>
<td>None</td>
<td>0/3</td>
</tr>
<tr>
<td>GI</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>4</td>
<td>-17.5</td>
<td>4</td>
<td>1-2</td>
<td>50</td>
<td>ADM, 5Fu, MITO</td>
<td>3/4</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>-14.0</td>
<td>3</td>
<td>0-1</td>
<td>50</td>
<td>MITO, 5Fu</td>
<td>4/5</td>
</tr>
</tbody>
</table>

Stage: Scale of 1-4 as described in Clinical Oncology Univ. of Rochester, 5th ed., American Cancer Society, 1978.

Tumor Burden—Scale of 0-3 see ref. (8).

* Change in body weight: body weight before illness less present body weight.
† Chemotherapeutic agents: MTX, Methotrexate; 5Fu, 5 Fluorouracil; CTX, Cytoxan; ADM, Adriamycin; BLM, Bleomycin; MITO, Mitomycin C; PRED, Prednisone.
‡ Not applicable.
§ A, patients gaining body weight over 6-month period; B, patients losing body weight over 6-month period.
ently, weight change (loss or gain) appears to serve as the best, albeit crude, measure of the "activity" of the neoplasms.

Anorexia (sometimes accompanied by nausea and vomiting) is another condition affecting body weight. The incidence of anorexia in the patients with solid tumors is shown in Table 1. Most of the patients (26/37) received one or more types of chemotherapy during the 6-month study period, as indicated.

The mean energy intake and protein intake for a representative sample of the cancer patients and normal age matched subjects are shown in Table 2. The energy, protein, carbohydrate, and fat intakes for patients with hematological disorders and for those patients with GI, head-neck, and lung tumors who maintained or gained weight were not significantly different from those of the normal subjects. In fact, for the patients with solid tumors, the mean values for protein intake were slightly higher than the values for normal subjects. For the patients with solid tumors who lost weight, however, the energy, protein, carbohydrate, and fat intakes were markedly reduced (40, 18, 48, and 30%, respectively).

The changes in the various components of body composition over the 6-month period in the cancer patients are shown in Table 3. The percentage gain or loss of each component is

**Table 2**

<table>
<thead>
<tr>
<th>Type cancer</th>
<th>n</th>
<th>∆ABWT</th>
<th>Energy intake</th>
<th>Protein intake</th>
<th>Carbohydrate intake</th>
<th>Fat intake</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>kcal</td>
<td>kcal/kg LBM</td>
<td>kcal/kg LBM</td>
<td>kcal/kg LBM</td>
</tr>
<tr>
<td>Normal population</td>
<td>8</td>
<td>0</td>
<td>10284</td>
<td>204</td>
<td>83.8</td>
<td>1.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>±10.7‡</td>
<td>±15.3</td>
<td>±14.8</td>
<td>±17.3</td>
</tr>
<tr>
<td>Hematological neoplasms</td>
<td>13</td>
<td>-0.2</td>
<td>9979</td>
<td>195</td>
<td>94.9</td>
<td>1.85</td>
</tr>
<tr>
<td>Solid tumors gaining weight; GI, head-neck and lung</td>
<td>3</td>
<td>-3.8</td>
<td>9742</td>
<td>214</td>
<td>93.3</td>
<td>2.05</td>
</tr>
<tr>
<td>Solid tumors losing weight; GI, head-neck and lung</td>
<td>6</td>
<td>-11.8</td>
<td>6800</td>
<td>124</td>
<td>75.2</td>
<td>1.36</td>
</tr>
</tbody>
</table>

* LBM = lean body mass, TBW (1)/0.73.
Energy conversion 4.2kJ = 1 kcal; † (Body weight prior to illness—present body weight)/prior body weight × 100; ‡ coefficient of variation = (SD/χ) × 100.

**Table 3**

<table>
<thead>
<tr>
<th>Cancer type</th>
<th>n</th>
<th>TBN</th>
<th>K̄g</th>
<th>Body wt</th>
<th>TBK</th>
<th>TBN</th>
<th>Protein*</th>
<th>TBW</th>
<th>TBF</th>
<th>Σ*</th>
</tr>
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<tbody>
<tr>
<td>GI A‡</td>
<td>4</td>
<td>5.2</td>
<td>6.2</td>
<td>0.0081</td>
<td>0.17</td>
<td>1.06</td>
<td>3.2</td>
<td>1.9</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>8.8</td>
<td>-3.2</td>
<td>-0.0103</td>
<td>-0.06</td>
<td>-0.38</td>
<td>-1.02</td>
<td>-2.3</td>
<td>-3.7</td>
<td></td>
</tr>
<tr>
<td>Head-neck</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>2</td>
<td>-3.9</td>
<td>0</td>
<td>0.0054</td>
<td>0.18</td>
<td>1.13</td>
<td>1.4</td>
<td>-1.9</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>4.1</td>
<td>-5.5</td>
<td>-0.0060</td>
<td>-0.03</td>
<td>-0.19</td>
<td>-3.5</td>
<td>-0.6</td>
<td>-4.3</td>
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<tr>
<td>Lung</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td>-2.8</td>
<td>2.2</td>
<td>0.0023</td>
<td>-0.04</td>
<td>-0.25</td>
<td>-0.25</td>
<td>-0.4</td>
<td>2.7</td>
<td>2.1</td>
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<tr>
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<td>6.9</td>
<td>-7.1</td>
<td>-0.0139</td>
<td>-0.17</td>
<td>-1.06</td>
<td>-2.8</td>
<td>-3.3</td>
<td>-7.2</td>
<td></td>
</tr>
<tr>
<td>Hematology</td>
<td>18</td>
<td>-1.0</td>
<td>-0.01</td>
<td>-0.0015</td>
<td>-0.04</td>
<td>-0.26</td>
<td>0.28</td>
<td>-0.19</td>
<td>-0.17</td>
<td></td>
</tr>
</tbody>
</table>

* Protein, derived from TBN.
† Σ, protein + TBW + total body fat.
‡ A, patients gaining body weight over 6 month period; B, patients losing body weight over 6 month period.
shown in Figure 1. Those patients who maintained or gained weight over the 6-month period (group A) showed an increase in TBN and TBK, (with the exception of the one lung cancer patient), but they exhibited a decrease in the TBN/TBK ratio, (with the exception of the GI cancer patients). Those patients who lost body weight (group B) showed a decrease in TBN and TBK, and an increase in TBN/TBK. The dissociation of the changes in TBN and TBK in cancer patients as well as in patients with other diseases has been noted by several investigators (1, 11).

For each category of patients, the mean protein, TBW, and total body fat are also listed. The last column, labeled Σ, lists the sum of the three parameters: protein, TBW, and total body fat. The mean TBK/TBW ratio in the patients with hematological neoplasms and in the patients with solid tumors who gained weight remained unchanged (Fig. 1). The TBK/TBW ratio fell 6.3% over the 6-month period in patients who lost weight.

**Discussion**

Dietary intake and body composition were studied in 22 cancer patients and eight normal individuals. The patients were divided into two groups according to whether, at the start of the study, they had lost over 10% of their “normal” body weight or had maintained or gained weight. The 13 patients with hematological neoplasms maintained or gained weight. Their intakes of protein, carbohydrates, and fat (hence, their energy intakes) were not significantly different from those of the eight normal individuals (Table 2). The three patients with solid tumors who maintained or gained weight had either unchanged or higher intakes of protein and fat than normal individuals.

The six patients with solid tumors who lost weight had significantly lower protein, carbohydrate, and fat intakes than the eight normal individuals. The mean energy intake per kilogram LBM of the former was lower by 40%. When their energy intake was expressed in terms of LBM, no difference was noted on the basis of sex. The difference between those who gained and those who lost weight appears to be related more to their caloric and protein intake than to their tumor burden or whether or not they were on chemotherapy. However, further research is required before a definite relation between diet and body composition in patients with advanced cancer can be established.

The cancer patients who lost weight were significantly undernourished. Presumably, they will require a 20% increase in protein intake and double the energy intake in order to bring these intakes up to the levels of normal subjects (Table 2). The percentage changes in protein and TBW were approximately equal to those of the loss of body...
weight, as shown in Figure 1. The percentage loss of body fat was most marked (∼18%) for cancer patients losing body weight.

The results of the dietary protein intake and energy intake studies are very similar to those recently reported by Burke et al. (9). They found no significant difference in dietary intake or metabolic rate between patients with cancer who maintained their weight and those with benign disease. They did, however, find that for cancer patients who lost weight, the only parameter that changed was the energy intake: it was lower than that of cancer patients who maintained or gained weight. In the present study, the mean intakes for patients who lost weight were 124 kJ/kg LBM and 1.36 g protein/kg LBM. These values are comparable to those reported by Burke et al.: 126 to 147 kJ/kg LBM and 1.1 g protein/kg LBM (9). Burke et al. also observed that the protein intake was usually well maintained for their cancer patients. This observation is in contrast to the results of the present study, in which not only the energy but also the protein intake was markedly decreased in cancer patients who lost weight.

In their study of the relationship of dietary intake to body composition, Burke et al. (9) showed a direct relationship between both protein intake and caloric intake and the TBK/TBW ratio in patients with benign disease. In the cancer patients who lost weight, however, only the protein intake was correlated with the TBK/TBW ratio. The relationship is expressed as:

\[
\text{TBK (mmol)/TBW (kg) = 0.13 daily intake of protein (g) + 65.06.}
\]

In the present study, the TBK/TBW ratio calculated by this relationship for cancer patients losing weight was 65.3, as compared to the actual measured mean value of 68.9 (TBK expressed in mmol).

The results of Burke et al. indicate that the value of the TBK/TBW ratio falls for individuals experiencing weight loss. Concomitant with the loss was a low caloric and protein intake. TBK decreases with loss of body cell mass, while TBW may either remain the same or increase, since water can be retained in the extracellular pool (10). The present study corroborates the observation of Burke et al. in that the cancer patients who lost weight also showed a decrease in the TBK (mmol)/TBW (kg) from 68.9 to 64.6 (loss of 6.2%) over the 6-month study period (Fig. 1).

Analysis of the changes in body composition over the 6-month period of this very heterogeneous group of 37 cancer patients who received varied chemotherapies or no chemotherapy is difficult. For convenience of analysis, the cancer patients with solid tumors were again divided into two groups on the basis of maintenance or gain of body weight (group A) or loss (over 10%, group B) in the 6-month study period. The 18 patients with hematological cancers maintained their body weight (within ±1%). As expected, their body composition (determined by TBK or TBN/TBK) changed little, if at all, over the 6-month study period (Table 3). Their body composition did not differ significantly from the body composition of normal subjects (11).

The technique of Hill et al. (2) for analysis of body composition was also applied to these data. In this analysis, fat, bone mineral, water, and protein (the latter two reflecting lean soft tissue) were used. It was assumed that bone mineral of the cancer patients did not change significantly during the 6-month study period. Hence, the sum of the changes in body protein, TBW, and total body fat, (denoted Δ), should equal the change in body weight. This expected result is verified, as seen in Table 3.

The weight loss observed in group B patients in all the cancer classifications studied appears to reflect loss of body fat and water, and, to a minor extent, body protein. The decrease in the ratio of BF/TFW appears to vary for patients with different types of tumors.

A technique based on the determination of the ratios of the components of lean tissue yields another useful approach for measuring the effects of hyperalimentation on cancer patients. The body may be resolved into two main compartments, fat, and the fat-free tissue (water, protein, and minerals). In healthy individuals, the composition of the fat-free compartment remains essentially constant. When weight loss occurs, these compartments should experience the loss proportionately. Thus, if 1 kg of lean body tissue is lost, the equivalent loss in protein is 209 g (see Reference 12). Since protein is the most stable of
the above constituents, body water and TBK can be related to the change in the protein level. In this manner, it is possible to analyze the nature of changes in body composition, to the extent of determining whether the tissue gained or lost is of “normal” composition in terms of fluid and potassium concentrations. Information on the nature of the tissue added will be of particular importance for patients receiving hyperalimentation, in order to ascertain whether there is an actual increase in LBM or merely an enhanced fluid retention.

In the present study, the average protein gain for GI cancer patients of group A (patients who maintain or gain weight) was 1.06 kg. If the tissue were normal, the associated gain in water should be 3.7 kg. The gain in water determined for this group was 3.2 kg (within 13% of the amount anticipated for normals). For the GI cancer patients of group B (patients who lost weight), the mean protein value was reduced by 0.38 kg. An associated loss of 1.3 kg TBW would be expected for normal subjects undergoing this amount of protein loss; the measured loss was 1.02 kg (22% less than expected). With the large experimental error in this study, it is not clear that this change is statistically significant.

For the patients with head-neck cancer who maintained or gained weight (group A), the average gain in protein was 1.13 kg. This value is calculated to correspond to increases of 4 kg body water and 0.014 kg potassium for normal subjects (see data on “Standard Normal Man”, Reference 12). As the measured values of TBW and TBK for these patients were only 0.36 of the values calculated for normal tissues, these levels are highly abnormal. For the head-neck cancer patients who lost weight (group B), the loss of TBW was five times the expected value and the loss of TBK was three times the expected value.

The level of total body protein in these patients varied widely. In a previous study of 54 patients with neoplastic disease, Watkin (13) also observed that the nitrogen balance ranged from very positive to very negative values. His data were obtained both from metabolic balance studies and isotope turnover studies. Analysis of his findings led Watkin to suggest that the activity of the neoplastic tissue was the most important factor in terms of the host response. He also found, unfortunately, quantification of tumor “activity” to be very difficult. An attempt to quantify tumor burden in the present study led to the same conclusion. While weight loss alone is not entirely adequate to measure the neoplastic activity, even when caloric and protein intake are adequate, it does give some measure of the catabolic activity of the neoplastic disease.

The results of the present study suggest that the TBN/TBK ratio may more adequately serve to define the recent or ongoing catabolic or anabolic activity of the neoplastic process than quantified tumor burden or weight loss. The ratio may be particularly useful for assessing patients with active neoplastic disease who experience loss of body weight in spite of adequate protein and caloric intake. As pointed out by Watkin (13), it is not at all certain that a high protein diet and adequate caloric intake will result in a positive nitrogen balance in all patients with active neoplastic disease.

In order to quantify the effects of active neoplastic disease, it is first necessary to estimate the dietary energy and protein intakes, and then to proportion the intake of the patient to meet the deficit. To evaluate the effects of the hyperalimentation, it is useful to measure the parameters of body composition (protein, water, and fat). The regime of hyperalimentation can then be designed in a quantitative fashion to make up the deficit in protein and to normalize the TBN/TBK and TBK/TBW ratios. The effects of the dietary program can then be monitored, and further modification introduced as deemed necessary. It would be highly desirable in such a program to evaluate the needs of individual patients, rather than to develop supplemental regimes on the basis of group means, as obtained in the present study.

The application of the techniques for the determination of body composition used in the present study suggests that it should be possible with current technology to assess regimes of hyperalimentation for cancer patients who are experiencing weight loss.

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