A Protein Energy Malnutrition Scale (PEMS)

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Most assessments of protein energy malnutrition have relied on clinical impressions, laboratory tests, or anthropometric measurements. There has been a split in the field between those who favor clinical *versus* laboratory approaches, and each alone misclassifies about 20% of the patients. A 23-item scale is described that provides four subscores derived from anthropometric measurements, clinical history, physical examination, and laboratory tests, as well as a total score. Items rated on logarithmic scales relate to degree of deviation from standards. Reliability was tested by having two physicians rate the same 25 patients and items with better than $r = 0.66$ retained. Validating information came from the finding that the scale discriminated before surgery ($p < 0.001$) between patients who did and did not develop postoperative complications. Use of the scale appears to be a good approach for assessing degree of malnutrition as well as for monitoring changes that occur over time.

OVER THE PAST DECADE, there has been increasing interest in the effects of preoperative protein energy malnutrition (PEM) upon postoperative morbidity and mortality, particularly upon postoperative infections. The prevalence of PEM among hospitalized patients has been found to be surprisingly high, ranging from 20% to 50% depending upon how PEM was assessed.[1-4] Although nutritional support, varying from supplementary oral feedings to total parenteral nutrition (TPN), has frequently been used after surgery, it is generally agreed that nutritional support after surgery may be too late to reverse the onset of complications that could have been caused by preoperative malnutrition. Several studies have focused on preoperative nutritional intervention as a means of altering adverse postoperative outcomes. Some[5-6] have shown positive results while others[7-10] have not. However, deficiencies in sample selection, size, duration of nutritional support, and measurement of outcomes have left the question of the value of preoperative nutritional support largely unanswered to date.

One of the major problems in assessing PEM has been identification of patients for whom nutritional intervention was warranted. At first this was simply done on the basis of diagnosis, so that for example, those with upper gastrointestinal (GI) malignancies were a target group because of their inability to eat an adequate diet. Currently, however, the identification process is more precisely focused upon the question of just who is malnourished and therefore a candidate for preoperative nutritional support as part of the preparation for elective surgery. One of the most sophisticated scales endeavoring to resolve this dilemma has been reported by Mullen et al.[11,12] They started with a relatively large number of potential indicators of PEM obtained on patients undergoing surgery. Patients were followed after surgery and classified by outcomes of mortality and morbidity. Using a combination of discriminant function analyses and regression techniques, they found that four variables were the best predictors of poor outcome. Weights were applied to these values and a per cent risk of mortality/morbidity determined. The four predictors of risk were then cross-validated on a subsequent 100 patients. The four predictors in their Prognostic Nutritional Index (PNI) were preoperative results of serum albumin, triceps skinfold thickness, serum transferrin, and delayed hypersensitivity skin tests.

The PNI, being based upon only a small number of variables that are related to postoperative complications, is deservedly very attractive. Yet there are still problems. Suppose one test cannot be procured. The skin tests, for example, take 48 hours to read. When one indicator is not available, the score, being a composite of only four unique and weighted indicators, would at best require reinterpretation, and at worst be inaccurate. Furthermore, the use of only four items predisposes to loss of some discriminatory sensitivity in relation to the degree of malnutrition present and tends therefore to identify the relatively small number of patients exhibiting nutritional extremes better than the much larger middle group. Furthermore, although the PNI may be effective in identifying morbidity and mortality after surgery, this does not mean that its validity as a measure of nutritional deficits has been established. For example, abnormal levels of serum albumin or anergy could be caused by

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factors other than malnutrition. (Actually this could be said for most of the currently available indicators of malnutrition.) Also along these lines, preoperative immunologic status, as measured by a large array of tests, may also predict postoperative course and, although nutritional and immunologic factors are known to interact, immunologic markers alone are not synonymous with nutritional state.

One reaction to this difficulty in testing scale validity, other than by using correlates of adverse outcomes, is the proposal by some to simply accept the inherent logic that if something appears to be useful when viewed through thoughtful clinical eyes, it automatically achieves what is termed "face validity." This pull between what seems obvious and what appears objective has resulted in a controversy between those in the field who would use hard data from anthropometric and laboratory tests and those who would include softer data from global clinical judgments (often referred to as "eyeballing") to determine nutritional status. While the latter is subjective, it is based upon experience and the value of such clinical judgment, which is at the heart of diagnosis and treatment, should not be underestimated. In fact, a recent study[13] demonstrated good agreement between these two approaches to nutritional assessment, but also showed that disagreement occurred in about 20% of the cases. There would seem to be a need then for a scale that combines what is most valuable from each of these two approaches to nutritional assessment.

Another type of problem in nutritional assessment arises from the fact that criteria used to indicate malnutrition vary considerably between studies. For example, serum albumin levels of 2.1, 2.7, 2.8, 3.0, and 3.5 are each cited in different references as being indicative of malnutrition. The fact that different nutritional markers vary in the rates with which they adjust to changes in nutritional status (*e.g.,* albumin levels are much more stable than those of prealbumin) adds further to the problem of assessment. Malnutrition, therefore, in common with so many other clinical conditions, is obviously not a yes–no dichotomy, but rather a dynamic changing process with many degrees of variation possible that range from borderline to severe deficiency states, depending on when the person is assessed. It would seem logical that using markers of PEM quantitatively rather than qualitatively should provide more accurate placement of an individual along a continuum of degree of malnutrition. Hence, comparison between studies would also be enhanced since it would not only be possible to identify when nutritional support was needed, but also, by serial monitoring, indicate when nutritional repletion had occurred.

In light of the foregoing, there seemed merit in still further attempting to develop a rating scale indicative of malnutrition that would (A) accept some degree of redundancy and use a larger number of indicators, (B) quantify each individual indicator used, and (C) use data derived from the broadest possible base of anthropometric, clinical, and laboratory sources. Furthermore, for biometric refinement of the scale, it is specifically planned to utilize factor analysis rather than regression techniques in order to result in correlated subgroups of indicators that can be totalled to produce a final score indicating degree of PEM. This is an advantage because such a score, derived from a larger number of indicators, should tend to retain validity in the event that a few of the indicators are missing. The purpose of this paper, therefore, is to describe the development, scoring, reliability, and validity of a new scale for assessing protein-energy malnutrition, which, based upon its achronym, is referred to as the PEMS.

The Scale Items

Figure 1 shows the current version of the scale. Items in the anthropometric and laboratory tests were selected on the basis of their usefulness as indicators of PEM in other studies. The clinical history and physical examination items were chosen from experienced clinicians such as Butterworth[14] and others in the field. Initially, more items were included in the scale, but only those that showed acceptable reliability were retained. Items in each of the four major groups will be briefly discussed, where pertinent, in regard to either method of measurement or rationale for inclusion.

Anthropometric Items

The rationale for including per cent of ideal body weight as well as per cent weight loss was that some individuals might be less than their ideal weight because of weight loss, others might be less than ideal but always maintain that weight, and still others might be obese and above their ideal weight but have lost weight because of malnutrition. Thus, both seem needed. The person's height, weight, and frame size are required to determine ideal weight. Frame size can be determined by measuring the person's wrist at the smallest point. The circumference in centimeters is divided by the person's height in centimeters. Medium size for women is 9.6 to 10.4 and for men is 9.9 to 10.9. Larger or smaller values represent large and small size frames. Once these figures are known, the ideal weight can be determined from standard charts such as the Metropolitan Life Insurance Tables.

The triceps skinfold is used as a measure of body fat reserves. A tape measure is placed down the back of the arm from acromion to olecranon while the forearm is bent across the abdomen. The midpoint is marked on ırm. With the arm relaxed at the person's side, a of skin and fat is pulled away from the muscle with humb and forefinger about 1 cm above the midpoint. ıng Skinfold Caliper is placed over the skinfold at narked midpoint for about 3 seconds. Three readings do not vary greatly should be taken and averaged.

ıe midarm muscle circumference was selected to sure skeletal muscle protein mass. The same mid- t on the arm is used. The tape is drawn around the without compressing the muscle. Midarm muscle ımference in centimeters is derived then from arm ımference (cm) times 10, minus 3.14 times skinfold :ness (mm).

ical History and Physical Examination

lthough clinical judgment derived from findings on history and physical examination is often used in rmining malnutrition, no attempt has been made to to quantify such observations in an objective man- Major manifestations of malnutrition were selected hese two sections of the scale. In addition to merely ıg each item under the history or physical exam ons, some of the conditions that might suggest the ence of that item have also been included, as re- ders, along with the item. Since there has been no npt to provide a comprehensive listing of all possible cal conditions that might be associated with each of tems, the physician will need to question the patient ıer in areas that he or she suspects might still have ficance in relation to nutritional status. The physical ıination items include observations related to PEM eneral more than to specific vitamin and mineral iencies. A trained observer can identify the signs kly in examination. Although some of the items are :ators of conditions other than malnutrition, they occur frequently in connection with PEM.

oratory Tests

number of laboratory procedures are available in : hospitals that can serve as indicators of nutritional .s. Visceral proteins that provide a balance between ıation of long- and short-term changes have been ıded. Over a 3-month period of time, if a person 30% of their weight, all plasma proteins will be essed. However, to detect changes that have occurred lly in response to an acute problem, thyroxin- ing prealbumin and retinol-binding protein may be ed in addition to serum albumin and serum trans- ı (which reflect longer term malnutrition). Persistent ›albuminemia, therefore, may suggest chronic nu- ›nal deficiency.

:rum transferrin transports iron in the plasma. Al- gh serum transferrin can be measured accurately

Directions: Circle the category under the 1-8 scales that applies. Sum each of the 4 areas separately and divide by the number of items obtained in each area. Scores should be exnressed to the second decimal place. Total the 4 areas for an overall malnutrition score.

	1	2	4	8	SCORES
Anthropometric:					
Relation to Ideal Body Weight (%)	≥ 90	85-89	80-84	< 80	
Weight Loss from Usual Weight (%) (not due to dieting or diaresis)	≤ 5	6-12	13-14	≥ 20	
Triceps Skinfold (mm)					
Men	≥ 9	7.0- 8.9	5.0- 6.9	< 5	
Women	≥ 16	11.0- 15.9	6.0- 10.9	< 6	
Mid-Arm Muscle Circumference (mm)					
Men	≥243	216.0-242.9	189.0-215.9	<189	
Women	≥192	170.0-191.9	148.0-169.9	<148	—.— —
Clinical History:					
Inadequate Nutrient Intake (alcoholism, upper GI cancer, NPO, deficient diet, poor dentition, etc.)	None	Mild	Moderate	Severe	
Excessive Nutrient Losses (vomiting, diarrhea, mal-absorption, fistula, draining wound, proteinuria, etc.)	None	Mild	Moderate	Severe	
Increased Metabolic Needs (burns, fever, trauma, infection, recent surgery, pregnancy, hyperthyroid, etc.)	None	Mild	Moderate	Severe	
Antinutrient or Catabolic Medication (steroids, immunosuppressants, anti-tumor, etc.)	None	Mild	Moderate	Severe	—.— —
Physical Examination:					
Cachexia	None	Mild	Moderate	Severe	
Hair (easily-pluckable) Nails (brittle or ridged)	None	Mild	Moderate	Severe	
Hepatomegaly/Ascities	None	Mild	Moderate	Severe	
Muscle Atrophy (generalized, temporal, hand, calf)	None	Mild	Moderate	Severe	
Edema (generalized)	None	Mild	Moderate	Severe	
Skin Changes (dry, scaling, lesions)	None	Mild	Moderate	Severe	—.— —
Laboratory/Tests:					
Serum Albumin (gm/dl)	≥ 3.5	2.8- 3.4	2.1- 2.7	< 2.1	
Hemoglobin (gm/dl)	≥ 14	13.9-12.0	11.9-10.0	< 10	
4 Delayed Hypersensitivity Skin Tests (mm)	≥2>5mm	1>5mm	Any<5mm	0mm	
Lymphocytes (cells/cc)	≥1500	1200-1500	1000-1200	<1000	
Creatinine Excretion Index (% standard)	≥ 80	60-79	40-59	< 40	
Serum Transferrin (mg/dl)	≥ 200	150-199	100-149	< 100	
Retinol-Binding-Protein (mg/dl)	≥ 3.0	2.5-2.9	2.0-2.4	< 2.0	
Serum Prealbumin (mg/dl)	≥ 15	12.5-14.9	10.0-12.4	< 10	
Negative Nitrogen Balance (gms lost per day)	≤ 5	5.1-10.0	10.1-15.0	> 15	—.— —
TOTAL PEMS SCORE					—.— —

FIG. 1. The PEMS (Protein Energy Malnutritional Scale).

by radial immunodiffusion, the value can also be determined from a measure of total iron binding capacity (TIBC) as follows:

$$\text{Serum transferrin} = (0.8 \times \text{TIBC}) - 43$$

Lymphocyte and hemoglobin levels are easily obtained and provide some useful information about nutritional status.

The creatinine excretion index serves as an indirect measure of lean body mass and calls for a 24-hour urine measurement of creatinine. Normal men excrete approximately 23 mg creatinine per kilogram of ideal body weight and women approximately 18 mg. The index is derived by dividing the predicted by the actual 24-hour creatinine excretion and multiplying the result by 100.

Nitrogen balance is measured in grams lost per day and is an estimate of the net flux of lean body mass. Nitrogen balance is calculated by dividing protein intake by 6.25 (which represents the nitrogen intake) and then

TABLE 1. *Correlations Between First and Second Ratings of the Same 25 Patients on the Four Subscale Scores*

Subscores	Intraclass Correlations
Anthropometric score	0.88
Clinical history score	0.74
Physical examination score	0.69
Laboratory score	0.91
Total PEMS score	0.84

Scores range from 1 to 4 for the four subscale scores and from 4 to 30 for the total score.

subtracting the nitrogen loss over the same period (total urinary nitrogen excreted over 24 hours + 5 mg N/kg to account for insensible nitrogen losses + 12 mg N/kg to account for nitrogen loss from the GI tract).

Lastly, immune status provides a good estimate of nutritional state. Subjects should receive a standard battery of at least four recall antigens such as purified protein derivative (PPD), mumps, candida, or trychophytin. Reactivity is determined 24 to 48 hours later by degree of induration and erythema. An induration of 5 or more mm in diameter is considered positive.

Scoring

The rating points on the scale correspond with ranges in the literature. In many items they range from 60% to 90% of the standards, unless other values represent either mild or severe malnutrition. The anthropometric and laboratory ratings for severe were set at levels above those found in a totally starved individual. If the severe values had been made lower, this category would seldom be used and thus the scale would essentially only discriminate three rather than four degrees of severity. The second category represents mild or borderline deficiency; the third category indicates a serious depletion that requires treatment but could be much worse; the fourth category represents a dangerously low level in regard to morbidity and mortality and definitely requires treatment. These same criteria hold for ratings made on the none to severe scales for the history and physical examination observations as well.

In order to have a scale that could still provide scores in the face of limited amounts of missing data, particularly in regard to some of the laboratory tests that may not be readily available on a routine basis, each of the four areas of the scale are averaged by the number of items rated. All items under anthropometric, history, and physical examination should, however, always be available. Since reliability and validity were tested with all items, the scale may not be as accurate as reported if any of the laboratory values are not available. Average ratings in each of the four areas should be calculated beyond two decimal points. Scores for each area can be used separately or totaled for an overall PEM rating. The totaled scores could therefore range anywhere between a low of 4.00 to a high of 32.00.

Reliability

Reliability refers to whether the scale is objective and reproducible. To assess reliability, two physicians independently rated the same 25 patients on the anthropometric, clinical history, and physical examination sections of the scale and the laboratory tests ordered twice for each patient. Intraclass correlations were computed between the two sets of ratings. Those items with values of $r = 0.66$ or above were retained. The original scale had included one more item under clinical history and two more under physical examination that were deleted because of low reliability. Table 1 shows the reliability for the four subscores. As can be seen, laboratory values were the most reliable, anthropometric next, clinical history next, and then physical examination.

Validity

Validity deals with whether the scale measures what it is intended to measure, namely malnutrition. One of the usual validating criteria in relation to preoperative nutritional assessment has been the incidence of postoperative complications. As indicated earlier, validity is difficult to evaluate here since there are causes of complications other than malnutrition. Thus, validating the scale against such criteria does not prove that it measures nutritional state, although it seems likely that it should be associated with such factors.

Initially, the scale was rated 1 to 4 with 4 being the highest value for the severe category. A total of 98 patients undergoing elective abdominal surgery was rated on the PEMS before surgery. They were followed after surgery in regard to morbidity and mortality until death or discharge from the hospital. Postoperative complications occurred in 18% of the patients. Patients with and without complications were compared on the PEMS items. Since there were only three deaths in this series (all having other postoperative complications as well), a comparable analysis between survivors and non-survivors was not done.

As can be seen in Table 2, the 23 scale items discriminated between those with and without postoperative complications at a multivariate level of $p < 0.001$ ($F = 26.4$) using all 23 items. Thirteen scale items reached univariate significance levels of $p < 0.05$ or better, with six items significant at better than the 0.01 level. Listed in order of importance, these six items were negative nitrogen balance, per cent of ideal body weight, serum albumin, skin tests, muscle atrophy, and excessive nutrient losses. It is noteworthy that these predictors emerged from each of the four subgroups and that although only two predictors were identical to those used for the PNI (serum albumin and skin tests), they were the two strongest found for that index.

One might ask whether the ten items that did not reach univariate 0.05 levels are really necessary to retain as part of the scale. The high multivariate F levels found using all items indicates their valuable interactive contributions. In addition, when all of the 23 scale items were summed for a total score, prediction was equally good, also reaching a level of $p < 0.001$. By principal component factor analysis, a technique that identifies the largest possible group of correlated variables, a large proportion of all of the indicators used in the scale were selected. This further assures that the scale items can be added to obtain a total scale score. Beyond these statistical reasons, the potential of these ten items as useful backups for a scale item such as a laboratory test, which might be unavailable for an individual patient, also argues in favor of their being retained.

Finally, the scale was rescored using a geometric rather than an arithmetic basis for scoring, so that the category values indicating degree of malnutrition were represented as 1, 2, 4, and 8 instead of 1, 2, 3, and 4. The rationale for geometric scoring is based in part upon the clinical observations in trauma patients that the severity of complications bears a logarithmic relationship to the number of injuries sustained. Interestingly, using the geometric scores increased the F-ratios related to the significance of the items as predictors of outcome, but of course did not change the order of the indicators of malnutrition that were identified.

Discussion and Conclusions

We have demonstrated the development of a rating scale for assessing degree of malnutrition that endeavors to capitalize upon the many existing significant findings of others in the field. It was desired first to incorporate clinical items from the history and physical examination as well as from anthropometric, immunologic, and laboratory tests in order to add some of the evident advantages of the "eyeball" school. In addition, it was proposed through use of factor analysis, rather than regression techniques, to identify a larger group of items so that the total scale score might not only yield greater predictive sensitivity, but also permit scoring in face of the occasional missing laboratory variables with less chance of losing significant degrees of predictive validity. Finally, the weighting of items in terms of severity was changed to a logarithmic basis to possibly further increase score validity.

It is felt that the present version of the scale holds promise for achieving the above goals. It is considered

TABLE 2. *Comparison of Significant Preoperative Mean Nutritional Ratings Between Those Patients Who Developed Postoperative Complications and Those Who Did Not*

	Postoperative Complications		
Variables	No (82%)	Yes (18%)	F-Ratios
Nitrogen balance	1.3	2.8	30.9*
% ideal weight	1.2	2.0	19.6*
Serum albumin	1.4	2.0	12.4*
Skin tests	1.7	2.3	7.6†
Muscle atrophy	1.2	1.8	6.4†
Excessive nutrient losses	1.2	1.9	5.0†
Serum transferrin	1.6	2.1	3.3‡
Triceps skinfold	2.0	2.9	3.2‡
Serum prealbumin	1.6	2.5	3.2‡
Increased metabolic needs	1.1	1.6	3.0‡
Cachexia	1.1	1.5	2.9‡
Retinol binding protein	1.4	1.9	2.8‡
Weight loss	1.6	2.1	2.7‡
Multivariate F (Using all 23 items on the PEMS)			26.4*

Items were scored 1 to 4, with 4 being more severe ratings.
* $p < 0.001$, † $p < 0.01$, ‡ $p < 0.05$.

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                         NUTRITIONAL ASSESSMENT DATA

                         DOE, JOHN
                              DATE....: 1/1/84
                              STUDY #.: 1
                              AGE.....: 52
                              GROUP...: 4
                              PERIOD..: 0

ANTHROPOMETRICS                              URINE TESTS
    HEIGHT (INCHES)          65.00               UR VOL (CC/24H)          1000.00
    CURRENT WEIGHT (LBS)    125.00               UR CR'TNINE (MG/24H)     1240.00
    USUAL WEIGHT (LBS)      145.00               UR PROTEIN (GM/24H)         0.05
    % WT CHANGE             -13.79               URINE UREA N (MG/DL)        0.63
    FRAME RATIO              10.32
    IDEAL WEIGHT (LBS)      130.90
    % IDEAL WEIGHT           95.49
    SA (SQ.M)                 1.62
    TRICEPS SKN FLD (MM)      5.00           CLINICAL AND METABOLIC
    MAMC (MM)               244.30               CALORIC INTAKE (24H)     3056.00
                                                 PROTEIN IN (GM/24H)       140.00
                                                 NITROGEN BAL (GMS)         18.39
                                                 % PROTEIN USED             65.68
                                                 CATAB STRESS INDEX        -14.19
BLOOD AND SKIN TESTS                             CREATININE EXC INDEX       41.19
    HEMOGLOBIN (GM/DL)        8.60               METAB ACTIV FACTOR          1.50
    WBC (CMM)              2900.00               FEVER (DEG>37/24H)          0.00
    LYMPHOCYTES (CMM)      1102.00               O2 USED (L/M@STP)           0.17
    ALBUMIN (GM/DL)           3.90               CO2 PROD (L/M@STP)          0.03
    PREALBUMIN (MG/DL)                           BEE (BY SA AND AGE)      1316.31
    RET-BND PROT (MG/DL)     11.00               BEE (BY CAL/HR/AGE)      1393.11
    TRANSFERRIN (MG/DL)     250.00               METAB (BY O2/CO2)        1008.29
    +SKN TSTS (PER 7)         6.00               % CALORIES (IN/BEE)       232.16
                                                 CAL/POS N BAL/24H        2032.06
                                                 CAL/ZERO N BAL/24H       1693.38

                    NUTRITIONAL SCORES
                         PNI                     28.26
                         NRI                     39.86
                         PEMS                    12.42
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FIG. 2. Computer printout of nutritional assessment data and nutritional scores.

important for busy clinicians to be aware that it does not take more than a few minutes to complete the scale since the majority of scale items will already be known to the patient's own examining physician. We have been able to simplify use of the scale even further by only requiring the clinician to record the actual values found for each indicator. A computer program has been developed that then calculates the scale value for each items and prints the values of significant findings as well as the final scale score on a form suitable for inclusion in the patient's clinical record. An example of this computerized output is provided as Figure 2. We are presently using both the PEMS and the PNI in a prospective randomized study of hyperalimentation in head and neck cancer patients. At the completion of the study, we hope to be able to derive some further conclusions in regard to the clinical utility of these nutritional scales as well as to the need for preoperative hyperalimentation.

References

1. Bistrian BR, Blackburn GL, Hallowell E, et al. Protein status of general surgical patients. JAMA 1974; 230:858.
2. Bistrian BR, Blackburn GL, Vitale J, et al. Prevalence of malnutrition in general medical patients. JAMA 1976; 235:1567.
3. Hill GL, Blackett RL, Pickford I, et al. Malnutrition in surgical patients: an unrecognised problem. Lancet 1977; 1:689.
4. Linn BS. Outcomes of older and younger malnourished and well-nourished patients one year after hospitalization. Am J Clin Nutr 1984; 39:66–73.
5. Heatley RV, Williams RHP, Lewis MH. Pre-operative intravenous feeding—A controlled trial. Postgrad Med J 1979; 55:541–545.
6. Mueller JM, Brenne U, Dienst J. Preoperative parenteral feeding in patients with gastrointestinal cancer. Lancet 1982; 9 January, 1:68–71.
7. Moghissi K, Hornshaw J, Teasdale PR, et al. Parenteral nutrition in carcinoma of the esophagus treated by surgery: nitrogen balance and clinical studies. Br J Surg 1977; 64:125–128.
8. Simms JM, Oliver E, Smith JAR. A study of total parenteral nutrition (TPN) in major gastric and esophageal resection for neoplasia. Journal of Parenteral and Enteral Nutrition 1980; 4:422.
9. Lim STK, Choa RG, Lam KH, et al. Total parenteral nutrition versus gastrostomy in the preoperative preparation of patients with carcinoma of the esophagus. Br J Surg 1981; 68:69–72.
10. Sako D, Lore JM, Kaufman S, et al. Parenteral hyperalimentation in surgical patients with head and neck cancer: a randomized study. J Surg Oncol 1981; 16:391–402.
11. Mullen JL, Buzby GP, Waldman MT, et al. Prediction of operative morbidity and mortality by preoperative nutritional assessment. Surg Forum 1979; 30:80.
12. Buzby GP, Mullen JL, Hobbs CL, et al. Prognostic nutritional index in gastrointestinal surgery. Am J Surg 1980; 134:160.
13. Baker JP, Detsky AS, Wesson DE, et al. Nutritional assessment: a comparison of clinical judgment and objective measurements. N Engl J Med 1982; 306:969–972.
14. Butterworth CE. Some clinical manifestations of nutritional deficiency in hospitalized patients. *In* Levenson SM, ed. Nutritional Assessment—Present Status, Future Directions, and Prospects. Columbus, Ohio: Ross Laboratories, 1981; 2–4.