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# Sensitivity and specificity of a nutrition screening tool for patients admitted to general medical and surgical services

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

SENSITIVITY AND SPECIFICITY OF A NUTRITION SCREENING TOOL  
FOR PATIENTS ADMITTED TO GENERAL MEDICAL AND SURGICAL  
SERVICES

A thesis submitted in partial satisfaction of the  
requirements for the degree of

MASTER OF SCIENCE  
IN  
DIETETICS AND NUTRITION

by

Vanessa Cruz

1998

To: Dean DeLois P. Weekes  
College of Health Sciences

This thesis, written by Vanessa Cruz, and entitled Sensitivity and Specificity of a Nutrition Screening Tool for Patients Admitted to General Medical and Surgical Services, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this thesis and recommend that it be approved.

Suanne Friedman

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Susan P. Himburg, Major Professor

Date of Defense: July 17, 1998

The thesis of Vanessa Cruz is approved.

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Florida International University, 1998

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ABSTRACT OF THE THESIS

SENSITIVITY AND SPECIFICITY OF A NUTRITION SCREENING TOOL  
FOR PATIENTS ADMITTED TO GENERAL MEDICAL AND SURGICAL  
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by

Vanessa Cruz

Florida International University, 1998

Miami, Florida

Professor Susan P. Himburg, Major Professor

It is standard practice in acute-care settings to screen patients upon admission to determine whether they need a nutritional assessment; however, there is limited information on the ability of the screening tools to detect patients at nutritional risk. The purpose of this study was to determine (1) the sensitivity and specificity of the screening tool used at Jackson Memorial Hospital and (2) whether a new proposed tool would be more sensitive and specific. Dietitians screened patients upon admission using the existing and proposed tools (n=141). Sensitivity and specificity of these tools in identifying patients at nutritional risk was calculated. Mantel-Haenszel chi-square statistics were used to identify indicators correlated with

nutritional risk. A revised tool was tested and found to have a higher sensitivity than the existing tool but lower specificity. Odds ratios indicated that the revised tool had a higher degree of association with nutritional risk than the existing one.

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## I. Statement of the Problem

The key trend in the 1990s in health care is "the need to do more and better with less" (1), and the challenge has become to reduce costs while maintaining quality of care (2). A challenge for dietitians in acute-care settings is to quickly identify which patients require nutritional intervention since it is not economically efficient for dietitians to interview, assess, and counsel all patients (3).

It is important to identify malnourished patients or patients at risk of malnutrition because the condition is linked to increased complications and therefore higher morbidity, mortality and costs (4). Furthermore, there is ample evidence that medical nutrition therapy is effective in improving outcomes in patients identified as malnourished (5).

Malnutrition is still a problem in acute-care settings; recent surveys indicate that between 31% and 61% of patients admitted to an acute-care facility in this country have some parameter indicative of undernutrition (6,7,8,9,10,11,12,13,14). Furthermore, the problem is aggravated with length of stay. In a prospective evaluation of general medical patients conducted in 1988, Coats (10) found that 46% of

patients were malnourished after two weeks in the hospital, an increase from 38% upon admission. The longer patients stay in the hospital, the more likely it is that they will become malnourished; therefore, it is imperative to identify patients at risk of malnutrition as early as possible in order to intervene appropriately.

An approach that has been used to address the problem of malnutrition in the acute-care setting has been to "screen" patients upon admission to identify patients that may be "at nutritional risk." Results of a survey mailed to dietitians in the nutrition support practice group of the American Dietetic Association (ADA) in 1991 indicated that most clinical dietitians conducted nutritional screenings and assessments (15). Some respondents identified the greater use of screening to identify nutritional risk as a significant change in practice within the previous five years, and only 11% of the hospitals in which nutrition support dietitians worked conducted a complete nutritional assessment of all patients admitted. The investigators concluded that there is a need to implement standardized practices for screening and assessment. Unfortunately, data on the sensitivity, the probability that a person predicted to be at risk by the tools is actually at nutritional risk, and specificity, the probability that a person predicted not to be at risk by the tools is actually not at nutritional

risk (16), of the tools used for screening purposes is scarce, and there is no consensus on what a cost-effective screening tool is (17).

Jackson Memorial Hospital is a 1500-bed, county-funded, acute-care facility in an urban setting, affiliated with the University of Miami Medical School. In an effort to prepare for the inspection by the Joint Commission on Accreditation of Hospital Organizations (JCAHO), a nutrition screening tool was developed and implemented in 1995. However, the tool is not uniformly utilized throughout the institution, and data validating its sensitivity and specificity has not been gathered. Since then, the institution has come under more strict financial scrutiny and has embarked on a reengineering project; therefore, it has become imperative to develop a screening tool to identify patients at nutritional risk. The purpose of this study was to develop a screening tool that is appropriate for the inpatient population at Jackson Memorial Hospital.

Questions to be answered:

1. What is the sensitivity and specificity of the screening tool used currently in the institution?
2. Would a new proposed tool be more effective in identifying patients at nutritional risk?

3. What questions could be used as indicators of nutritional risk in an acute-care setting?
4. What would be the sensitivity and specificity of such indicators in predicting nutritional risk?

#### Limitations of the study

Sample size is small due to practical limitations of time and money, and, therefore, statistically significant results may not be documented. Study results may be biased due to the particular characteristics of the patient population of the institution (urban, many indigent patients, largely Hispanic and African American.)

Although the newly developed tool will be used primarily by paraprofessionals with very little training in nutrition, the data gathering for this project was conducted by registered dietitians. Further research may be necessary to test whether this tool can be effectively used by paraprofessionals.

Unfortunately, resource limitations did not allow for gathering data regarding outcomes. Therefore, the effectiveness of the screening tools was only evaluated by their ability to detect certain parameters that have been found in the literature to be associated with unfavorable outcomes. In addition, accurate diagnosis data was not

available upon admission; therefore, admission diagnosis was not included in the analysis.

## II. Review of Literature

Since 1974 when Charles Butterworth brought to light the existence of malnutrition in hospitalized patients (18), there have been efforts to address the problem. Indeed, when Coats revisited a study published by Weinsier in 1979, the incidence of malnutrition after two weeks in the hospital was reduced to 46% compared to 62% fourteen years earlier (10). The causes of deteriorating nutritional status in hospitalized patients are many; patients frequently miss meals because they are scheduled for tests and procedures, or are given medications that reduce appetite or cause nausea, vomiting or diarrhea (19,20). Furthermore, physicians may not recognize or address malnutrition. Roubenoff found that medical students are not trained to recognize malnutrition (21), which is consistent with reports in the literature that in general most physicians trained in this country receive very limited nutrition education (22).

Frequently dietitians are the only ones standing between patients and deteriorating nutritional status. In the most recent position of the ADA on the role of dietitians in nutrition support, dietitians are expected to identify patients at nutritional risk, perform nutritional assessments and "act as the advocate for all aspects of



nutritional care" (23). The most recent standards published by the JCAHO require that registered dietitians conduct nutritional assessments and recommend a nutritional care plan (24).

Documented efforts by dietitians to conduct assessments date as far back as 1906, and a perennial problem for the profession seems to be that dietitians have much less time than they need to assess patients (25). Shapiro in 1979 proposed "preliminary screening by paraprofessionals and the use of short-cuts and tools to simplify nutritional assessments." In 1980, Simko (26) outlined a desirable process of nutritional management of hospitalized patients designed to address the problem of malnutrition. The first step was an assessment by a dietitian. Since then a number of programs have been described in the literature. Winbourn (27) in 1981 described a program implemented by the nutrition support services of three Chicago hospitals. This program required extensive weekly evaluations of patients referred to the service by physicians for follow-up by the Metabolic Support Service. Sandrick (28) in 1980 described the functions of nutrition support teams at various hospitals. The author used the term "screening" to refer to the process of nutritional assessment conducted by dietitians.

The concept of "screening" as we currently know it began to appear in the literature in the early to mid 80's. Ometer (29) in 1982 described the screening program at a 489-bed, specialty referral hospital. Dietetic technicians would interview all patients within 24 hours of admission and gather data from the medical record. This information would then be relayed to the dietitians who would conduct an assessment if the patient had: a weight < 85% of ideal body weight (IBW); weight loss > 10% of usual body weight (UBW); serum albumin level < 3.5 g/dl; reduced food intake; nausea, vomiting, or diarrhea; recent major surgery; illness for longer than three weeks; or "a diagnosis with nutritional implications." No evaluation of this program was documented.

Potosnak (30) in 1983 described a "Nutrition Assessment Screening" technique implemented at a 940-bed, acute-care facility. The form was filled out by nursing personnel as part of the standard admission procedure and given to the dietitian to record biochemical data. Patients were considered to be at risk if they met three or more of the following criteria: weight loss of > 7% of UBW, serum albumin level < 3 g/dl, hemoglobin less than 11 g/dl, total lymphocyte count (TLC) < 1500/mm<sup>3</sup>, and blood urea nitrogen (BUN) < 10 mg/dl or > 20 mg/dl. A feasibility study conducted on 50 patients concluded that the form required

fifteen to twenty minutes to be filled out. No further evaluation was documented.

Frey (31) in 1984 described the development of a screening program in an 185-bed, acute-care facility in a rural area. All patients were to be screened by a Certified Dietetic Assistant (paraprofessional) who would review the cardex, interview the patients, and over the course of two days gather medical and laboratory data. The registered dietitian on staff would then review this information and "using available data and exercising clinical judgment" decide who would require a full assessment. A review of 793 randomly selected patients revealed that approximately 40% of them did not require nutrition care and that filling out and reviewing the screening tool took less than seven minutes of the assistant's time and less than one minute of registered dietitian's time.

Thompson (32) in 1984 published the results of nutrition screenings conducted on 1141 adult surgical patients at the University of Nebraska Medical Center. A registered dietitian was to "screen" patients within 48 hours of admission. Although a number of indicators were gathered by the dietitian, including information on current eating patterns, appetite, and recent operations, patients were considered at risk only if they were at less than 90% of IBW

(midpoint of Met Life medium frame), had serum albumin level < 3.4 g/dl, or TLC < 1,400/mm<sup>3</sup>. The study found that more than a third of all patients had at least one abnormal parameter.

Another such program is described by Hannaman (33). Using "clinical judgment" a committee of dietitians developed a list of "high risk diagnoses" to be used as indicators for nutrition assessment in addition to other frequently used parameters such as serum albumin level < 3.5 g/dl, weight loss > ten pounds in six months, and poor food intake for the previous five days. No evaluation of this program was reported.

Christensen (34) in 1985 described a screening program in a 300-bed, acute-care community hospital. The author reported that prior to the implementation of this program, registered dietitians spent most of their time educating patients on modified diets and relied on referrals by other medical staff to identify patients at risk of malnutrition. As part of the screening program, dietetic assistants (paraprofessionals) interviewed all patients within 24 hours of admission. Although a number of questions were asked, malnutrition was defined as serum albumin level < 3.5 g/dl, or TLC < 1,500/mm<sup>3</sup>, and only patients meeting the criteria for malnutrition were referred to the registered dietitian.

Completing the form required an average of ten minutes. Approximately one third of the patients receiving routine diets or modified diets met the criteria for malnutrition, leading the author to conclude that modified diets are not a good indicator for detecting nutritional risk. In a follow-up evaluation of this study (35), of 110 malnourished patients identified by the screening, 68 patients qualified for increased reimbursement as the result of the diagnosis of malnutrition. This translated into an increase in revenue > \$16,000 for those patients. When extrapolated to the general patient population for that hospital, these results translated into an estimate of > \$200,000/year increase in revenue for the hospital. Sayarath (36) in 1993 also concluded that screening is good business for hospitals. In a review of medical charts of 34 malnourished patients at a 200-bed, community hospital, she concluded that if malnutrition had been coded as a comorbidity, an increase of > \$34,000 in revenues could have been realized.

In 1985, Hunt (37) described a nutritional assessment program at a teaching facility of the University of Texas Medical School. Of interest is that the process to implement this program was "fueled by an increase in the patient to registered dietitian ratio." An initial step to implementation was a review of the literature on screening to date which identified the following problems:

sophisticated programs were costly, effectiveness of programs was not well documented, and practical information on how to implement such programs was not readily available.

A task force of registered dietitians and registered diet technicians "determined the essential elements" of a desirable program to be: height, weight, and serum albumin level available upon admission; review of previous medical history for other risk factors; communication to others via the medical record; and minimal time requirements. A form called the "Screening Nutritional Profile" was developed to be filled out in part by the patient and by the admitting nurse within 24 hours of admission. A diet clerk collected the forms and gave them to the registered dietitians for evaluation. Nutritional risk as defined by the presence of any of the following: > ten pounds weight loss in six months; missing meals for more than five days; daily vomiting or diarrhea; presence of Crohn's disease; chronic renal failure; chronic liver disease; cancer; diabetes mellitus; bedsores; recent surgery or illness lasting more than three weeks; or fever for more than three days combined with either serum albumin level < 3.5 g/dl or weight < 80% of IBW. Registered dietitian's time spent on data gathering was reduced from 25 minutes per patient to five minutes. Approximately one third of all patients answered yes to one of the questions, and patients found to be at risk had a

significantly higher mean length of stay than patients at low risk.

Hedberg (38) in 1988 described a program in a 931-bed, acute-care, nonprofit, general hospital. Patients were screened by registered diet technicians on the fifth day of admission using data from the nursing cardex and the medical record. Patients were considered to be at risk if they met any of the following criteria: serum albumin level < 2.8 g/dl, TLC < 900/mm<sup>3</sup>, weight < 80% of IBW, weight < 80% of UBW, weight < 80% of admission weight, > ten days without food, or diagnosed as malnourished by a physician. Patients were also referred to the registered dietitian if they met two of the following criteria: serum albumin level < 3.5 g/dl, TLC < 1500/mm<sup>3</sup>, weight < 90% of IBW, weight < 90% of UBW, weight < 90% of admission weight, > five days without food, reduced appetite, patient receiving enteral or parenteral nutrition, nutrition related diagnosis, more than one surgery during this admission, or > fourteen days in the hospital. Of 225 patients screened, 36% met the criteria for nutritional risk. The screening process took approximately fifteen minutes per patient. The process was later changed to screen immediately upon admission all patients receiving enteral or parenteral nutrition and those with bedsores.

Although screening is a normal part of how we currently conduct the business of dietetics in acute-care facilities (39) and is believed to be a key element in assuring accountability in clinical nutrition services (40), data on the sensitivity and specificity of the tools used is scarce. Brown (41) in 1988 described a screening program for patients admitted to a 300-bed, acute-care hospital. Indicators were gathered from interviews with the patients and a review of the medical records. Patients were considered to be at risk if they had three or more indicators of risk such as weight < 93% of UBW or any biochemical abnormality. The authors attempted to validate this program by assessing the ability of these indicators to predict whether parenteral nutrition or a nutritional consult was ordered. One might argue that the only value of this tool is predicting nutrition support costs, since other authors have not found the presence of nutrition support to be a good indicator of malnutrition (42) and that the purpose of a nutrition screening program is to identify patients that may be missed by physicians.

Elmore (43) in 1994 evaluated a nutrition screening program implemented with surgical and medical patients. The screening tool was a form designed to be filled out by the patient, a family member or a volunteer upon admission. Elmore compared the sensitivity and specificity of the



screening criteria to the results of a full nutrition assessment on 100 consecutively admitted patients. The original screening tool, which included parameters such as vomiting, diarrhea, admitting diagnoses and age, was based on "clinical impression of importance to the diagnosis of malnutrition." It failed to identify 60% of the patients at risk. Adding albumin improved the sensitivity, but the authors noted that only 4% of the patients had albumin levels drawn on admission. In this study, the best predictors of nutritional status were a combination of serum albumin levels, total lymphocyte count, and percent weight loss. Elmore then tested the validity of this equation on a different population of randomly selected patients and found that the derived equation reduced the percentage of false negatives from 9% with the original screening tool to 2% and that adding prealbumin to the equation did not improve the results. This may be a function of how the authors defined malnutrition. If malnutrition is defined as a combination of a certain level of albumin, weight loss, and TLC, then the best predictors of malnutrition will be those markers. Prealbumin will not be a good predictor because it is a more sensitive indicator of recent intake than albumin and weight loss.

Part of the challenge is that the forms described in the literature are intended to serve a variety of purposes:

identifying patients food concerns, educational needs, and risk of malnutrition. Addressing food acceptance concerns and modifying menus accordingly are traditional registered dietitian tasks. A recent survey indicated that physicians see clinical dietitians as having a large degree of responsibility in ensuring patients' satisfaction with the food served, helping patients select food from the menu, checking food trays before delivery to patients, and distributing and collecting menus from patients (44). Therefore, some of these screening forms are intended to identify which patients may need diet adaptations. However, need for a modified diet has not been demonstrated in the literature to be an indicator of nutritional risk.

Another traditional registered dietitian task is instructing patients on modified diets. Meyer (3) in 1989 found that dietitians spent most of their time providing for the educational needs of patients on modified diets. With the increase in awareness of the importance of medical nutrition therapy for chronic conditions such as diabetes, obesity, hypertension, and heart disease, providing appropriate patient education has become critical. Furthermore, patients with liver, lung and kidney diseases, cancer, and AIDS require education on specific diet adaptations for better management, but need for a therapeutic diet has not been identified as an indicator of nutritional risk. There is

considerable discussion currently on how medical nutrition therapy can reduce medical costs (5). However, there is no consensus on the best way to implement this in acute-care settings (45).

It seems that the major problem with devising a screening tool for "malnutrition" is that there is no consensus on what exactly we are trying to find. A broken leg or a gastrointestinal bleed are easily diagnosed conditions with specific markers; malnutrition, however, is a fuzzy condition that sometimes can be identified clinically and sometimes not. There is some controversy in the literature as to whether it is feasible to define "malnutrition" in the acute-care setting as a condition separate from other underlying diseases (46).

The earliest work on defining the biochemical markers currently used for the diagnosis of malnutrition was conducted on populations of clearly malnourished African children (47,48,49,50,51). After a child was diagnosed as having marasmus, kwashiorkor or mixed-marasmus-kwashiorkor, the researchers described the biochemical and anthropometric characteristics of these populations and came up with "definitions of malnutrition." These standards were then applied in acute-care settings to search for malnourished patients. Unfortunately, at present, there is no

universally accepted definition of malnutrition in acute-care settings (52). Therefore the problem of devising nutrition screening tools becomes one of devising a tool that will detect something we have not yet defined very well (53). In that light, it is not surprising that we have not been successful.

The ADA has defined nutrition screening as "the process of identifying characteristics known to be associated with nutrition problems" (54). This definition is so broad that it is of little use in the acute-care setting where almost everybody has some degree of loss of appetite, nausea, vomiting, or diarrhea. An alternative approach has been to skirt the issue of malnutrition altogether and focus on specific risk parameters in relation to clinical outcomes. Mullen (55) has proposed defining malnutrition as "specific factors that when abnormal would prospectively identify a subpopulation of malnourished patients who would have a less than optimal hospital course because of nutritional deficits." A number of articles have been published in recent years exploring the value of anthropometric and biochemical measurements in predicting morbidity, mortality and costs. The outcomes of more interest seem to be length of stay, complications, mortality, and, more recently, hospital costs and charges (56,57).

Clinical judgment has been proposed as a good indicator of malnutrition (58). However, some studies suggest that this indicator is accurate only in the more extreme cases and that, in general, it fails to identify mild to moderate malnutrition (59,60,61).

Extreme overweight has been associated with an increase in length of stay (62). In epidemiological studies, excess weight in men along with other conditions has been associated with increased mortality (63). However, it is not a condition that can be effectively addressed during the usual length of stay of the acute-care patient. Therefore, discussions of weight as a risk factor in the acute-care setting are generally limited to underweight patients. It is widely recognized that a certain amount of weight loss is incompatible with survival. Weight as parameter to assess nutritional risk, however, is problematic. Weighing the patient is a traditional nursing function that frequently does not get done (38). Frey (31), Hedberg (38), Hunt (37) and Thompson (32) found height and weight data missing in 86%, 72%, 22%, and 14% of the patients screened respectively. If the weight is available, it may be unreliable due to mechanical problems with the scales or the patient's fluid status. Even when the weight is available and reliable, it has to be compared to something in order to be assessed. Comparison to published standards presents a

number of problems and has not been found in the literature to be a good predictor of undesirable outcomes unless the weight loss is extreme (62). Weight compared to usual body weight has been documented to be a good parameter indicative of nutritional risk, but is also a problematic measurement. First, someone has to ask patients what their pre-illness weight was because it is rarely documented in the medical chart. Second, the way in which this question is asked may have an effect on the data obtained (64). If the patient is well enough to answer the question, which is not the case in about two thirds of nursing home residents admitted to the hospital emergency room (65), the answer can be extremely unreliable (66). For that reason, this parameter may be more appropriate for long-term care, where sequential measurements are documented, than in acute-care settings. Even known weight loss may not be a good parameter by itself; Windsor has argued that clinical impairment of bodily function should also be present. Of interest is that several indicators of organ dysfunction used in this study (prealbumin, transferrin, and respiratory function) are known to be affected by nutritional status (67).

In epidemiological studies, anthropometric measurements have been found to be good predictors of mortality (68). However, in the acute-care setting, anthropometric measurements by themselves have been found to be of little

predictive value (69). Anthropometric measurements have not been found to be predictive of postoperative mortality (56, 70,71) and are not sensitive to marginal protein depletion (72).

Energy is a good predictor of complications. Energy is a good indicator of nutritional state (73) and a good predictor of mortality and pressure sore development in the elderly (74). However, it is not practical to test for energy as part of screening criteria because it is invasive and time-consuming.

Serum albumin level has been found in epidemiological studies to be a good predictor of mortality (75,76,77,78), and it seems to be one of the best predictors of negative outcomes in the acute-care setting. Serum albumin level falls quickly with starvation (79) and is a good indicator of cellular immunity (80). According to Blackburn patients with a serum albumin level of 2.6 g/dl or less have less than a 5% chance of immune competence, absence of infections, and survival (81). Serum albumin level has been found to be strongly correlated with negative outcomes (73,82,83,84,85,86,87,88,89,90,91). A recent study found serum albumin level to be an excellent predictor of hospital readmission to an acute-care setting in a rehabilitation hospital population (92). Even in the intensive care

setting, where weight and anthropometrics are unreliable due to fluid overload and where UBW is not available, serum albumin level has been found to be a good indicator of nutritional associated complications (93,94). In the critically ill patient, serum albumin level may be a good parameter for assessment of nutritional status because its half-life is reduced from seventeen days in the well-person to between five and twelve days (95).

A problem with the studies that have used serum albumin level as a parameter to assess nutritional risk is the lack of consistency in the timing of collection. Serum albumin levels have been documented to decrease within several days of admission to a hospital and increase slightly over the following week (85). Albumin also decreases after major surgery (96). In a study in which serum albumin levels were measured within 48 hours of admission, this parameter was found to be an independent predictor of unfavorable outcomes (97). In another study where albumin was drawn upon admission, it provided the most accurate assessment (sensitivity of 53% and specificity of 71%) for likelihood of increased length of stay (98). Anderson (99) found that a low serum albumin level on admission was a good predictor of length of stay. Some researchers caution that this relationship may not be indicative of malnutrition but a sign of underlying sepsis or chronic disease (100), and that



it may not be a sensitive enough screening tool by itself because it fails to detect malnutrition in some populations such as chronic hemodialysis patients (101). It has been found to be a poor predictor of body composition (102), a poor indicator of marginal reduction in nutritional status (103), and a fair index of nutritional repletion because of fluid dynamics (104) and its slow turnover (105). Serum albumin levels are lower in the elderly compared to younger patients, but epidemiological studies indicate that normal levels for the elderly fall within the normal limits generally used to assess nutritional status (106,107).

Assuming it may not be economically feasible to screen all patients entering the hospital for decreased serum albumin levels, what would be good clues to reduced levels? In an epidemiological study, the incidence of serum albumin level  $< 3.5$  g/dl in the general population was found to be  $< 2\%$ ; the following factors were associated with decreased levels: chronic obstructive pulmonary disease, vomiting, feeling tired, low salt diet, problems chewing, and smoking (108). In another epidemiological study, the incidence of hypoalbuminemia among elderly was found to be  $3.1\%$  and was "associated with anemia, recent diagnosis of cancer, two or more limitations in activities of daily living, residence in a nursing home, heavy cigarette smoking, and older age (109)." Patients with pressure sores (110) or being admitted

to an acute-care facility from a nursing home (111) have been found to have a very high incidence of hypoalbuminemia.

Different parameters indicative of nutritional risk have been found to select different populations (112). There is some evidence in the literature that for certain outcomes, recent food intake is a more predictive factor than general nutritional status (113,114). For that population, the best biochemical indicator might be prealbumin which has a rapid turnover rate and allows for quick detection of pre-kwashiorkor (47,50). Somatomedin-C has also been proposed as a good indicator of nutritional repletion (115,116). Total body potassium has been proposed as a good indicator for patients with cardiac cachexia (117).

A number of authors have proposed multivariate models with combinations of anthropometric and biochemical measurements. Buzby found a combination of serum albumin level, weight as a percentage of UBW, and mid arm muscle circumference to be the best predictor of complications (118). Linn proposed a "protein-energy scale" (119), Hall an "index of undernutrition" (120), and Ingenbleek a "prognostic inflammatory and nutritional index" (121). One of the best documented models is the Prognostic Nutritional Index (122,123,124,125,126,127). However, the cost-effectiveness

of applying these indexes to all patients admitted to a hospital has not been addressed.

Although hospitals are required to screen all patients for malnutrition, good documentation on appropriate risk indicators is still lacking. This is partly due to lack of well designed studies to develop cost-effective tools. There is better documentation on the predictive value of parameters traditionally used in assessing nutritional status, but it may not be practical to measure these parameters for all patients. Therefore, the question of what constitutes a sensitive and specific screening tool still remains unanswered.

### III. Methods

The objectives of this study were to 1) determine the sensitivity and specificity of the screening tool used currently in the institution and 2) to determine whether a new proposed tool would be more effective than the existing one in identifying patients at nutritional risk.

Jackson Memorial Hospital is a 1500-bed, county-funded, acute-care facility in an urban setting, affiliated with the University of Miami Medical School. The medical and surgical services include ten floors with approximately 30 beds each, including floors specifically designated for oncology, special immunology and transplant patients, and three intensive care units.

The goal of data collection was to include enough subjects so that at least 140 would have enough data to make a determination of nutritional risk ("Complete" group). That sample size was chosen because it was consistent with previous studies on this subject (41,43). With that goal in mind, a field test of the data gathering form was conducted, and it indicated that approximately 25% of all patients were discharged prior to 48 hours of admission and approximately 50% of the remaining patients had serum albumin levels available. Therefore, approximately 450 patients were needed

to meet the sample goal. Because there were on the average 50 new admitted patients every day to the medical and surgical services, a period of nine days was determined appropriate to obtain the desired sample size.

All patients admitted to the medical and surgical services over the data collection period were considered for inclusion in the study. Patients transferred from other institutions or admitted and discharged within 48 hours were excluded. The purpose of excluding these patients was to reduce bias in data gathering because serum albumin levels drawn up to 48 hours of admission were used.

All newly admitted patients were interviewed by a registered dietitian within 24 hours of admission using the form presented in Appendix 1. Parts A, B and C of the form were used to gather data to determine population statistics and to make a determination of whether each patient was at nutritional risk. Data for parts A and B were obtained from the hospital's computer information system. Missing data for part A and data for part C were obtained from the patients or caretakers. Part D of the form was the existing nutrition screening tool, and part E was the new proposed tool. These parts were filled out by the dietitian by asking the questions (indicators) to the patients or caretakers.

Patients who were not available the first day of admission due to surgery or tests were interviewed prior to 48 hours of admission and asked to answer the questions describing their status when they were admitted. Although this presented some problems regarding data consistency, it replicated the conditions under which the screening tools are used. Even though the hospital policy requires nursing staff to complete the nutrition screening within 24 hours of admission, this is not always possible.

The study was part of the Nutrition Services Department's existing performance improvement program and therefore did not require institutional approval. Meeting the criteria for nutritional risk with the existing tool or answering yes to any of the questions in the proposed tool triggered a referral to the registered dietitian assigned to that floor for a nutritional assessment. Patients identified by the screening tools were provided with nutrition care consistent with the department's policies.

For each patient, the results of the existing and proposed screening tools were compared to a determination of nutritional risk. For purposes of this study, patients were considered "at risk" using the criteria identified by Chima (128): serum albumin level < 3.0 g/dl; current weight < 90% of UBW defined as patient's weight six months prior to

admission; or current weight < 75% IBW determined as the midpoint of Metropolitan Weight Tables for medium frame (129). These criteria were used as parameters indicative of nutritional status because they have been linked in the literature with increased length of stay, hospital costs, and discharge destination.

Means and standard deviations of age and risk parameters and frequencies of the risk indicators (questions) from the existing and proposed screening tools (parts D and E of Appendix 1) were calculated using SAS (130). Because only data for patients with complete information (Complete group) were used to test the predictive value of the screening tools, Student's t-tests were used to evaluate differences between patients with complete data (Complete group) and patients with partial data (Partial group) in terms of incidence of nutritional risk. Chi-square tests were used to determine whether the incidence of risk indicators was the same in the Complete and Partial groups. The purpose of testing for these differences was to ensure that patients in the Complete group did not represent a selected subset of patients and therefore the results of the Complete group could be extrapolated to the inpatient population as a whole.

The study questions were matched to the appropriate statistical methods as follows:

1. What is the sensitivity and specificity of the screening tool used currently in the institution?

Sensitivity, the probability that a person predicted to be at risk by the tools is actually at risk, and specificity, the probability that a person predicted not to be at risk by the tools is actually not at risk (16), were calculated for the existing screening tool (part D of Appendix 1) using data for the Complete group.

2. Would a new proposed tool be more effective in identifying patients at nutritional risk?

Sensitivity and specificity of the proposed screening tool (part E of Appendix 1) were calculated using data for the Complete group.

Results of both screening tools were compared using McNemar's test (16).



3. What questions could be used as indicators of nutritional risk in an acute-care setting?

Mantel-Haenszel Chi-square statistics were used to evaluate the correlation between risk indicators (individual questions in both screening tools) and nutritional risk parameters in order to identify the most appropriate indicators to include in a revised screening tool.

4. What would be the sensitivity and specificity of such indicators in predicting nutritional risk?

Sensitivity and specificity of the revised screening tool were calculated using data for the Complete group.

Odds ratios with 95% confidence intervals were calculated to indicate the degree of association between the results of the screening tools and nutritional risk. For this study, a 95% level of confidence was preferred.

#### IV. Results

Dietitians screened 454 patients admitted to their floors over a period of nine days. Approximately 25% of those were discharged before 48 hours and, therefore, were not included in this study. One hundred and forty one patients had complete data to determine if they were at nutritional risk: height, weight, UBW, and serum albumin level. For purposes of this analysis that group is known as the "Complete" group. The rest had less than those four parameters and is referred to as the "Partial" group. In the Partial group (n=194) an additional 27 patients had enough data to make a determination of risk. The data set including the Complete and Partial data sets is heretofore referred to as "All" (n=335).

Weight information was available for most patients, but serum albumin level was missing for most. Three hundred and fifteen patients (94%) had height and weight available; however, this data may be unreliable because in most cases it was self-reported (131). Patients with missing height and weight data were either unable to communicate or had not been weighed recently. Usual body weight was available for 285 patients (85%); as with height and weight, this parameter was unavailable if the patient was unable to communicate or remember his or her weight six months before

the study. Serum albumin level was available for 167 patients (50%) which is similar to the findings of Elmore (43). Availability of serum albumin level was the limiting factor in making a determination of risk.

Reduced availability of risk parameter data does not seem to be a function of characteristics of the Partial group. A question that needed to be answered was whether physicians were more likely to order serum albumin tests for older or thinner patients; however, this does not seem to be the case, and availability of serum albumin level can probably be attributed to non-nutritional reasons. In Table 1, age and risk parameters are presented as means and standard deviation.

Table 1. Means and standard deviations of age and risk parameters

	Complete	Partial	Range
Age (years)	49 (14)	51 (16)	17 - 93
Percentage of IBW	112 (28) n=141	117 (28) n=174	42 - 253
Percentage of UBW	96 (11) n=141	97 (10) n=144	58 - 147
Serum Albumin g/dl	3.4 (0.7) n=141	3.4 (0.4) n=26	1.8 - 5.2

The differences in means and standard deviations of these parameters in the Complete and Partial groups were not statistically significant. The patients in the Complete and Partial groups were similar in age, weight as a percentage of IBW, weight as a percentage of UBW, and serum albumin level. Therefore, it is appropriate to assume that conclusions based on data from the Complete group could be extrapolated to the inpatient population as a whole.

The Complete and Partial groups were also similar in the prevalence of risk indicators. A question that needed to be answered was whether physicians were more likely to order serum albumin tests for patients that presented with nutritional problems such as poor appetite or vomiting; however, this does not seem to be the case. Patients in both groups had a similar incidence of nutritional problems; therefore, availability of serum albumin level can probably be attributed to non-nutritional causes. The fact that serum albumin level is part of a test panel commonly used in the hospital may account for its availability in approximately 50% of the patients. In Tables 2 and 3, the frequency of screening indicators from the existing and proposed tools are presented.

Table 2. Indicators in existing screen presented in descending order of frequency

	All N = 306	Complete N = 141	Partial N = 165
Special diet	108 (35%)	50 (35%)	58 (35%)
Reduced appetite	103 (34%)	53 (38%)	50 (30%)
> five pounds weight loss in one month	83 (27%)	48 (34%)	35 (21%)
Difficulty swallowing or chewing	43 (14%)	20 (14%)	23 (14%)
Need diet instruction	38 (12%)	18 (11%)	20 (12%)
Nausea/Vomiting > five days	26 (8%)	16 (11%)	10 (6%)
Diarrhea > five days	19 (6%)	12 (8%)	7 (4%)
Tube Feeding/TPN	7 (2%)	4 (3%)	3 (2%)

The proportion of patients presenting with a risk indicator was not significantly different ( $P < 0.05$ ) for any indicators. Being on a special diet was slightly more prevalent in the Partial group, and nausea and vomiting were slightly less prevalent in the Partial group. However, these differences only achieved marginal statistical significance ( $P < 0.01$ ). Table 3 presents the frequencies of indicators in the proposed tool.

Table 3. Indicators in proposed screen presented in descending order of frequency

	All N = 316	Complete N = 139	Partial N = 177
Unintentional weight loss > 10 lb. in 6 mos.	102 (34%)	55 (39%)	47 (30%)
Difficulty eating	48 (15%)	19 (16%)	29 (16%)
Pt appears emaciated	40 (12%)	15 (11%)	25 (13%)
Unhealed wounds	24 (8%)	8 (6%)	16 (9%)
Tube Feeding/TPN (actual and expected)	24 (7%)	10 (7%)	14 (8%)

The proportion of patients presenting with a risk indicator in the proposed screen was not significantly different between the Complete and Partial group ( $P < 0.05$ ) for any of the indicators. For all patients, the most frequent indicators were reduced appetite, special diet and weight loss > ten pounds in six months. Existing or expected nutrition support, unhealed wounds and diarrhea for more than five days were the least frequent indicators. Only two patients did not have any indicators of risk.

The results of the screening tools were compared to the presence of "nutritional risk" which was defined as the

presence of weight less than 75% of IBW, weight < 90% of UBW, or serum albumin level < 3.0 g/dl. Risk determination was done only for patients in the Complete group because the absence of serum albumin levels for approximately 50% of the patients skews the data by increasing the relative prevalence of nutritional risk in the partial group. Therefore, the evaluation of the predictive power of the existing and proposed tool in detecting nutritional risk was done only for the Complete group. In Table 4, the frequency of risk parameters in the Complete group is presented.

Table 4. Parameters indicative of nutritional risk in the Complete group presented in order of frequency

	Frequency
	N=141
Weight < 90% UBW	34 (24%)
Serum Albumin < 3.0 g/dl	31 (22%)
Weight < 75% IBW	7 (5%)
At nutritional Risk (defined by the presence of any of the above parameters)	57 (40%)

Although most patients were at an appropriate weight for height, a significant proportion of them had lost weight recently or had depleted visceral protein stores. Very few

patients were underweight according to current standards. Most patients who were at nutritional risk were at or above appropriate weight for height despite recent weight loss or low serum albumin levels.

A cutoff point for serum albumin level of 3.0 g/dl was used for this study because it has been well documented as a predictor of negative outcomes (128). If this criteria is expanded to include patients with albumin < 3.5 g/dl, which is generally considered as a cutoff for nutritional risk (71,75,78,86,89,90,98,99,100), the number of patients at risk increases to 91 (65%).

As expected, some indicators were found to be significantly correlated with nutritional risk. In the existing tool, several indicators were significantly correlated with nutritional risk ( $P < 0.05$ ). Table 5 presents Mantel-Haenszel chi-square statistics for the indicators in the existing tool. It is important to note that the low prevalence of certain indicators did not allow for statistical validity of the tests for those indicators.



Table 5. Correlation of indicators in existing tool with nutritional risk presented in order of statistical significance

Indicator	Mantel-Haenszel Chi-square	P
> 5 pounds weight loss in one month	8.525	0.004
Difficulty swallowing or chewing	5.803	0.016
Diarrhea > five days	3.861*	0.049
Reduced appetite	3.471	0.062
Special diet	1.442	0.230
Nausea/vomiting > five days	0.747	0.387
Needs diet instruction	0.146*	0.703
Tube Feeding/TPN	0.137*	0.712

\* Chi-square may not be a valid test due to small sample size

Recent weight loss of five pounds or more was highly correlated with nutritional risk ( $P < 0.005$ ); difficulty chewing or swallowing and diarrhea were significantly correlated with nutritional risk ( $P < 0.05$ ). Table 6 presents results for the proposed tool.

Table 6. Correlation of indicators in proposed tool with nutritional risk presented in order of statistical significance

Indicator	Mantel-Haenszel Chi-square	P
Unintentional weight loss > 10 lb. in 6 mos.	14.990	0.000
Difficulty eating	10.319	0.001
Patient appears emaciated	10.944	0.001
Tube feeding/TPN (actual or expected)	1.700	0.192
Unhealed wounds	1.656*	0.198

In the proposed tool, several indicators were significantly correlated with nutritional risk. Unintentional weight loss of ten pounds or more, difficulty eating and emaciated appearance were highly correlated with nutritional risk ( $P < 0.001$ ). The level of correlation for these indicators is greater than that of any in the existing tool; therefore, it would be expected that the proposed tool is better at identifying patients at nutritional risk than the existing tool.

The existing and proposed screening tools seem to be equally sensitive and specific in detecting nutritional risk. Both

tools selected similar proportions of the population into the "at risk" and "not at risk" categories. In Tables 7 and 8, evaluations of the ability of the existing and proposed screening tools in detecting nutritional risk are presented.

Table 7. Results of existing screening tool

	Positive Screen	Negative Screen
At risk	(True Positives)	(False Negatives)
	34 (24%)	23 (16%)
Not at risk	(False Positives)	(True Negatives)
	38 (27%)	46 (33%)

The existing screening tool identified 34 patients at risk, out of a total of 57 patients truly at risk, for a 60% sensitivity and a 47% positive predictive value. This means that the tool missed 40% of the patients at risk. The tool identified 46 patients not at risk, out of 84 truly not at risk, for a 55% specificity and a 67% negative predictive value. This means that this tool would trigger an assessment for 45% of the patients not at risk.

Table 8. Results of proposed screening tool

	Positive Screen	Negative Screen
At risk	(True Positives) 35 (25%)	(False Negatives) 20 (14%)
Not at risk	(False Positives) 33 (24%)	(True Negatives) 51 (37%)

The proposed screening tool identified 35 patients at risk, out of 55 truly at risk, for a 64% sensitivity and a 51% positive predictive value. This means that the tool missed 36% of the patients at risk. The tool identified 51 patients not at risk, out of 84 patients truly not at risk, for a 61% specificity and a 72% negative predictive value. This means that the tool would trigger an assessment for 39% of the patients not at risk. Therefore, the proposed screening tool is only marginally better than the existing one in identifying patients at nutritional risk.

Since both tools selected similar proportions of the population for the "at risk" and "not at risk" categories, the next question to ask is: Are they selecting the same patients? In Table 9, data is presented to answer this question.

Table 9. Agreement between existing screening tool and proposed screening tool

	Positive Screen Existing	Negative Screen Existing
Positive Screen Proposed	41 (29%)	27 (19%)
Negative Screen Proposed	29 (21%)	42 (30%)

Both screening tools agree in approximately 60% of the cases. Cohen's Kappa measure of agreement (132) for this sample was 0.19, indicating poor agreement between the tools. Therefore, even though the tools are selecting similar proportions of the patients for the "at risk" and "not at risk" categories, they are selecting different patients for these categories. McNemar's test indicates that the tools are selecting significantly different populations.

Is the proposed tool better than the existing one in detecting nutritional risk? In answering this question, it may be helpful to divide the patients at risk into different classifications of malnutrition because these may be correlated with different indicators. In protein-calorie malnutrition, there is a deficit in intake of both protein and calories; the patient loses weight and exhibits a

depletion in visceral protein stores that can translate after a period of time in low serum albumin levels. If the depletion continues for a long period of time, the body adapts, and visceral protein stores are preserved despite significant weight loss. This condition is known as marasmus and is defined by normal serum albumin levels despite significant weight loss. A different type of malnutrition is known as kwashiorkor. Patients with this condition have an adequate intake of calories and do not have significant weight loss. These patients, however, do not consume adequate amounts of protein, and therefore will have low serum albumin levels in the absence of significant weight loss (133). Since these three conditions have different characteristics, they may not be detected equally by a screening tool.

In the Complete group, ten patients had both low serum albumin levels and low weight compared to a standard (PCM group). Twenty six patients had normal levels of serum albumin but decreased weight compared to a standard (marasmic group). Twenty one patients had serum albumin levels below 3.0 g/dl (kwashiorkor group). Table 10 presents the sensitivity and specificity of the existing and proposed tools in detecting different types of malnutrition.

Table 10. Results of screening tools by type of malnutrition

	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Existing				
PCM	60%	55%	14%	92%
Marasmus	65%	53%	26%	86%
Kwashiorkor	52%	25%	79%	86%
Proposed				
PCM	100%	61%	23%	99%
Marasmus	75%	62%	31%	94%
Kwashiorkor	33%	0%	64%	0%

When the results of the screening tools are analyzed by type of malnutrition, it seems that the existing tool has the same level of sensitivity in detecting all types of malnutrition, whereas the proposed tool is extremely sensitive in detecting PCM, is better than the existing tool in detecting marasmus, but is not a sensitive tool to detect low serum albumin levels in the absence of significant weight loss.

In an effort to identify any indicator in the existing screening tool that gave it an advantage over the proposed tool in identifying low serum albumin levels in the absence

of significant weight loss, Mantel-Haenszel chi-square statistics were calculated for all risk indicators in the existing and proposed tools. In the existing tool, only reduced appetite was marginally correlated with low albumin ( $P < 0.1$ ). In the proposed tool, expected or actual TPN/tube feeding and emaciated appearance were somewhat correlated with low albumin but the results may not be valid due to sample size. Using this data, a revised proposed tool was constructed combining indicators from both tools. The indicators included were:

1. reduced appetite
2. problems eating (chewing, swallowing or neurological)
3. actual or expected TPN/tube feeding
4. unintentional weight loss > 10 pounds in six months
5. emaciated appearance

When the results of the revised tool were compared to nutritional risk, as presented in Table 11, it seems to have an advantage over the previously discussed tools.

Table 11. Results of revised screening tool

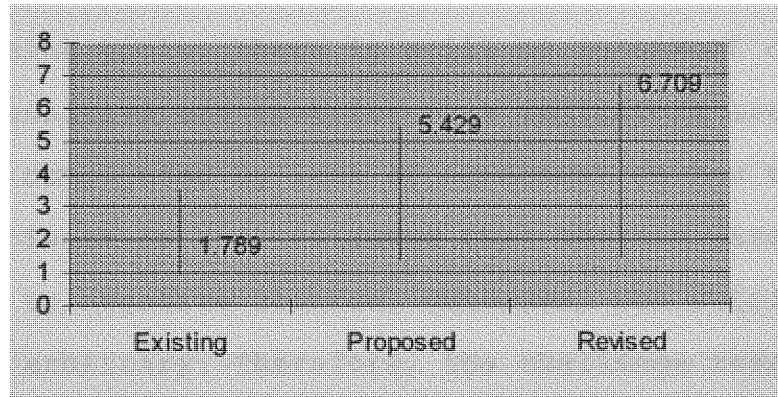
	Positive Screen	Negative Screen
At risk	(True Positives) 43 (31%)	(False Negatives) 12 (9%)
Not at risk	(False Positives) 45 (32%)	(True Negatives) 39 (28%)



The revised screening tool identified 43 patients at risk, out of 55 patients truly at risk, for a sensitivity of 0.78 and a 0.49 positive predictive value. This means that the revised tool missed only 22% of the patients at risk, a reduction compared with 40% for the existing tool and 36% for the proposed tool. Therefore, the revised tool is better than the existing and proposed tool at finding patients who are at nutritional risk. The revised tool identified 39 patients not at risk, out of 84 patients truly not at risk, for a 0.46 specificity and 0.76 negative predictive value. This means that the tool would trigger an assessment for 54% of the patients not at risk. This is an increase compared with 45% for the existing tool and 39% for the proposed tool. It seems that the gains in sensitivity were obtained at the expense of a loss in specificity. The revised tool retained the sensitivity of the proposed tool in detecting PCM and marasmus and gained higher sensitivity in detecting kwashiorkor (0.67) than either of the other tools (0.52 for the existing tool and 0.33 for the proposed tool).

Odds ratios for all three tools were constructed to estimate their association with nutritional risk. Results are presented in Figure 1.

Figure 1. Degree of association expressed as odds ratios and 95% confidence intervals between tools and nutritional risk



The confidence intervals for the odds ratios for the proposed and revised tools fall well within the range indicative of association. The revised tool seems to have a stronger association.

## V. Discussion

Identifying patients at nutritional risk is a challenge in acute-care settings. Despite several decades of experience with screening tools, there is still no agreement on what the most sensitive and specific risk indicators are. This problem is compounded by lack of agreement on how to define "at risk". There is some evidence that certain parameters are linked to negative clinical outcomes, but cutoff points are mostly arbitrary. Therefore, the challenge remains to design sensitive and specific tools to identify a condition that we have been unable to define clearly.

The prevalence of parameters indicative of risk found in this study (40% if serum albumin level of 3.0 g/dl is used as a cutoff, 65% if serum albumin level of 3.5 g/dl is used as a cutoff) is consistent with previously published reports (6,7,8,9,10,11,12,13,14). Therefore, the need to identify patients with compromised nutritional status upon admission still remains, especially in an environment of reduced length of stay and cost containment.

Certain risk indicators, such as reduced appetite, nausea, recent weight loss and being on a therapeutic diet are known to be prevalent in the patients admitted to an acute-care setting. This is to be expected with a population of

chronically ill patients who may have difficulty maintaining appropriate oral intake, acutely ill patients who may be temporarily too sick to eat, or critically ill patients who may have increased needs due to the body's response to stress. The results of this study support that finding; however, the sample was not large enough and not enough data was collected due to resource limitations to be able to differentiate between those categories of patients.

Some authors have proposed using the presence of or expectation of needing nutrition support (enteral and parenteral nutrition) as a risk indicator. The prevalence of this risk indicator in this study was 7%, which is far below the 40% estimate of patients at nutritional risk. This is in agreement with the findings of Mullen (42) who found no difference in nutritional status between patients receiving nutrition support and those who were not. Therefore, a tool that used this indicator as the sole criterion for triggering a nutrition assessment would be grossly inadequate.

Another indicator that has been proposed as a sole criterion has been whether or not the patient "looks thin". Only 11% of the Complete group would be described as emaciated in the judgment of a trained clinical dietitian, very low compared to a 40% prevalence of nutritional risk. Furthermore, only

5% of the complete group had weight < 75% of IBW. The mean percentage of IBW of the complete group was 117% (standard deviation 28%), indicating that most patients were within or above the range that is considered appropriate.

Indicators in the proposed screen were chosen because they have been shown in the literature to be associated with nutritional risk. The proposed screen seems to be an excellent tool in detecting patients with PCM and marasmus and seems to be a better tool than the existing one for that purpose. The proposed tool, however, is not sensitive enough to detect depleted serum albumin levels in the absence of significant weight loss. The revised tool retained the sensitivity of the proposed tool in detecting PCM and marasmus and gained some sensitivity in detecting kwashiorkor but at the expense of specificity.

The low sensitivity of all the tools in detecting depleted serum albumin levels could be because they focus on nutrition-related risk factors whereas a depleted serum albumin level may not be due to nutritional factors. This may account for the absence of statistically significant correlations between many of the indicators and nutritional risk as defined for purposes of this study. Serum albumin level has been criticized as a marker of malnutrition, and most authors who recommend its use for that purpose do so

with caution (134). Therefore, it may be appropriate that a screening tool to detect nutritional risk does not identify patients with depleted serum albumin levels due to non-nutritional causes.

Elmore (43) tested a screening tool's ability to detect nutritional risk and discarded that approach in favor of a predictive equation that required only three parameters: serum albumin level, TLC and weight as a % of UBW. Clearly, any screening criteria that includes a given parameter will be more effective in detecting that parameter than one that only uses factors associated with it. Therefore, screening criteria that includes serum albumin level would be more effective in identifying patients with levels indicative of depletion than one that does not. However, many institutions are unwilling to require that serum albumin levels be drawn on all patients because there are not documented cost-benefit analyses to support that approach. Elmore reported that only 4% of the patients had serum albumin levels available at the time of the screening, and 58% had it by the time of the assessment. In this study, only 50% of the patients had serum albumin levels available within 48 hours of admission. In addition, there seemed to be no clear differences between the patients who had that data available and those who did not.

## VI. Conclusions and Recommendations

Results of the study show that nutritional risk is prevalent in patients being admitted to medical and surgical services. Most of the patients in this study did not "look thin"; indeed, most would probably be considered overweight by current standards. Most were able to eat, were not receiving nutrition support, and did not have severe nausea, vomiting or diarrhea at the time of admission. However, at least 40% of them met criteria for nutritional risk.

This study indicates that the questions used to identify these patients have to be researched carefully because the design of the tools used will determine which patients are selected for assessment. The present study has provided evidence that some indicators are more sensitive than others in detecting nutritional risk. It has also provided evidence that including biochemical markers in screening criteria may be necessary to detect levels of depletion that may not be easily detected solely by nutritional indicators. The proposed tool is better than the existing tool in identifying patients with significant weight loss but is worse than the existing tool in identifying patients with depleted visceral protein stores in the absence of significant weight loss. The revised tool recaptures some of that sensitivity but it still misses 38% of the patients

with kwashiorkor. Since this depletion may not be due to nutritional factors, it may not be easily detected by asking nutrition-related questions. More research could be done to find out which questions may be good indicators to detect low serum albumin levels, but it may be easier to just test all patients upon admission since current testing seems to be a function of chance. Therefore, the findings of this study support those of Elmore (43), and provide further evidence that the best approach to nutrition screening may be a combination of nutrition-related questions and serum albumin levels.



## List of References

1. Balch GI. Employers' perceptions of the roles of dietetics practitioners: Challenges to survive and opportunities to thrive. *J Am Diet Assoc.* 1996;96:1301-1305.
2. Eddy DM. Broadening the responsibilities of practitioners. *JAMA.* 1993;93:1849-1855.
3. Meyer MK, Olsen MS. Productivity of the clinical dietitian: Measurement by a regression model. *J Am Diet Assoc.* 1989;89:490-493.
4. Gallagher-Allred CR, McCamish MA, Voss AC. *Malnutrition: A hidden cost in health care.* Columbus, Ohio:Ross Products Division, Abbott Laboratories; 1994.
5. Gallagher-Allred CR, Voss AC, Finn SC, McCamish MA. *Malnutrition and clinical outcomes: The case for medical nutrition therapy.* *J Am Diet Assoc.* 1996;96:361-366,369.
6. Bistran BR, Blackburn GL, Hallowell E, Heddle R. Protein status of general surgical patients. *JAMA.* 1974;230:858-860.
7. Bistran BR, Blackburn GL, Vitale J, Cochran D, Naylor J. Prevalence of malnutrition in general medical patients. *JAMA.* 1976;235:1567-1570.

8. Willard MD, Gilsdorf RB, Price RA. Protein-calorie malnutrition in a community hospital. JAMA. 1980;243:1720-1722.
9. Weinsier RL, Hunker EM, Krumdieck CL, Butterworth CE. Hospital malnutrition: A prospective evaluation of general medical patients during the course of hospitalization. Am J Clin Nutr. 1979;32:418-426.
10. Coats KG, Morgan SL, Bartolucci AA, Weinsier RL. Hospital-associated malnutrition: A reevaluation 12 years later. J Am Diet Assoc. 1993;93:27-33.
11. Kamath SK, Lawler M, Smith AE, Kalat T, Olson R. Hospital malnutrition: A 33-hospital screening study. J Am diet Assoc. 1986;86:203-206.
12. O'Leary JP, Dunn G, Basil S, Butler B, Long S, Nichols A, Waller R. Incidence of malnutrition among patients admitted to a VA Hospital. So Med J. 1982;75:1095-1098.
13. Apelgren KN, Rombeau JL, Miller RA, Waters LN, Carson SN, Twomey P. Malnutrition in veterans administration surgical patients. Arch Surg. 1981;116:1059-1061.
14. Bienia R, Ratcliff S, Barbour GL, Kummer M. Malnutrition in the hospitalized geriatric patient. J Am Geriatr Soc. 1982;30:433-436.

15. Foltz MB, Schiller MR, Ryan AS. Nutrition screening and assessment. Current practices and dietitians' leadership roles. J Am Diet Assoc. 1993;93:1388-1395.
16. Fletcher RH, Fletcher SW, Wagner EH. Clinical Epidemiology - The essentials. Baltimore, MD: Williams & Wilkins; 1982.
17. Smith PE, Smith AE. Screening for Hospital Malnutrition. Deerfield, IL: Clintec Nutrition Corporation; 1987.
18. Butterworth CE. The skeleton in the hospital closet. Nutr Today. 1974;2:4-7.
19. Tobias AL, VanItallie TB. Nutritional problems of hospitalized patients. J Am Diet Assoc. 1977;71:253-257.
20. Simko MD, Cowell C, Gilbride JA. Nutritional management of hospitalized patients. Qual Rev Bull. 1980;20-25.
21. Roubenoff R, Roubenoff RA, Preto J, Balke CW. Malnutrition among hospitalized patients: A problem of physician awareness. Arch Intern Med. 1987;147:1462-1465.
22. Young EA. Perspectives on nutrition in medical education. Am J Clin Nutr. 1992;56:745-751.
23. Mueller C, Shronts EP. Position of the American Dietetic Association: The role of registered dietitians

- in enteral and parenteral nutrition support. J Am Diet Assoc. 1997;97:302-304.
24. Accreditation Manual for Hospitals, 1997. Oakbrook Terrace, Ill: Joint Commission on Accreditation of Healthcare Organizations; 1997.
  25. Shapiro LR. Streamlining and implementing nutritional assessment: the dietary approach. J Am Diet Assoc. 1979;75:230-236
  26. Simko MD, Cowell C, Gilbride JA. Nutritional management of hospitalized patients. Qual Rev Bull. 1980;20-25.
  27. Winborn AL, Banaszek NK, Freed BA, Kaminski MV. A protocol for nutritional assessment in a community hospital. J Am Diet Assoc. 1981;78:129-134.
  28. Sandrick KM. Finding and feeding the malnourished. Qual Rev Bull. 1980;13-16.
  29. Ometer JL, Oberfell MS. A levels of care model: Quality assurance. J Am Diet Assoc. 1982;81:129-132.
  30. Potosnak L, Chudnow LP, Simko MD. A simple tool for identifying patients at nutritional risk. Qual Rev Bull. 1983;81-83.
  31. Frey PW, Littleton EM. The nutrition care profile: An aid to delivery of quality nutrition care in a small community hospital. J Am Diet Assoc. 1984;84:1468-1469.

32. Thompson JS, Burrough CA, Green JL, Brown GL.  
Nutritional screening in surgical patients. J Am Diet Assoc. 1984;84:337-338.
33. Hannaman KN, Penner SF. A nutrition assessment tool that includes diagnosis. J Am Diet Assoc. 1985;85:607-609.
34. Christensen KS, Gstundtner KM. Hospital-wide screening improves basis for nutrition intervention. J Am Diet Assoc. 1985;85:704-706.
35. Christensen KS. Hospitalwide screening increases revenue under prospective payment system. J Am Diet Assoc. 1986;86:1234-1235.
36. Sayarath VG. Nutrition screening for malnutrition: Potential economic impact at a community hospital. J Am Diet Assoc. 1993;93:1440-1442.
37. Hunt DR, Maslovitz A, Rowlands BJ, Brooks B. A simple nutrition screening procedure for hospital patients. J Am Diet Assoc. 1985;85:332-335.
38. Hedberg AM, Garcia N, Trejus IJ, Weinmann-Winkler S, Gabriel ML, Lutz AL. Nutritional risk screening: Development of a standardized protocol using dietetic technicians. J Am Diet Assoc. 1988;88:1553-1556.
39. Queen PM, Cladwell M, Balogun L. Clinical indicators for oncology, cardiovascular, and surgical patients:

- Report of the ADA Council on Practice Quality Assurance Committee. J Am Diet Assoc. 1993;93:338-344.
40. Ford DA, Fairchild MM. Managing inpatient clinical nutrition services: A comprehensive program assures accountability and success. J Am Diet Assoc. 1990;90:695-702.
  41. Brown CSB, Stegman MR. Nutritional Assessment of Surgical patients. Qual Rev Bull. 1988;302-306.
  42. Mullen JL, Buzby GP, Matthews DC, Smale BF, Rosato EF. Reduction of operative morbidity and mortality by combined preoperative and postoperative nutritional support. Ann Surg. 1980;192:604-613.
  43. Elmore MF, Wagner DR, Knoll DM, Eizember L, Oswalt MA, Glowinski EA, Rapp PA. Developing an effective adult nutrition screening tool for a community hospital. J Am Diet Assoc. 1994;94:1113-1118, 1121.
  44. Boyhtari ME, Cardinal BJ. The role of clinical dietitians as perceived by dietitians and physicians. J Am Diet Assoc. 1997;97:851-855.
  45. Schafer RG, Bohannon B, Franz M, Freeman J, Holmes A, McLaughlin S, Haas LB, Kruger DF, Lorenz RA, McMahon M. Translation of the diabetes nutrition recommendations for health care institutions: Technical review. J Am Diet Assoc. 1997;97:43-53.

46. Weinsier RL, Heimburger DC. Distinguishing malnutrition from disease: The search goes on. *Am J Clin Nutr.* 1997;66:1063-1064.
47. Inglebleek YC, Van Den Schrieck HG, De Nayer P, De Visscher M. Albumin, transferrin and the thyroxine-binding prealbumin-retinol-binding protein (TBPA-RBP) complex in assessment of malnutrition. *Clin Chim Acta.* 1975;63:61-67.
48. Reeds PJ, Laditan AAO. Serum albumin and transferrin in protein-energy malnutrition, their use in the assessment of marginal undernutrition and the prognosis of severe undernutrition. *Br J Nutr.* 1976;36:255-263.
49. Whitehead RG, Coward WA, Lunn PG. Serum-albumin concentration and the onset of kwashiorkor. *Lancet.* 1973;63-66.
50. Inglebleek YC, De Visscher M, De Nayer P. Measurement of prealbumin as index of protein-calorie malnutrition. *Lancet.* 1972:106-108.
51. McFarlane H, Ogveide MI, Reddy S, Adcock KJ, Adeshina H, Gurney JM, Cooke A, Taylor GO, Mordie JA. Biochemical assessment of protein-calorie malnutrition. *Lancet.* 1969:392-395.

52. Reuben DB, Greendale GA, Harrison GG. Nutrition screening in older persons. J Am Geriatr Soc. 1995;43:415-425.
53. Collins JA. Clinical judgment versus the laboratory. N Eng J Med. 1982;306:987-988.
54. Posthauer ME, Dorse B, Foiles RA, Escott-Stump S, Lysen L, Balogun L. Identifying patients at risk: ADA's definitions for nutrition screening and nutrition assessment. J Am Diet Assoc. 1994;94:838-839.
55. Mullen JL, Gertner MH, Buzby GP, Goodhard GL, Rosato EF. Implications of malnutrition in the surgical patient. Arch Surg. 1979;114-121,125.
56. Shulkin DJ, Kinosian B, Glick H, Glen-Puschett C, Daly J, Eisenberg JM. The economic impact of infections: An analysis of hospital costs and charges in surgical patients with cancer. Arch Surg. 1993;128:449-452.
57. Riffer J. Malnourished patients feed rising costs: study. Hospitals. 1986;60:86.
58. Baker JP, Detsky AS, Wesson DE, Wolman SL, Stewart S, Whitewell J, Langer B, Jeejeebhoy KN. Nutritional assessment: A comparison of clinical judgment and objective measurements. N Eng J Med. 1982;306:969-972.



59. The Veterans Affairs Total Parenteral Nutrition Cooperative Study Group. Perioperative nutrition in surgical patients. *N Eng J Med.* 1991;325:525-532.
60. Pettigrew RA, Hill GL. Indicators of surgical risk and clinical judgment. *Br J Surg.* 1986;73:47-51.
61. Naveau S. Comparison of clinical judgment and anthropometric parameters for evaluating nutritional status in patients with alcoholic liver disease. *J Hepatol.* 1995;23:234-235.
62. Epstein AM, Read JL, Hoefer M. The relation of body weight to length of stay and charges for hospital services for patients undergoing elective surgery: A study of two procedures. *Am J Public Health.* 1987;77:993-997.
63. Tayback M, Kumanyika S, Chee E. Body weight as a risk factor in the elderly. *Arch Intern Med.* 1990;150:1065-1072.
64. Ebrahim S, Morgan K, Dallosso H, Bassey J, Harries U, Terry A. Interviewing the elderly about their health: Validity and effects on family doctor contacts. *Age Ageing.* 1987;16:52-57.
65. Gillick M, Steel K. Referral of patients from long-term to acute-care facilities. *J Am Geriatr Soc.* 1983;31:74-78.

66. Morgan DB, Path MRC, Hill GL, Burkinshaw L. The assessment of weight loss from a single measurement of body weight: The problems and limitations. *Am J Clin Nutr.* 1980;80:2101-2105.
67. Windson JA, Hill GL. Weight loss with physiologic impairment: A basic indicator of surgical risk. *Ann Surg.* 1988;207:290-296.
68. Campbell AJ, Spears GFS, Brown JS, Busby WJ, Borrie MJ. Anthropometric measurements as predictors of mortality in a community population aged 70 years and over. *Age Ageing.* 1990;19:131-135.
69. Rich AJ. The assessment of body composition in clinical conditions. *Proc Nutr Soc.* 1982;41:389-403.
70. Broden G, Bark S, Nordervall, Backman L. Nutritional assessment and postoperative morbidity. *Acta Chir Scand.* 1984;520(Suppl.):27-32.
71. Klidjian AM, Foster KJ, Kammerling RM, Cooper A. Karran SJ. Relation of anthropometric and dynamometric variables to serious postoperative complications. *Br Med J.* 1980;281:899-901.
72. Young GA, Chem C, Hill GL. Assessment of protein-calorie malnutrition in surgical patients from plasma proteins and anthropometric measurements. *Am J Clin Nutr.* 1978;31:429-435.

73. Forse RA, Christow N, Meakins JL. Reliability of skin testing as a measure of nutritional state. Arch of Surg. 1981;116:1284-1288.
74. Ek AC, Larsson J, vonSchenck H, Thorslund S, Unosson M, Bjurulf P. The correlation between anergy, malnutrition and clinical outcome in an elderly hospital population. Clin Nutr. 1990;9:185-189.
75. Phillips A, Shaper AG, Whincup PH. Association between serum albumin and mortality from cardiovascular disease, cancer, and other causes. Lancet. 1980;2:1434-1437.
76. Sahyoun NR, Jackques PF, Dallal G, Russell RM. Use of albumin as a predictor of mortality in community-dwelling and institutionalized elderly populations. J Clin Epidemiol. 1996;49:981-988.
77. Klonoff-Cohen H, Barrett-Connor EL, Edelsten SL. Albumin levels as a predictor of mortality in the healthy elderly. J Clin Epidemiol. 1992;45:207-212.
78. Corti MC, Guralnik JM, Salive ME, Sorkin JD. Serum albumin level and physical disability as predictors of mortality in older persons. JAMA. 1994;272:1036-1042.
79. Woods HF. Biochemical methods in nutritional assessment. Proc Nutr Soc. 1982;41:419-425.

80. Bistrian BR, Blackburn GL, Scrimshaw NS, Flatt JP.  
Cellular immunity in semistarved states in hospitalized adults. Am J Clin Nutr. 1975;28:1148-1155.
81. Comment by Blackburn in Buzby GP, Mullen JL, Matthews DC, Hobbs CL, Rosato EF. Prognostic nutritional index in gastrointestinal surgery. Am J Surgery. 1980;139:160-167.
82. Mitchell C, Lipshitz D. The effect of age and sex on the routinely used measurements to assess the nutritional status of hospitalized patients. Am J. Clin Nutr. 1982;36:340-349.
83. Harvey KB, Moldawer IL, Bistrian BR, Blackburn GL.  
Biological measures for the formulation of a hospital prognostic index. Am J Clin Nutr. 1981;34:2013-2022.
84. Ferguson RP, O'Connor P, Crabtree B. Serum albumin and prealbumin as predictors of clinical outcomes of hospitalized elderly nursing home residents. J Am Geriatr Soc. 1993;41:545-549.
85. Velanovich V. The value of routine preoperative laboratory testing in predicting postoperative complications: A multivariate analysis. Surgery. 1991;109:236-243.

86. Randle NW, Hubert-Hartmann K, Mulheran LC. Serum albumin levels: Relationship to length of hospital stay. *Hosp Pharm.* 1984;18:802-805.
87. Warnold I, Lundholm K. Clinical significance of preoperative nutritional status in 215 noncancer patients. *Ann Surg.* 1984;199:299-305.
88. Dreblow DM, Anderson CF, Moxness K. Nutritional assessment of orthopedic patients. *Mayo Clin Proc.* 1981;56:51-54.
89. Anderson CF, Wochos DN. The utility of serum albumin values in the nutritional assessment of hospitalized patients. *Mayo Clin Proc.* 1982;57:181-184.
90. Constans T, Bacq Y, Brechot JF, Guilmot JL, Choutet P, Lamisse F. Protein-energy malnutrition in elderly medical patients. *J Am Geriatr Soc.* 1992;40:263-268.
91. Antonelli-Incalzi R, Landi F, Cipriani L, Bruno E, Pagano F, Gemma A, Capparella O, Carbonin PU. Nutritional assessment: A primary component of multidimensional geriatric assessment in the acute care setting. *J Am Geriatr Soc.* 1996;44:166-174.
92. Sullivan DH. Risk factors for early hospital readmission in a select population of geriatric rehabilitation patients: The significance of nutritional status. *J Am Geriatr Soc.* 1992;40:792-798.

93. Apelgren KN, Rombeau JL, Twomey PL, Miller RA.  
Comparison of nutritional indices and outcome in critically ill patients. Crit Care Med. 1982;10:305-307.
94. Murray MK, Marsh HM, Wochos DN, Moxness KE, Oxford KP, Callaway CW. Nutritional assessment of intensive-care unit patients. Mayo Clin Proc. 1988;63:1106-1115.
95. Spiess A, Mikalunas V, Carlson S, Zimmer M, Craig RM. Albumin kinetics in hypoalbuminemic patients receiving total parenteral nutrition. JPEN. 1996;20:424-428.
96. Hoyer RC, Bennett SH, Geelhoed GW, Gorschoth G. Fluid volume and albumin kinetics occurring with major surgery. JAMA. 1972;222:1255-1261.
97. Herrmann FR, Safran C, Levkoff SE, Minaker KL. Serum albumin level on admission as a predictor of death, length of stay, and readmission. Arch Intern Med. 1992;152:125-130.
98. Anderson MD, Collins G, Davis G. Malnutrition and length of stay - a relationship? Henry Ford Hosp Med J. 1985;22:190-193.
99. Anderson CF, Moxness K, Meister J, Burritt MF. The sensitivity and specificity of nutrition-related variables in relationship to the duration of hospital

- stay and the rate of complications. Mayo Clin Proc. 1984;59:477-483.
100. Sullivan DH, Patch GA, Walls RC, Lipschitz DA. Impact of nutritional status on morbidity and mortality in a select population of geriatric patients. Am J Clin Nutr. 1990;51:749-758.
  101. Bilbrey GL, Cohen TL. Identification and treatment of protein calorie malnutrition in chronic hemodialysis patients. Dial Transplant. 1989;18:669-700.
  102. Forse RA, Shizgal HM. The assessment of malnutrition. Surgery. 1980;88:17-24.
  103. Reeds PJ, Laditan AAO. Serum albumin and transferrin in protein-energy malnutrition: Their use in the assessment of marginal undernutrition and the prognosis of severe undernutrition. Br J Nutr. 1976;36:255-263.
  104. Starker PM, Gump FE, Askanazi J, Elwyn DH, Kinney JM. Serum albumin levels as an index of nutritional support. Surgery. 1982;91:194-199.
  105. Carpentier YA, Barthel J, Bruyins J. Plasma protein concentration in nutritional assessment. Proc Nutr Soc. 1982;41:405-417.
  106. Champion EW, deLabry LO, Glynn RJ. The effect of age on serum albumin in healthy males: Report from the normative aging study. J Gerontol. 1988;43:M18-20.

107. Cooper JK, Gardner C. Effect of aging on serum albumin. *J Am Geriatr Soc.* 1989;37:1039-1042.
108. Reuben DB, Moore AA, Damesyn M, Keeler E, Harrison GG, Greendale GA. Correlates of hypoalbuminemia in community-dwelling older persons. *Am J Clin Nutr.* 1997;66:38-45.
109. Salive ME, Cornoni-Huntley J, Phillips CL, Guralnik JM, Cohen HJ, Ostfeld AM, Wallace RB. Serum albumin in older persons: Relationship with age and health status. *J Clin Epidemiol.* 1992;45:213-221.
110. Breslow RA, Hallfrisch J, Guy DG, Crawley B, Goldberg AP. The importance of dietary protein in healing pressure ulcers. *J Am Geriatr Soc.* 1993;41:357-362.
111. Gillick M, Steel K. Referral of patients from long-term to acute-care facilities. *J Am Geriatr Soc.* 1983;31:74-78.
112. Pettigrew RA, Hill GL. Indicators of surgical risk and clinical judgment. *Br J Surg.* 1986;73:47-51.
113. Windsor JA, Knight GS, Hill GL. Wound healing response in surgical patients: Recent food intake is more important than nutritional status. *Br J Surg.* 1988;75:135-137.
114. Boles JM, Garre MA, Youinou PY, Mialon P, Menez JF, Jouquan J, Miossec PJ, Pennec Y, Lemmen G. Nutritional



- status in intensive care patients: Evaluation of 84 unselected patients. Crit Care Med. 1983;11:87-90.
115. Unterman TG, Vazquez RM, Slas AJ, Martyn PA, Phillips LS. Nutrition and somatomedin: XIII. Usefulness of Somatomedin-C in nutritional assessment. Am J Med. 1985;78:228-234.
116. Clemmons DR, Underwood LE, Dickerson RN, Brown RO, Hak LJ, MacPhee RD, Heizer WD. Use of plasma somatomedin-C/insulin-like growth factor I measurements to monitor the response to nutritional repletion in malnourished patients. Am J Clin Nutr. 1985;41:191-198.
117. Walesby RK, Goode AW, Spinks TJ, Herring A, Ranicar ASO, Bentall HH. Nutritional status of patients requiring cardiac surgery. J Thor Cardiovasc Surg. 1979;77:570-576.
118. Buzby GP, Williford WO, Peterson OL, Crosby LO, Page CP, Reinhardt GF, Mullen JL. A randomized clinical trial of total parenteral nutrition in malnourished surgical patients: The rationale and impact of previous clinical trials and pilot study on protocol design. Am J Clin Nutr. 1988;47:357-365.
119. Linn BS. A protein energy malnutrition scale. Ann Surg. 1984;200:747-752.

120. Hall JC. Use of internal validity in the construct of an index of undernutrition. JPEN. 1990;14:587-592.
121. Ingenbleek Y, Carpentier YA. A prognostic inflammatory and nutritional index scoring critically ill patients. Int J Vitam Nutr Res. 1985;55:91-101.
122. Buzby GP, Mullen JL, Matthews DC, Hobbs CL, Rosato EF. Prognostic nutritional index in gastrointestinal surgery. Am J Surgery. 1980;139:160-167.
123. Smale BF, Mullen JL, Buzby GP, Rosato EF. The efficacy of nutritional assessment and support in cancer surgery. Cancer. 1981;47:2375-2381.
124. Mullen JL. Consequences of malnutrition in surgical patients. Surgical Clinics of North America. 1981;61:465-487.
125. Dempsey DT, Mullen JL, Buzby GP. The link between nutritional status and clinical outcome: Can nutritional intervention modify it? Am J Clin Nutr. 1988;47:352-356.
126. Mullen JL, Buzby G. Nutritional assessment of the hospitalized patient: Why bother? Drug Therapy Hospital. 1980:33-41.
127. Vehe KL, Brown RO, Kuhl DA, Boucher BA, Luther RW, Kudsk KA. The prognostic inflammatory and nutritional

- index in traumatized patients receiving enteral nutrition support. J Am Coll Nutr. 1991;10:355-363.
128. Chima CS, Barco K, Dewitt MLA, Maeda M, Teran JC, Mullen KD. Relationship of nutritional status to length of stay, hospital costs, and discharge status of patients hospitalized in the medicine service. J Am Diet Assoc. 1997;97:975-978.
129. Metropolitan Life Insurance Company. Metropolitan height and weight tables. Stat Bull Metrop Insur Co. 1983;64:2-5.
130. SAS/STAT User's guide. Version 6, Fourth Edition. Cary, NC: SAS Institute; 1989.
131. Rowland ML. Self-reported weight and height. Am J Clin Nutr. 1990;52:1125-1133.
132. Armitage P, Berry G. Statistical methods in medical research. Oxford: Blackwell Scientific Publications; 1994.
133. Zeman FJ. Clinical Nutrition and Dietetics. New York, NY: MacMillan Publishing Company; 1991.
134. Klein S. The myth of serum albumin as a measure of nutritional status. Gastroenterology. 1990;99:1845-1846.

Appendix 1

Data Gathering Tool

Case No. \_\_\_\_\_ RD/DTR \_\_\_\_\_ Date \_\_\_\_\_

Part A

Room No. \_\_\_\_\_  
Last Name \_\_\_\_\_  
First Name \_\_\_\_\_  
Adm. Date \_\_\_\_\_  
Height (in.) \_\_\_\_\_  
Weight (lb.) \_\_\_\_\_  
Age \_\_\_\_\_  
Sex \_\_\_\_\_

Part B

Patient No. \_\_\_\_\_  
Serum Alb \_\_\_\_\_ Date Drawn \_\_\_\_\_

Part C

What was the patient's weight 6 months ago? \_\_\_\_\_

Part D

Time Started \_\_\_\_\_

- |   |                              |                              |
|---|------------------------------|------------------------------|
| 1. Tube Feeding/TPN                       | <input type="checkbox"/> No  | <input type="checkbox"/> Yes |
| If yes contact RD If no continue:         |                              |                              |
| 2. Good Appetite                          | <input type="checkbox"/> Yes | <input type="checkbox"/> No  |
| Special diet                              | <input type="checkbox"/> No  | <input type="checkbox"/> Yes |
| if yes previous instruction               | <input type="checkbox"/> Yes | <input type="checkbox"/> No  |
| 3. Nausea/vomiting > 5 days               | <input type="checkbox"/> No  | <input type="checkbox"/> Yes |
| 4. Diarrhea > 5 days                      | <input type="checkbox"/> No  | <input type="checkbox"/> Yes |
| > 5 lb. weight loss in 1 mo.              | <input type="checkbox"/> No  | <input type="checkbox"/> Yes |
| 5. Difficulty swallowing/chewing          | <input type="checkbox"/> No  | <input type="checkbox"/> Yes |
| If 2 or more in this box contact RD _____ |                              |                              |

Time ended \_\_\_\_\_

Part E

Time started \_\_\_\_\_

- |  |  |
|--|--|
| <input type="checkbox"/> Yes <input type="checkbox"/> No | 1. Does the patient have unhealed wounds?  |
| <input type="checkbox"/> Yes <input type="checkbox"/> No | 2. Does the patient have any mouth/tooth or neurological problems that make it difficult to eat? |
| <input type="checkbox"/> Yes <input type="checkbox"/> No | 3. Is the patient receiving enteral/parenteral nutrition or is expected to need it?              |

- Yes  No    4. Has the patient unintentionally lost  
> 10 lb. in 6 months?
- Yes  No    5. Does the patient appear emaciated?

Time ended \_\_\_\_\_