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ABSTRACT

Nutrition is well-recognized as a necessary component of educational programs for physicians. This is to be valued in that of all factors affecting health in the United States, none is more important than nutrition. This can be argued from various perspectives, including health promotion, disease prevention, and therapeutic management. In all cases, serious consideration of nutrition related issues in the practice is seen to be one means to achieve cost-effective medical care. These modules were developed to provide more practical knowledge for health care providers, and in particular primary care physicians. The modules were written by dieticians and nutritionists working closely with physicians. The modules were field tested and reviewed by basic and clinical science faculty in a number and variety of educational programs. This module is designed to describe the clinically applicable techniques and procedures of nutritional status assessment, and provide guidelines for implementing these techniques in a primary care setting. Emphasis is placed on common nutritional problems likely to be encountered by the family physician. Included are the learning goals and objectives, self-checks of achievement with regard to goals, and references for the physician and for the physician to give to the patient. The appendices include skinfold thickness and arm-muscle circumference techniques, and a chart of ideal weight and urinary creatinine for height. (CW)

2 Appraisal of Nutritional Status

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Nutrition in Primary Care

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The Nutrition in Primary Care Series Contains These Modules:

1. Nutrient Content of Foods, Nutritional Supplements, and Food Fallacies
2. Appraisal of Nutritional Status
3. Nutrient and Drug Interactions
4. Normal Diet: Age of Dependency
5. Normal Diet: Age of Parental Control
6. Normal Diet: Adolescence
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12. Dietary Management in Hyperlipidemia
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14. Dietary Management for Alcoholic Patients
15. Nutritional Care of Deteriorating Patients
16. An Office Strategy for Nutrition-Related Patient Education and Compliance

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2 Appraisal of Nutritional Status

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2 Appraisal of Nutritional Status

Nutrition in Primary Care

Tables, Figures and Chart

Introduction

A comprehensive goal for patient care is the promotion and maintenance of good health for patients throughout all stages of the life cycle. The process of achieving this goal includes several steps, the first of which is the assessment of each patient's present health status. From this assessment, a care plan can then be devised to best meet the patient's health-care needs.

A good diet is essential for an individual to fully realize genetic potential, develop and maintain good health, and combat disease. Therefore, a comprehensive assessment process for each patient should include an evaluation of his nutritional status. This requires that you know the methods for measuring and assessing nutritional status.

As a physician concerned about the nutritional status of your patient, you may have asked yourself the following questions:

- "Are my patients eating a nutritionally adequate and balanced diet?"
- "Of the many patients in my practice, which are most likely to have a nutrition-related problem?"
- "Are there any simple biochemical tests I can use for assessing the nutritional status of patients with regard to particular nutrients?"
- "How can a dietitian help me in assessing the nutritional status of my patients, and how can I obtain the services of a clinical dietitian?"

Goals

This module is designed to help answer the questions in the Introduction. Specifically, the objectives of the module are (1) to describe the clinically applicable techniques and procedures of nutritional status assessment, and (2) to provide clinically useful guidelines for implementing these techniques in a primary care setting. Emphasis is placed on common nutritional problems likely to be encountered by the family physician. As a result of this unit of study, you should be able to:

1. *Describe clinically applicable techniques and procedures in the following 4 major areas of nutritional status assessment: clinical parameters, anthropometric measurements, biochemical analyses, and dietary evaluation;*

2. *Discuss the advantages and limitations of the above techniques and procedures, and describe how they can be most useful in clinical practice;*

3. *Recognize the persons who are at high risk for nutritional problems in your daily practice;*

4. *Given a list of the more common medical problems confronting family physicians, ascertain the possible impact of each disorder on the ingestion, digestion absorption, and utilization of food and on the subsequent nutritional status of patients;*

5. *Given a care study, outline the nutritional status assessment procedure appropriate for the patient; and*

6. *When presented with a patient who requires further nutritional assessment and counseling, request the services of a registered clinical dietitian.*

Nutritional Status Assessment Techniques and Procedures

Overt nutritional deficiencies are not seen in the average American except under unusual circumstances such as in patients with advanced cancer, with chronically large medication usage, and who live in extreme poverty.

Malnutrition, simply stated, is any disorder of nutrition, and it includes disorders of both undernutrition and overnutrition. You are more likely to encounter subtle nutritional problems such as anemia, underweight, or poor immunocompetence which compromise the health of patients than you are to encounter frank nutritional deficiency diseases.

It is necessary to identify individuals with subtle nutritional problems in the early stage so that preventative measures can be taken before the nutritional deficiencies result in overt functional or anatomical changes.[1] Techniques for evaluating the nutritional status of an individual, therefore, must be sufficiently sensitive to identify those who have health problems that may eventually result in subclinical nutritional deficiencies. Because nutritional deficiencies have multiple etiologies plus diverse and often overlapping symptoms, no one method of assessment is complete. Several methods, including the following, are required to accurately assess the nutritional status of an individual:

- Clinical parameters,
- Anthropometric measurements
- Biochemical analyses, and
- Dietary evaluations.

Although vitamin deficiencies immediately come to mind when nutritional deficiency diseases are discussed, more prevalent diseases commonly seen today in both hospitalized and free-living individuals include energy-protein malnutrition (particularly among hospitalized surgical patients),[2] osteoporosis, and nutritional anemia.

A note of interest should be mentioned at this point regarding nutrient deficiency diseases. The sequence of events leading to a nutritional deficiency has been diagrammed as shown in Figure 2-1.

Clinical Parameters

Eliciting information regarding the nutritional assessment of a patient should begin when you obtain the medical history and perform the physical examination.

The Medical History

In assessing nutritional status, include in the history identification of (1) socioeconomic, cultural, and ethnic status, (2) life-cycle status, and (3) present and past medical and surgical problems.

The following general areas of nutritional status assessment information should be ascertained when a medical history is elicited from the patient:

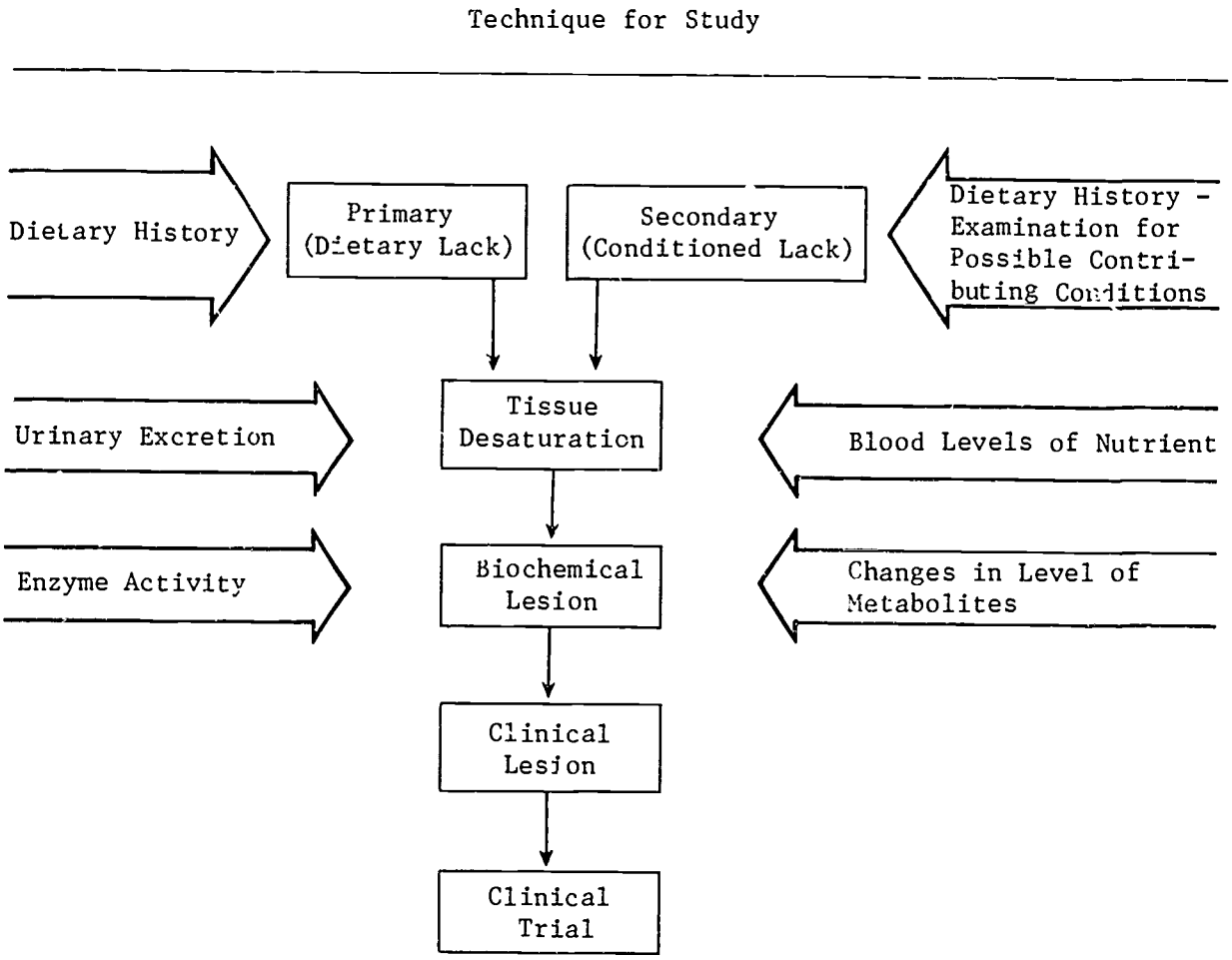
1. *To what economic, cultural, social, or ethnic group does the patient belong?* There is a higher incidence of nutrition-related problems in lower income groups and among individuals with limited education than among higher socioeconomic and more highly educated groups. Particular problems of undernutrition are seen in migrant workers, urban and rural laborers, some American Indians and Mexican Americans, and many individuals and their offspring who follow bizarre and rigid diet regimens which may be either culturally or religiously imposed.
2. *In what stage of the life cycle is the patient?* Certain stages of the life cycle increase an individual's vulnerability to nutritional problems. Infants and young children are susceptible to impaired growth and development if inadequate kilocalories and other nutrients are consumed. Iron-deficiency anemia is the most common nutritional problem among infants from 6 to 12 months old, as was among adolescents, women during the reproductive years, and adults over 60 years old.

   In the Ten-State Nutrition Survey conducted in the late 1960s,[3] children under age 6 were frequently found to have low levels of se-

rum iron and vitamin A; Mexican-American children were particularly susceptible. The Health and Nutrition Examination Survey (HANES) conducted from 1971 to 1974[4] identified low calcium intake in black females, 18 to 44 years old. Low vitamin A intakes also occurred in white females, aged 18 to 44 years, and in normal-income black adolescents, aged 12 to 17 years.

Clinical studies have indicated that adolescents, particularly pregnant adolescents, are vulnerable to nutritional problems due to growth needs compounded by poor eating habits. Women on oral contraceptives are subject to deficiencies of pyridoxine, folic acid, and vitamin B_{12}.[5] The elderly individual living alone (and sometimes also in a long-term care facility) often receives an inadequate diet

Figure 2–1 Sequence of Events Leading to Clinical Nutrition Lesion



From Pearson, W N "Biochemical Appraisal of the Vitamin Nutritional Status in Man." *Journal of the American Medical Association*, 180:49-55, 1962. Used with permission of the American Medical Association, © 1962, Chicago, IL.

due to lack of financial resources, lack of socialization, senility, and disorders which preclude adequate consumption or utilization of nutrients and kilocalories.

3. *What is the patient's present and past medical history?* You should obtain a profile of the patient's present and past medical history which has nutritional implications. This includes such notations as diseases and illnesses, surgeries, allergies, infections, accidents, and medication usage. Many surgical procedures, especially those of the gastrointestinal tract, have nutritional implications. Some examples are as follows:

   a. *Head and neck surgery for cancer.* Inadequate dietary intake due to malocclusion or mastication and swallowing difficulties.

   b. *Gastrectomy, partial or total:* dumping syndrome, maldigestion, malabsorption, pernicious anemia, and anorexia.

   c. *Small bowel surgery:* malabsorption of fat, fat-soluble vitamins, and minerals; vitamin B_{12} deficiency (pernicious anemia) in ileectomy patients; bile acid deficiency.

   d. *Colon surgery:* loss of electrolytes and fluid, diarrhea, and/or constipation.

Table 2-1 Questions Appropriate During Medical History Elicitation to Spot the Patient at Risk for Dietary Deficiency

Have you recently suffered a major illness? If so, what and when?
Are you under unusual stress at the present time? If so, of what kind?
Are you pregnant? Breastfeeding?
Have you recently lost more than 15 pounds (or 10% of body weight)? If so, what do you consider the reason for the weight loss?
What is your usual weight (or desired weight)?
Do you consider yourself overweight (more than 15% above desirable weight)? If yes, are you dieting?
Do you actively engage in exercises or sports or have a regular exercise routine? If so, what?
Are you frequently nauseated?
Do you ever vomit your food?
Do you have chronic diarrhea, constipation, heartburn, or other gastrointestinal problems?
Are you taking oral contraceptives? Water pills? Antibiotics? (Other drugs that might interfere with food absorption?)
Do you wear dentures? If so, do they fit well?
Do you live alone or eat your meals with anyone? (If the patient is elderly)

e. *Gallbladder and pancreas surgeries.* fat malabsorption, diarrhea, maldigestion due to lack of pancreatic digestive enzymes, diabetes mellitus.

Table 2–1 lists a set of questions which would be appropriate and desirable for you to ask patients while taking their medical histories in order to assess their nutritional risks.

The Physical Examination

The physical examination can diagnose obesity, underweightness, and overt, yet rare, nutritional deficiencies such as pellegra, scurvy, and beriberi, but does not usually indicate subclinical deficiencies which are more likely to occur.

The physical examination is probably the least sensitive portion of the clinical evalution for detecting nutritional deficiencies. The tissues most likely to exhibit nutritional abnormalities that may be identified by physical examination are the eyes, mucous membranes, skin, hair, mouth, teeth, tongue, thyroid gland, nervous system, and the extremities.[1] Although many changes in these tissues are specific for a single nutrient, most of the time they represent multiple deficiencies and do not occur unless the deficiencies are well advanced. Clinical observations are subjective and often unreliable. but they can be used to confirm biochemical and dietary data. Table 2–2 outlines some clinical signs of probable nutritional significance that would indicate the need for future evaluation.[6]

Anthropometric Measures

Anthropometric measures include height, weight, skinfold thickness, arm circumference, and arm muscle circumference.

Some anthropometric measures can be of assistance to you in assessing a patient's nutritional status. This information is most valuable when obtained over a period of time with regular, accurate, and consistent recording of measurements and development. Physical measurements reflect total nutritional status over a lifetime. Height and head circumference measurements reflect past nutrition or chronic nutritional status. Present nutritional status can be measured by body weight, skinfold measurements, arm circumference measurements, and arm muscle circumference calculations. Of these, the most reliable and easily obtained parameters are the patient's height and weight.

Height and Weight

Height and weight measurements should be performed on all patients since verbal reports by patients are not always reliable. Your office should be equipped with accurate and reliable scales. Weight is best measured on lever-balance (beam balance) scales. Spring balances, such as the common household (bathroom) scales, are unreliable. It is important that the scales are accurate and calibrated periodically. Nothing can be more devastating to the conscientious dieter than to weigh in at your office on a scale that inaccurately registers a weight gain or no change in weight status. Weights are more accurately measured if obtained at the same time of day, preferably in the early morning after emptying the bladder and before breakfast. The person should be weighed wearing light clothing without shoes. Record weight to the nearest half pound for adults or quarter pound for infants.

Height should be measured against a flat surface with the patient standing erect, without tipping the head up or down, and barefoot or wearing socks only. Read the height to the nearest quarter inch. Children less than 36 months old should be measured in the recumbent position (crown-heel length), with the length plotted on a growth chart.

A major problem in evaluating a patient's weight relative to height is the choice of standards to use for comparison. Height-weight tables are commonly used, but they have many limitations. Some tables are devised without taking into consideration differences in body build. Another type of table which is useful in evaluating nutritional status is one giving "ideal" or "desirable" weights for height. Table 2–3 shows such desirable weights according to height and frame.

Table 2-2 Some Clinical Signs of Probable Nutritional Significance

Area of Examination	Clinical Signs	Disorder or Probable Nutrient Deficiency
Hair	Lack of luster	Protein and Kilocalorie
	Easy pluckability	Protein and Kilocalorie
Skin	Follicular hyperkeratosis	Vitamin A
	Petechiae, purpura	Vitamin C
	Pellagrous dermatitis	Nicotinic Acid
	Scrotal and vulval dermatitis	Riboflavin
	Xanthomas	Hyperlipidemia
Face	Nasolabial seborrhea	Riboflavin
	Swollen face	Kwashiorkor
Eyes	Xerosis of conjunctiva	Vitamin A
	Keratomalacia	Vitamin A
	Corneal vascularization	Riboflavin
	Blepharitis	Pyridoxine and other B vitamins
	Bitot's spots	Vitamin A
Lips	Cheilosis	Riboflavin
	Bilateral angular fissures/ scars	Riboflavin
Tongue	Edema, swollen	Niacin
	Magenta tongue	Riboflavin
Gums	Swollen interdental papillae	Vitamin C
	Bleeding gums	Vitamin C
Teeth	Mottled enamel	Fluoride excess
Glands	Thyroid enlargement	Iodide
	Parotid enlargment	Starvation
Skeleton	Enlarged wrist epiphyses	Vitamin D
	Bossing of the skull	Vitamin D
	Beading of the ribs	Vitamin C
	Bowed legs	Vitamins D and C
	Fractures in elderly	Osteoporosis
Neurological	Hyporeflexia	Thiamin
	Tender calf muscles	Thiamin
Extremities	Dependent edema	Fluid overload Protein deficiency

Adapted from Goodhart, R.S. and Shils, M E. "Clinical Evaluation of Nutritional Status." Chapter 19 in *Modern Nutrition in Health and Disease*. Philadelphia, Lea and Febiger, 1973.

Table 2–3 Desirable Weights for Men and Women According to Height and Frame (Ages 25 and Over)

Height (in shoes)*	Weight in pounds (in indoor clothing)		
	Men		
	Small Frame	Medium Frame	Large Frame
5 ft 2 in.	112–120	118–129	126–141
5 ft 3 in.	115–123	121–133	129–144
5 ft 4 in.	118–126	124–136	132–148
5 ft 5 in.	121–129	127–139	135–152
5 ft 6 in.	124–133	130–143	138–156
5 ft 7 in.	128–137	134–147	142–161
5 ft 8 in.	132–141	138–152	147–166
5 ft 9 in.	136–145	142–156	151–170
5 ft 10 in.	140–150	146–160	155–174
5 ft 11 in.	144–154	150–165	159–179
6 ft 0 in.	148–158	154–170	164–184
6 ft 1 in.	152–162	158–175	168–189
6 ft 2 in.	156–167	162–180	173–194
6 ft 3 in.	160–171	167–185	178–199
6 ft 4 in.	164–175	172–190	182–204
	Women		
	Small Frame	Medium Frame	Large Frame
4 ft 10 in.	92–98	96–107	104–119
4 ft 11 in.	94–101	98–110	106–122
5 ft 0 in.	96–104	101–113	109–125
5 ft 1 in.	99–107	104–116	112–128
5 ft 2 in.	102–110	107–119	115–131
5 ft 3 in.	105–113	110–122	118–134
5 ft 4 in.	108–116	113–126	121–138
5 ft 5 in.	111–119	116–130	125–142
5 ft 6 in.	114–123	120–135	129–146
5 ft 7 in.	118–127	124–139	133–150
5 ft 8 in.	122–131	128–143	137–154
5 ft 9 in.	126–135	132–147	141–158
5 ft 10 in.	130–140	136–151	145–163
5 ft 11 in.	134–144	140–155	149–168
6 ft 0 in.	138–148	144–159	153–174

*1-inch heels for men and 2-inch heels for women

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A patient's weight history is often pertinent to his present health status. A recent gain or loss of weight may cue you to possible problems.

Skinfold Thickness

The need to recognize those individuals with excess or deficient stores of body fat, and hence caloric reserves, is an important aspect of nutritional assessment. Height and weight measurements are gross assessments of the patient's nutriture, and weight is easily affected by the patient's state of hydration. To further identify the fat and lean body mass components of body weight, skinfold thickness (which measures body fat) and arm circumference and arm muscle circumference parameters (which measure lean body mass) can be performed.

Skinfold calipers have been developed to measure the thickness of skinfolds of various parts of the body. The skinfold thickness is an indication of the body's leanness-fatness. Consolazio[7] and Brozek and Keys,[8] as well as other researchers, have derived regression equations from skinfold thickness measurements for predicting body specific gravity. From these body density or specific gravity estimates, formulas have been developed for converting these figures to an index of leanness-fatness, usually expressed as percentage of total body weight that is fat. It is generally agreed that skinfold measurements over the triceps and scapular region are the most practical sites of measurement for all age groups. Women of normal weight are approximately 20% to 25% body fat by weight; men of normal weight are approximately 15% to 20% body fat by weight.

Appendix A at the back of this module includes a description of the correct method and appropriate sites for measuring skinfold thickness. It also includes standards to which an individual's measurements can be compared.

With a little practice, these body composition assessment techniques can be perfected. They take relatively little time to perform and can give useful information regarding the patient's nutritional status. This, in turn, is often an excellent diagnostic and prognostic indicator for various illnesses.

Is it necessary to perform such measurements in daily medical practice? Following are several reasons why skinfold measures can be helpful to you:

1. Overweightness and underweightness as single criteria are not accurate indicators of general health and well-being, determination of body composition, on the other hand, is of greater usefulness. Some patients may appear overweight by height-weight tables but will actually fall within recommended fatness levels when skinfolds are determined. Such patients include athletes who are heavily muscled and have a low percentage of body fat.
2. For patients on a weight-control program, such measurements provide a more tangible estimation of changes in body fatness (the ultimate goal of therapy), rather than simply changes in body weight. This is especially true for both the dieter who has engaged in an exercise program and for the patient who has problems with fluid retention.
3. There is the psychological factor of "doing something to the patient," in addition to routine weighins. Taking time to do skinfold measurements indicates an interest in the patient that reinforces weight-change attempts.

As with any assessment technique, skinfold measurements have limitations with which you should be familiar. These limitations include the following:

1. Skinfold measures are difficult to reproduce and are subject to the skill of the assessor performing the measurements. The assessor should be trained in the use of calipers, and the same assessor should perform repeat or follow-up measurements on the same patients. The services of a clinical dietitian can be employed to assist you in obtaining accurate skinfold measurements and nursing personnel and office receptionists can be taught how to take reliable measurements.
2. The state of the patient's hydration can alter the measurement results. If possible, repeat measurements should be made at the same time of day, preferably during the morning.
3. Repeat measurements should be made at the same point at each body site for utmost accuracy.
4. Measurements are difficult to perform and decrease in accuracy for the very muscular or obese patient. Very lean patients are the easiest for palpating subcutaneous skinfolds.

5. The formulas and standards for estimating body fatness are derived from population studies that might not represent an accurate standard for individual patients. This may be especially true of the geriatric patient, the chronically ill patient, and the patient undergoing rehabilitation.

In spite of these limitations, skinfold measurements, when performed correctly, can provide a useful measure of the nutritional status of a patient. They are especially useful in assessing body fat of underweight and overweight persons so that you or a dietitian can correctly decide whether or not weight gain or weight loss is indicated.

Arm Circumferences

There are several occasions when you will need an estimate of the patient's lean body mass in addition to the body fat mass as determined by skinfold measurement. One such occasion would be when you are faced with a chronically ill patient who has mobilized a substantial amount of lean body tissue to maintain blood glucose levels through gluconeogenesis or to provide a substrate for cellular energy production. These conditions occur frequently in the malnourished alcoholic, the cancer patient, the malabsorptive or hypermetabolic patient, and the elderly person living on a substandard income.

A simple and fairly accurate method of assessing the skeletal muscle compartment can be made by measuring the person's mid-upper arm circumference with a tape measure. This total arm circumference measure includes skin, fat, muscle, and bone components. From this measurement and the skinfold measurements, the arm muscle circumference, which is an index of total lean body mass, can be calculated. Lean body mass is expressed as a deviation from normal, using standards developed from population studies by the World Health Organization as well as other researchers.[7-12] Appendix B includes an outline of the procedure for measuring arm circumference, the formula for calculating arm muscle circumference, and the standards for comparison.

Other circumference measurements may be important to you in evaluating the nutritional status of children. The measurement of head circumference is useful in children, especially for those under age 3 years. Head circumference, if smaller than the standard, may reflect malnourishment and possibly decreased brain growth, but it must always be viewed in relation to overall body size. Measuring the chest circumference is valuable during the second and third years of life. In children betweeen the ages of 6 months and 5 years, a chest circumference smaller than the head circumference suggests possible developmental failure or a wasting of muscle and fat from the chest wall, this can be indicative of protein-calorie malnutrition.

Biochemical Analyses

The complete blood count, blood indices, BUN, creatinine, plasma albumin, and transferrin provide valuable clues to nutritional status and may provide the indications for further testing. Abnormal results provide the basis for objective monitoring of therapy.

The biochemical evaluation of nutritional status involves quantitative determination of nutrients or related metabolites in tissues and in the blood and urine. Occasionally, analyses will be needed from tissues, including liver or bone marrow, but this is done infrequently because of the discomfort and risks it poses the patient.

When performing laboratory tests, it is essential that proper handling and storage of samples are undertaken to assure reliable data. Often you will arrange with an affiliate hospital or laboratory to do outpatient laboratory testing. **It is, however, your responsibility to instruct the patient in any pretest procedures and precautions.**

Many biochemical tests for nutritional status assessment require that the patient fast at least twelve hours before the test is performed. Some examples of blood tests for which fasting is necessary include the glucose tolerance test, the fasting blood sugar test, and the serum triglyceride test. It is frustrating for a patient to make a special trip to the hospital or laboratory for tests and then discover that the tests cannot be completed because breakfast or medications were taken which would alter the test results. Before leaving your office, patients should be provided with *printed and verbal instructions* on how to prepare for the test and

Table 2–4 Normal Values of Nutrition-Related Blood Tests

Blood *		Serum *	
Hematocrit		Total protein	6-8 gm/dl
Men	40-54%	Albumin	4.0-5.5 gm/dl
Women	37-47%	Vitamin A	40-120 IU/dl
		Vitamin C	0.4-1.0 mg/dl
Hemoglobin		Folic Acid (folacin)	7-16 ng/ml
Men	14-17 gm/dl	Vitamin B_1 (thiamin)	3.4 µg/dl
Women	12-15 gm/dl	Vitamin B_2 (riboflavin)	20 µg/dl
		Vitamin B_{12}	350-750 µg/dl
Cell differential		Tocopherol (vitamin E)	1.0-1.2 mg/dl
Lymphocytes	25-33% or at least 1,800	Prothrombin time	10-15 sec
Monocytes	3-7%	Calcium	4.5-5.5 mEq/liter
Neutrophils	54-62%	Chloride	100-106 mEq/liter
Eosinophils	1-3%	Copper	130-230 µg/dl
Basophils	0-0.75%	Protein-bound iodine	4-8 µg/dl
		Iron	80-180 µg/dl
Transferrin	170-250 mg/dl	Magnesium	1.6-2.4 mEq/liter
		Phosphate	1.6-2.7 mEq/liter
Total iron-binding capacity	250-410 µg/dl	Phosphorus	3.0-4.5 mg/dl
		Potassium	4.0-5.0 mEq/liter
Urea nitrogen	10-20 mg/dl	Sodium	136-145 mEq/liter
Mean corpuscular volume	80-94 μ^3		

*Because these values vary among laboratories due to different instruments and procedures, normal values as defined by individual laboratories should be used

From Alfin-Slater, R.S et al. "Helping Patients Learn to Eat Right" *Patient Care*, 12 76-135, March, 1978 Used with permission of Patient Care Publications, Inc., © 1978, Darien, CT

Table 2–5 Plasma and Urine Nutrient Levels Indicative of Inadequate Intake, Malabsorption, or Increased Requirement

Plasma[a]		Urine (all values/gm urinary creatinine)[a]	
albumin	3.5 gm/100 ml	iodine	50 µg
iron	70 µg/100 ml	N-methylnicotinamide	1.6 mg
retinol	20 µg/100 ml	riboflavin	80 µg
carotene	80 µg/100 ml	thiamin	66 µg
ascorbic acid	300 µg/100 ml	in children under six years[b]	
vitamin B_{12}	70 pg/ml	riboflavin	300 µg
folic acid	7 ng/ml	thiamin	120 µg

[a]Values at or below these levels suggest nutrient deficiency and the need for dietary supplements or treatment.
[b]In addition, a serum alkaline phosphatase level in a child above 4 Bodansky (25 King-Armstrong) units suggests subclinical vitamin D deficiency Higher values are, however, not infrequently found in children with no radiographic evidence of rickets.

From Sandstead, H.H , Carter, J P. and Darby, W J "How to Diagnose Nutritional Deficiencies" *Nutrition Today*, 4(2).26, Summer, 1969. Used with permission of Nutrition Today, Inc , © 1969, Annapolis MD

what to expect when the test is conducted, these instructions could be given by your staff.

It is not within the scope of this module to describe all the biochemical tests available for assessing nutritional status. Tables 2–4 and 2–5, however, provide standards for use in evaluating the status of the nutrients that are the most important and the most routinely used to assess the nutriture of patients.[13-14]

Routine biochemical tests that are particularly useful in assessing the nutritional status of a patient are the complete blood count, including the differential counts for lymphocytes, serum albumin, and serum lipids. Crucial tests that should be utilized — although not routinely — include transferrin, folic acid, and vitamin B_{12} levels.

Biochemical data can serve either to confirm findings from clinical observations and dietary evaluations or to identify subclinical deficiencies before clinical symptoms are evident. The interpretation of findings from biochemical data is complicated by the fact that the levels of many nutrients and metabolites in the blood and urine vary significantly throughout the day, and the use of values from a single determination might be misleading. In many instances, the homeostatic mechanisms of the body will cause blood nutrient changes that make determination of subclinical nutrient deficiencies difficult. Also, the causes of any observed deviations — whether dietary, genetic, environmental, or physiological — cannot always be identified on the basis of biochemical data.[1] For example, blood hemoglobin and hematocrit levels may appear normal, yet dietary intake of iron may be chronically low, or slow chronic iron loss may be occurring which may not show up as decreased hemoglobin and hematocrit values until iron stores are considerably diminished or actually nonexistent. Yet, the patient should be treated for iron deficiency with iron supplements even though hemoglobin and hematocrit levels may be normal or low normal.

It is important for you to assess the visceral protein compartment for a nutritionally at risk patient. The status of the visceral proteins dictates the patient's ability to clinically respond to stress, such as mounting an immune response and healing wounds. Proteins which indicate the status of this compartment include serum albumin, serum transferrin, and total lymphocyte count. Kaminski and Winborn[15] have designated categories of visceral proteins and the values associated with expected survival (mild deficit) or expected mortality (severe deficit) secondary to malnutrition (Table 2–6).

Proteins with short half-lives are particularly sensitive to deficiencies of kilocalories and protein. Their synthesis is slowed with semistarvation. Transferrin and lymphocytes appear to be more accurate indicators of visceral protein status than does albumin. Serial measurements, particularly of transferrin, can be used to assess the results of nutritional therapy. In patients with low visceral proteins, decreased ability to fight antigens occurs, and the patient is placed at high risk for infection and mortality.

The creatinine height index is an accurate measurement of somatic protein. A creatinine height index is defined as the 24-hour urinary creatinine excretion of an individual compared with the ex-

Table 2–6 Categorical Diagnosis of Visceral Protein Deficiencies.

Visceral Proteins	Degree of Deficiency		
	Severe	Moderate	Mild
Serum albumin (gm%)	<2.5	2.5-3.0	3.0-3.5
Transferrin (mg%)	<160	160-180	180-200
Total lymphocyte count	<900	900-1,500	1,500-1,800

From Kaminski, M V and Winborn, A L *Nutritional Assessment Guide* Chicago, Midwest Nutrition, Education, and Research Foundation, Inc , 1978 Used with permission of Midwest Nutrition, Education, and Research Foundation, Inc , © 1978, Chicago, IL

cretion of a "normal" male or female of the same height. This test is based upon the evidence that

1. Creatinine is elaborated from the muscle at a constant rate regardless of the patient's metabolic state.
2. Creatinine excretion correlates well with body cell mass.

Such a test can be used to determine if a patient does or does not have a deficit in lean body mass. The creatinine height index is calculated as follows:

$$\text{\% Deficit in Creatinine Height Index} = 100 - \left[\frac{\text{actual urinary creatinine}}{\text{ideal urinary creatinine}} \times 100 \right]$$

Appendix C, Table 2–12, shows ideal weight and urinary creatinine for height of both males and females. The values in this table should be used as standards for comparison of your patient's 24-hour creatinine excretion as shown in the previous formula.

Cell-mediated immunity is an important host defense system against infection and is highly affected by the nutritional status of the patient.

Depression of cellular immunity is associated with increased morbidity and mortality from infections. It also has been described in hospitalized children and adults who became malnourished as a result of disease and the semistarvation regimens routinely employed.

Tests of cellular immunity involve the intradermal injection of skin test antigens such as Candida, mumps, P.P.D. or streptokinase/streptodornase. After 24 and 48 hours, the area of induration is examined. According to Kaminski and Winborn,[15] a patient with a response greater than 15 millimeters on any one test is considered immune competent. A 0- to 5-millimeter area of induration indicates immune incompetence or anergy. Nutritional repletion can often reverse anergy, raise serum protein and lymphocyte levels, and decrease incidence of mortality associated with infection secondary to malnutrition.

Blackburn et al.,[16] described 3 common types of protein-calorie malnutrition that have been characterized by assessment of malnourished hospitalized patients in the United States. According to the *International Classification of Diseases*,[17] protein malnutrition or kwashiorkor is #260, nutritional marasmus is #261, and the more severe kwashiorkor-marasmus mix is #262.

With kwashiorkor, due to the usual rapid onset, patients maintain their anthropometric measurements (weight, skinfold thickness, and arm muscle circumference) despite severe depression of visceral proteins (transferrin, total lymphocytes, and albumin). Usually, marked depression of cellular immunity also occurs as measured by delayed hypersensitivity skin testing and depressed total lymphocyte counts. Use of protein-sparing regimens in these patients is often employed as a means of maintaining or restoring visceral proteins. In this regimen, fluid, electrolytes, vitamins, minerals, and proteins are supplied at levels slightly greater than the Recommended Dietary Allowances.[18,19].

With nutritional marasmus, marked depletion of anthropometric measures occurs, accompanied by maintenance of serum proteins until late in the course. Possible anergy or impaired immunity can also occur. This type of malnutrition is common, secondary to an inadequate diet and mild catabolic stress. It is best treated by vigorous dietary intervention, with daily intake of protein and kilocalories superseding requirements.

With kwashiorkor-marasmus mix, deficits in both visceral proteins and somatic (skeletal) proteins occur as well as deficits in cellular immunity. In the marasmic patient who is already depleted of skeletal muscle protein reserves, rapid depression of visceral protein levels and development of kwashiorkor-marasmus mix occurs if semistarvation regimens are employed. Because these patients are less able to withstand catabolic stress than the adult with optimal fat and skeletal muscle protein, the need for vigorous nutritional therapy is urgent. Patients with kwashiorkor-marasmus mix require vigorous hyperalimentation, either orally or parenterally.

In order to evaluate the efficacy of the chosen dietary therapy, determination of nitrogen balance is an appropriate technique. Nitrogen balance is calculated from a 24-hour urine urea nitro-

gen determination and the known dietary nitrogen intake for the same 24-hour period. The following nitrogen balance formula can be used. The constant figure of 3 grams for nonurine urea nitrogen includes nitrogen lost through the feces, and sweat and other obligatory losses.

$$\text{Nitrogen balance} = \text{Nitrogen intake} - \left(\begin{array}{c}\text{Urine urea nitrogen} \\ \text{in grams} + 3 \text{ grams}\end{array}\right)$$

Nitrogen intake is equal to protein intake divided by 6.25.

Dietary Intake Evaluation

It is essential to ascertain the patient's typical dietary intake. When a low dietary intake of a nutrient is found in conjunction with biochemical and clinical symptoms, the dietary data can serve to confirm the diagnosis.

In order to fully complete the nutritional assessment of a patient, it is essential to ascertain the patient's typical dietary intake. In fact, it is a helpful practice to include some type of dietary evaluation as part of every patient's medical history. A knowledge of your patient's eating habits may bring light to any number of complaints. Also, the preventative-medicine aspect of reinforcing good nutritional practices can benefit patients and their families. It should be remembered that the reliability of the dietary information presented by the patient should be open to question; the validity of the information to a large extent depends on the acceptance, trust, and rapport you share with your patients.

An evaluation of the patient's dietary intake is not, in itself, sufficient evidence to suggest that a person is well or poorly nourished. However, when a low dietary intake of a nutrient is found in conjunction with biochemical and clinical symptoms, the dietary data serve to confirm the diagnosis and provide a basis upon which to build appropriate dietary treatment. A dietary history is also necessary before recommending any type of dietary modification to the patient. A good diet history is essential in enhancing patient compliance by adapting the diet to the patient's life-style.

A vital part of any dietary assessment and evaluation includes knowledge of the patient's life-style, religious background, ethnic and cultural origin, and economic status. This information is important not only for assessing and evaluating the patient's intake, but also for planning with the patient a diet which can be incorporated into the life-style.

Obtaining this information is not necessarily a task which must be performed by you. Your nursing staff can obtain dietary, life-style, religious, ethnic, cultural, and economic information from patients. A standard nutrition history form can be used to obtain this information from the patient, or the information presented in Table 2–7 can be incorporated into the standard medical history.

After this baseline information is received, any of the methods outlined in Table 2–8 — the 24-hour recall method, the dietary history method, or the food intake record — can be used to validate this information and obtain a history of the patient's typical daily eating pattern. The type you choose will depend on the needs of your patients, the interviewing skills of you and your staff, and the time available for such assessments.

Evaluation of the Patient's Food Intake

The physician must be able to evaluate intake for general nutrient sufficiency. A practical method for evaluating a patient's intake is comparing it to the Daily Food Guide, more commonly known as the Basic Four Food Groups.

No matter what method is chosen for obtaining the patient's typical food intake, you must next be able to evaluate this intake for general nutrient sufficiency. A variety of methods are available for such evaluations. Nutrient content can be calculated using food composition data such as the United States Department of Agriculture Handbook No. 456[24] and then comparing the calculated nutrient intake to the RDA.[19] (See Module 1 on the nutrient content of foods for additional information.) However, this is usually not possible in your busy practice.

A more practical, although more general, method for evaluating a patient's intake is comparing it

to the Daily Food Guide, more commonly known as the Basic Four Food Groups. The guide in Figure 2-2[23] is an excellent patient handout that describes the food groups and the number of recommended servings per day for various age groups. (See Module 1 for an in-depth discussion of the guide.) This method of evaluation cannot determine if a patient's food intake is deficient in a particular nutrient, but it can provide a general guideline as to the overall nutritional adequacy of the patient's diet. It can also serve as a tool for patient education if the patient regularly consumes fewer servings within a particular food group than recommended. A woman who rarely drinks milk and does not substitute milk with other dairy products is likely not to consume adequate amounts of vitamin D, calcium, and riboflavin, consequently, she might be at risk for osteoporosis in later life. Nutritional counseling is indicated in instances such as this.

Table 2-7 Questions Appropriate for Obtaining Information on Dietary Intake

Do you drink milk or eat products made with milk? If so, how much and how often?

Do you eat fruits or vegetables or drink fruit or vegetable juices? If so, how much and how often?

Do you eat meat, eggs, fish, poultry? If so, how much and how often?

Do you eat cereal, bread, starches? If so, how much and how often?

Do you eat pies, pastries, cakes, candy, nuts, butter or margarine? If so, how much and how often?

How do you prepare any foods which you cook? Do you cook with butter, margarine, salt, spices, oils, gravies, sugar, syrup or other items?

Do you drink more than four ounces of liquor a day? How much beer? Wine?

Do you take vitamins, minerals, or "tonics" as supplements? If so, what do you take?

How often do you grocery shop? (If the patient is elderly, ask if grocery shopping is difficult due to lack of transportation or problems carrying heavy bags.)

Who does the grocery shopping for the family?

What cooking facilities do you have?

Who prepares meals at your home?

How many meals do you eat at home weekly?

How many meals do you eat outside the home weekly? When you eat out, how much different is your food selection from when eating at home?

Have you ever been on any previous dietary modifications, or are you presently following any special diet?

Do you have any food allergies?

Do you have any food intolerances?

Do you use any "health foods" or buy any special foods from health food stores? If so, what?

Table 2-8 Advantages and Disadvantages of Dietary Intake Methods

Methods	Advantages
1. The 24-hour recall method: This method utilizes the patient's memory of all the foods eaten during the previous 24-hour period. The interviewer asks the patient to describe the kinds and amounts of food and beverages eaten during the previous day. Methods of preparation (baked, fried, etc.) and items added to foods (cream, sugar, butter, etc.) are also elicited. The intake is generally recorded on a blank piece of paper or form separating meals and "snacks." Lifesize plastic "food models" or pictures from the National Dairy Council, along with measuring cups and spoons, can be used to help the patient estimate amounts of foods eaten. To avoid "leading" the patient, open-ended questions are used as much as possible. Some examples are: - "Could you remember for me everything you had to eat or drink yesterday, starting with when you awoke" not "Tell me what you ate for breakfast" or "Did you have eggs for breakfast?" - "Do you ever have anything to eat or drink between meals, if so, what might you have?" not "Do you eat snacks?" or "What do you have for snacks?"	1. Since it is a retrospective account at an unannounced time, it reduces the possibility that the patient will modify the account of intake to meet the interviewer's expectations. 2. The use of the past 24 hours does not involve an appreciable memory span, thus increasing the likelihood of obtaining a complete record. 3. It is suitable for use with an illiterate patient. 4. It can give the interviewer a general idea of the patient's normal dietary intake and point out usual eating patterns and habits.

Limitations

1. The previous day's intake may not be "typical" for the patient. It is important to ask the patient whether or not the intake is typical. If it is not, the patient should be asked to relate a "typical" day's intake and routine.

2. Day-to-day variation of intake can be great, and weekend intake can be very different from the weekday's. Find out if weekend patterns vary and in what ways.

3. An intake record of a single day cannot isolate a nutritional deficiency, nor does it have a high degree of correlation with physical or biochemical findings.

4. The interview can be time consuming and requires a skilled, trained interviewer for increased accuracy.

To facilitate the interview the patient can be requested by the receptionist to write out the past 24-hour intake on a special form. It can then be reviewed and cross-checked during the interview.

(Table 2-8 continued on pages 18 and 19.)

Table 2-8 (continued)

Methods	Advantages
2. Dietary History Method: This is conducted as a supplement to the 24-hour recall method in order to obtain more complete data and when greater accuracy of the patient's overall intake is required. After recording the 24-hour intake, the interviewer, using A Guide to Good Eating[21,23] asks the patient how many times per day or week he eats various foods. Example: How many times per week do you eat: - green leafy vegetables - yellow vegetables such as carrots, squash - eggs, milk - citrus fruits (oranges, grapefruit, lemon)	1. Good supplementation to 24-hour recall to obtain data on overall intake patterns. 2. Can obtain intake information on food source of nutrients that need not be consumed daily for adequate overall intake, such as vitamin A or carotene. 3. Can identify blatant omission of certain food groups such as omission of milk or dairy products.
3. Food Intake Records: With this method the patient is instructed to record on a special form (see Chart 2-1) or in a small notepad everything he eats or drinks within a specified period of time such as 3 days or 7 days. The patient must record all foods and beverages (including alcoholic) consumed and estimate amounts. The foods should be recorded immediately after they are eaten, not at the end of the day, and the time eaten should be noted. Particular attention should be directed toward identifying foods "nibbled" or "tasted while cooking" since they can be significant. When the patient returns with his record, it is then reviewed and discussed with the patient by the physician or dietitian.	1. Intake records provide a complete picture of the patient's overall food intake and eating patterns. They are especially useful for the obese patient and those who require extensive dietary modifications such as the diabetic or patient with renal disease. 2. The patient's intake record provides a baseline from which to make dietary alteratives and is a useful instructional device; for example, based on the food records, you might ask the patient to switch from regular pop to diet pop if that appears to be a problem from his intake. 3. It provides the patient with some insight into his eating patterns which is essential before modifications can be made.

Limitations

1. Time limitations might prevent this additional cross-check.

1. This method is time consuming for both the reviewer and the patient and requires complete patient cooperation for accuracy. Often patients forget to record time, and a 2-day practice run is recommended so that the patient can get an idea of what is expected.

2. The 7-day record often becomes tedious for the patient and might be forgotten by the end of the week. The 3-day record (include one weekend day) is the easiest to complete and is the most accurate.

3. The act of recording one's intake often leads to some alteration in foods eaten since the patient realizes it will be reviewed later. This is especially true for the overweight patient.

4. It is difficult to record foods eaten immediately after they are consumed, and sometimes the record is done at the end of the day, with the exclusion of some "forgotten items."

Chart 2-1 One Week's Food Intake

Name_____

Date_____

Write in all foods and beverages consumed.
Write in amounts of each.
Include all snacks.
Try to do this as you are eating, not at the end of the day.

Meal	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
BREAKFAST							
MID A.M.							
LUNCH							
MID P.M.							
DINNER							
BED-TIME							

Figure 2–2 The Daily Food Guide

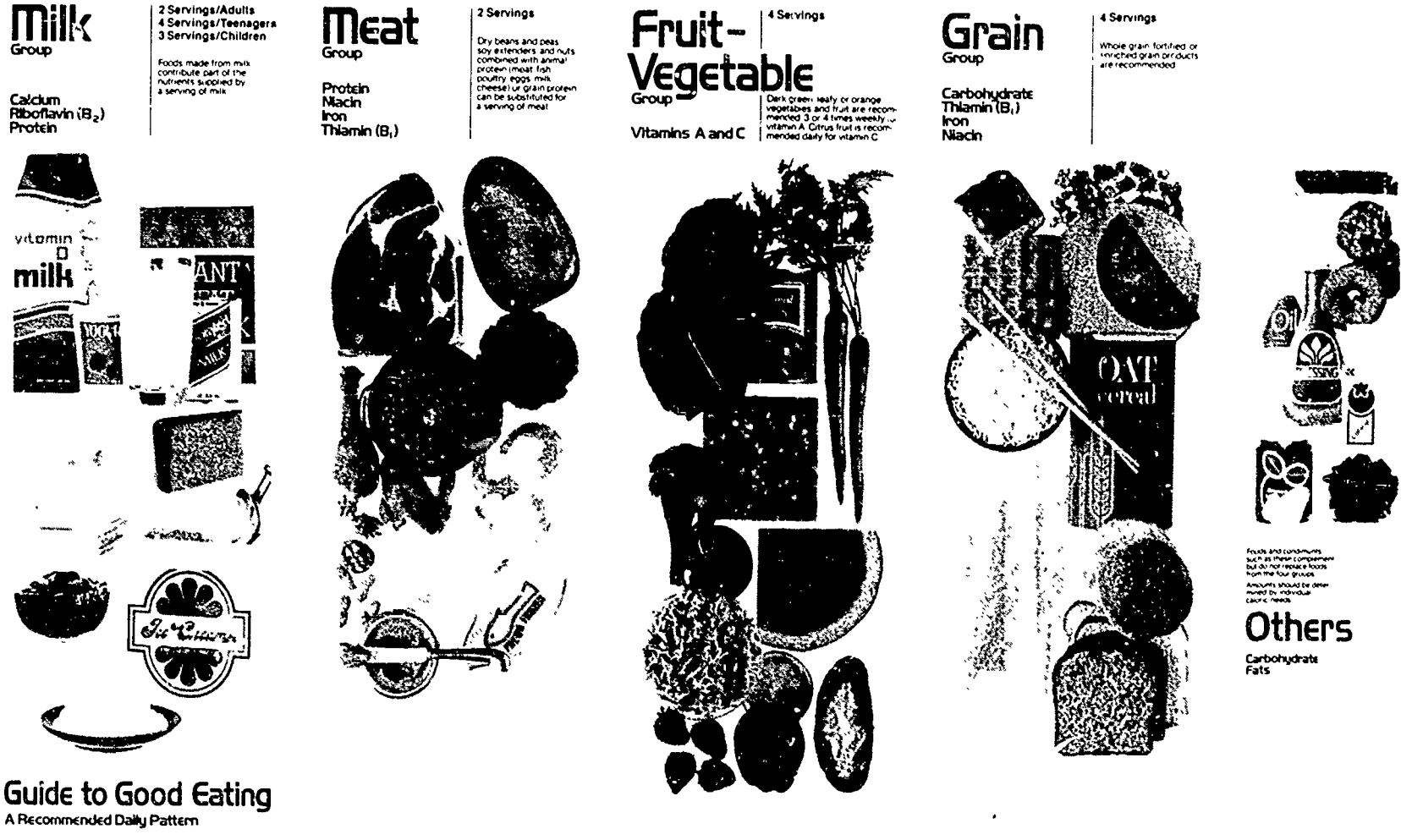

Figure 2-2 (continued)

Guide to Good Eating...

A Recommended Daily Pattern

The recommended daily pattern provides the foundation for a nutritious healthful diet

The recommended servings from the Four Food Groups for adults supply about 1200 Calories The chart below gives recommendations for the number and size of servings for several categories of people

Food Group	Recommended Number of Servings				
	Child	Teenager	Adult	Pregnant Woman	Lactating Woman
Milk 1 cup milk yogurt OR **Calcium Equivalent** 1½ slices (1½ oz) cheddar cheese* 1 cup pudding 1¾ cups ice cream 2 cups cottage cheese*	3	4	2	4	4
Meat 2 ounces cooked lean meat fish poultry OR **Protein Equivalent** 2 eggs 2 slices (2 oz) cheddar cheese* ½ cup cottage cheese* 1 cup dried beans peas 4 tbsp peanut butter	2	2	2	3	2
Fruit-Vegetable ½ cup cooked or juice 1 cup raw Portion commonly served such as a medium size apple or banana	4	4	4	4	4
Grain, whole grain fortified, enriched 1 slice bread 1 cup ready to eat cereal ½ cup cooked cereal pasta grits	4	4	4	4	4

*Count cheese as serving of milk OR meat not both simultaneously

Others" complement but do not replace foods from the Four Food Groups Amounts should be determined by individual caloric needs

Nutrients for Health

Nutrients are chemical substances obtained from foods during digestion They are needed to build and maintain body cells regulate body processes and supply energy

About 50 nutrients including water are needed daily for optimum health If one obtains the proper amount of the 10 leader nutrients in the daily diet the other 40 or so nutrients will likely be consumed in amounts sufficient to meet body needs

One s diet should include a variety of foods because no single food supplies all the 50 nutrients and because many nutrients work together

When a nutrient is added or a nutritional claim is made nutrition labeling regulations require listing the 10 leader nutrients on food packages These nutrients appear in the chart below with food sources and some major physiological functions

Nutrient	Important Sources of Nutrient	Some major physiological functions		
		Provide energy	Build and maintain body cells	Regulate body processes
Protein	Meat Poultry Fish Dried Beans and Peas Egg Cheese Milk	Supplies 4 Calories per gram	Constitutes part of the structure of every cell such as muscle blood and bone supports growth and maintains healthy body cells	Constitutes part of enzymes some hormones and body fluids and antibodies that increase resistance to infection
Carbohydrate	Cereal Potatoes Dried Beans Corn Bread Sugar	Supplies 4 Calories per gram Major source of energy for central nervous system	Supplies energy so protein can be used for growth and maintenance of body cells	Unrefined products supply fiber – complex carbohydrates in fruits vegetables and whole grains – for regular elimination Assists in fat utilization
Fat	Shortening Oil Butter Margarine Salad Dressing Sausages	Supplies 9 Calories per gram	Constitutes part of the structure of every cell Supplies essential fatty acids	Provides and carries fat-soluble vitamins (A D E and K)
Vitamin A (Retinol)	Liver Carrots Sweet Potatoes Greens Butter Margarine		Assists formation and maintenance of skin and mucous membranes that line body cavities and tracts such as nasal passages and intestinal tract thus increasing resistance to infection	Functions in visual processes and forms visual purple thus promoting healthy eye tissues and eye adaptation in dim light
Vitamin C (Ascorbic Acid)	Broccoli Orange Grapefruit Papaya Mango Strawberries		Forms cementing substances such as collagen that hold body cells together thus strengthening blood vessels hastening healing of wounds and bones and increasing resistance to infection	Aids utilization of iron
Thiamin (B_1)	Lean Pork Nuts Fortified Cereal Products	Aids in utilization of energy		Functions as part of a coenzyme to promote the utilization of carbohydrate Promotes normal appetite Contributes to normal functioning of nervous system
Riboflavin (B_2)	Liver Milk Yogurt Cottage Cheese	Aids in utilization of energy		Functions as part of a coenzyme in the production of energy within body cells Promotes healthy skin eyes and clear vision
Niacin	Liver Meat Poultry Fish Peanuts Fortified Cereal Products	Aids in utilization of energy		Functions as part of a coenzyme in fat synthesis tissue respiration and utilization of carbohydrate Promotes healthy skin nerves and digestive tract Aids digestion and fosters normal appetite
Calcium	Milk Yogurt Cheese Sardines and Salmon with Bones Collard Kale Mustard and Turnip Greens		Combines with other minerals within a protein framework to give structure and strength to bones and teeth	Assists in blood clotting Functions in normal muscle contraction and relaxation and normal nerve transmission
Iron	Enriched Farina Prune Juice Liver Dried Beans and Peas Red Meat	Aids in utilization of energy	Combines with protein to form hemoglobin the red substance in blood that carries oxygen to and carbon dioxide from the cells Prevents nutritional anemia and its accompanying fatigue Increases resistance to infection	Functions as part of enzymes involved in tissue respiration

Persons at Risk for Nutritional Problems

Patients who are especially prone to nutritional disorders include those who are pregnant, infants and adolescents, the elderly, alcoholics, diabetics, cancer patients, those with chronic gastrointestinal diseases, and individuals on certain medications.

Throughout the previous sections of this module, questions have been posed whose answers will determine the nutritional assessment of the patient. The following nutrition check list (Table 2–9), developed by Butterworth and colleagues at the University of Alabama in Birmingham,[25] can be completed by the clinical dietitian with the patient or family. Butterworth states that 3 or more positive answers to any of the questions on this check list automatically place the patient at high-nutritional risk.

Consider especially the following patients as high risk for nutritional problems and in need of nutritional support and counseling:

1. *The pregnant woman*, particularly one who has had previous pregnancies close together, such as within one year. Total kilocalories, protein, vitamin B_{12}, folic acid, iron, and calcium are nutrients that are commonly deficient. Vitamin and mineral supplementation is generally recommended during this time and during lactation. A special case for increased nutritional burden is the pregnant adolescent who must meet her own as well as the fetus's growth needs. Special dietary monitoring and counseling is necessary in these situations.
2. *The infant*. The infant is particularly sensitive to nutritional inadequacies which carry severe consequences. Iron deficiency is the most common nutritional problem in infants over 6 months old in the United States, usually due to being fed solely with cow's milk or formulas without iron. Breast feeding and iron-enriched formulas are recommended to aid in decreasing iron deficiency in infants. (See Module 4 on normal diet, age of dependency, for additional information.)
3. *The adolescent*. Individuals in this group who might be receiving an unbalanced, inadequate diet are those who participate in athletic training programs and those who are attempting to attain the skinny "Twiggy" look, such as adolescent girls, including a few who develop anorexia nervosa. Considerable nutrition misinformation is presented by the media, peers, and coaches that, if put into practice, could be harmful to the growing adolescent. "Making weight" for wrestling and then fasting to "weigh in lighter" is an example of poor nutritional practice. The dieting teen-ager who follows any number of popular diets for weight loss is vulnerable to nutritional inadequacies. (See Module 6 on the normal diet for adolescents for additional information.)
4. *The adult*. Nutritional problems can often be associated with a variety of disorders. Some examples are as follows:
   a. Chronic alcoholism, particularly in an individual with a low income.
   b. Gastrointestinal disorders: malabsorption due to pancreatic, gallbladder, liver, or small and large bowel diseases.
   c. Gross overweightness or underweightness.
   d. Post-gastrointestinal surgery such as gastrectomy (total or partial), ileectomy, pancreatectomy, and cholecystectomy.
   e. Increased metabolic requirements such as fever, infection, trauma, hyperthyroidism, and burns.
   f. Fad diets and strict vegetarianism.
   g. Chronic disease states such as diabetes mellitus, arteriosclerosis and heart disease, cancer (especially if receiving radiation and/or chemotherapy), emphysema, renal disease, and cirrhosis.
   h. Mental illness and mental retardation.
   i. Use of oral contraceptive agents for prolonged periods.
   j. Prolonged drug therapy which has an effect upon the absorption and utilization of specific nutrients.
   k. Lactase deficiency: exclusion of dietary milk or milk products may result in calcium deficiency frequently seen as osteoporosis in adults and rickets in children.

5 *The elderly.* More attention is being directed towards the nutritional needs of the elderly. Those living alone with little interest in food or its preparation, with poor incomes, without necessary dentures, or with disorders which preclude adequate food intake or nutrient utilization are particularly susceptible to inadequate diets. Special counseling is needed for these elderly persons including referral to nutrition programs for the elderly (such as Meals-on-Wheels, Title VII-funded noon meals, and local church programs). (See Module 8 on geriatrics.)

A sensitivity on your part regarding the possible nutritional problems and concerns of your patients can go a long way toward reducing their incidence and severity. Often, simple advice offered with sincerity is all that is required. Merely showing an interest in the patient's eating patterns can help reinforce the patient who has been placed on a modified diet. The careful selection and use of accurate nutrition-related materials can be a beneficial and simple method of relating nutritional information to the patient. These materials can be obtained from a variety of sources, including national offices and local chapters. The names and addresses are listed near the end of this module in the section titled Resources for the Patient.

Table 2–9 Check List for Assessment of Nutritional Status

Part I
(To be completed by trained staff member, physician's assistant, or other)

	Yes	No
Usual body weight 20% above or below desirable?		
Recent loss or gain of 10% of usual body weight?		
Any evidence that income and meals are not adequate for needs?		
More than half of meals eaten away from home?		
Does patient live alone and prepare own meals?		
Ill fitting dentures?		
Excessive use of alcohol?		
Frequent use of fad diets, or monotonous diets?		
Any chronic disease of GI tract? (describe)		
Has there been any surgical procedure on GI tract (other than appendectomy)? (describe)		
Recent major surgery, illness, or injury?		
Recent use of large doses of:		
catabolic steroids?		
immunosuppressants?		
anti-tumor agents?		
anti-convulsants?		
anti-biotics?		
oral contraceptives?		
vitamins?		
other?		
Has patient been maintained more than 10 days on intravenous fluids?		
Any reason to anticipate that patient will be unable to eat for 10 days or longer?		

Table 2-9 (continued)

	Yes	No
Is patient known to have:		
diabetes?		
hypertension?		
hyperlipidemia?		
coronary artery disease?		
malabsorption?		
chronic lung disease?		
chronic renal disease?		
chronic liver disease?		
circulatory problem or heart failure?		
neurological disorder or paralysis?		
mental retardation?		

(Note: If all answers to the above items are "No," the patient may be regarded as a "low-risk" or "acceptable risk." The risk increases in direct proportion to the number of "Yes" answers. Patients with more than 3 "Yes" answers should be considered at an increased risk of developing medical complications, unless special attention is given to providing their nutritional requirements.)

Part II
(To be completed by dietitian)

Description of recent food consumption patterns, eating habits and meal composition.
Circumstances of food purchase, storage and preparation in the home.
Estimate of daily average caloric consumption.
Estimate of energy expenditure (e.g. low, average, or high level of physical activity).
Estimate of possible nutrient deficiencies, based on suspected imbalances.
Food tray viewed.

Part III
(To be completed by nursing staff)

Estimate of actual food consumption, including any provided by non-hospital sources.
Estimate of fluid intake.
Estimate of stool frequency, urinary losses, losses by suction tube, drainage, etc.
Behavior patterns, eccentricities, vomiting (including surreptitious vomiting).
Careful recording of body weight at regular intervals.

From Butterworth, C.E., "The Skeleton in the Hospital Closet," *Nutrition Today*, 9 4 8, March April, 1974 Used with permission of Nutrition Today, Inc., © 1974, Chicago, IL.

Referral

Situations will arise in your daily practice that will require the services of a registered clinical dietitian. The clinical dietitian can provide in-depth assessment, education, and feedback concerning the nutritional aspect of patient care.

Situations will arise in your daily practice that require more knowledge of nutrition and time and skill in nutrition techniques than you can or wish to provide. In these situations, the services of a registered clinical dietitian are invaluable. Services that the clinical dietitian can provide include the following:

1. *In-depth assessment* of the patient's nutrient intake and other aspects of nutritional status.
2. *Patient and family education* (both individual and group) on various aspects of nutrition for all stages of the life cycle.
3. *Patient counseling* on how to incorporate necessary changes in eating patterns into the patient's life-style. Follow-up education and reinforcement are provided as needed.
4. *Feedback* — The dietitian can provide you with valuable information regarding the patient's willingness and ability to follow dietary recommendations and can also make recommendations on possible adjustments in medical treatment based upon the patient's compliance to dietary recommendations. For example, although a 2,000-milligram sodium diet might be warranted for treating the patient's pedal edema, if he can only realistically adhere to 4,000 milligrams, then a reassessment of the diuretic dosage might be in order. This is also true for the diabetic in a situation when insulin dosages may need to be adjusted to the patient's life-style and eating patterns and not vice versa in order to achieve regulation of blood glucose levels.

There are several methods for obtaining the service of a registered clinical dietitian. The ideal situation would be to have a consulting dietitian work in your practice or for several practice groups, depending on patient load and circumstances within the community. There are a growing number of clinical dietitians entering private practice, either by establishing their own consulting firms or by offering their services to physicians in private and group practices. The local or state dietetic association or a local hospital dietitian can put you in touch with an individual who would be interested in working with you.

If a dietitian is not feasible or available for your private practice, accredited hospitals are required to have a registered dietitian on staff. It is often possible to refer patients to hospital dietitians for nutritional assessment and instruction. Arrangements can be made through the hospital administrator and dietetic department regarding fees, procedure for referral, and feedback. Nutritionists employed by local public health departments can aid you in providing nutrition education and special diet instructions. Also, nutritionists in county extension agencies can provide considerable information on normal nutrition, food preparation, and food storage that can be useful to you and your patients.

Summary

Nutritional status assessment is invaluable as an aid to making correct clinical judgments. The assessment can be done simply and efficiently with available techniques which include gaining information through the medical history and physical examination and through anthropometric measurements, biochemical analyses, and dietary history elicitation and assessment. Anorexia, frequently associated with disease, when not overcome and treated can be an obstacle to survival. Recent advances in the technology of nutritional support make it possible to meet total nutritional requirements of all patients at all times under nearly all circumstances.

Test Your Knowledge

The following care study has been selected as an example of a patient you might care for in your practice.

Care Study

C.M. is a 45-year-old Caucasian man who consults with you about active Crohn's disease of several months' duration. He complains of 10 to 15 watery and fatty stools daily and a 35-pound weight loss within the past six months. His current weight is 125 pounds; his height is 5 feet 11 inches.

Mr. C.M. tells you he attempts to eat as often as possible, even when not hungry. His activity level includes minimal work at home for his self-employed business. He states that he has some chewing difficulties.

Physical examination data reveal the following:

B.P.:	110/70
Pulse:	100
Heart:	Normal rhythm, no murmurs
Chest:	Clear
HEENT:	Unremarkable except for dentures, upper and lower, which appear loose
Extremities:	Skin appears sallow, dry, and wrinkly; musculature and fat stores are minimal
Abdomen:	Tender to palpation; no abdominal fat
Lab:	HCT:32 ml/100 ml HGB: 10.5 gm/100 ml MCV: 103 cubic microns MCH and MCHC: Normal

Questions

1. What information elicited in this patient's medical history and physical examination is important to you in assessing the nutritional status of this patient and identifying that he is at high risk for nutritional problems?

2. What anthropometric measurements in addition to body weight might be useful to you in further assessing this patient's weight status?

3. What is this patient's "desirable" weight range according to the Metropolitan Life Insurance Table (Table 2–3 in this module)?

4. Malnourished patients frequently have poor visceral protein nutriture. . If you had ordered the following biochemical te s, you might well have noted these results:

Total Protein:	low normal at 6.0 grams %
Serum Albumin:	low at 3.0 grams %
Serum Transferrin:	low at 180 milligrams %
Total Iron-Binding Capacity:	low at 275 μg %
Skin Testing:	normal or slightly low

If these tests were actually correct for Mr. C.M. in which category of malnutrition would he be diagnosed?

5. The following is a 24-hour recall of Mr. C.M.'s intake. Evaluate it for nutritional adequacy using the recommendations of the Daily Food Guide.

Breakfast
1 fried egg
1 strip bacon
6 ounces orange juice
1 slice toast with 1 Tablespoon jelly and 1 teaspoon margarine
1 cup whole milk

Lunch
1 cup cream of chicken soup
1 tuna sandwich consisting of:
- 2 slices bread
- 2 ounces tuna
- 2 Tablespoons mayonnaise
- 1 slice tomato
- 1 leaf lettuce

1 cup whole milk

Dinner
2 ounces Salisbury steak with 2 Tablespoons gravy
½ cup mashed potatoes with 2 Tablespoons gravy
1 Tablespoon green beans with 1 teaspoon margarine
1 roll with 1 teaspoon margarine and 1 Tablespoon jelly
½ cup chocolate pudding
1 cup whole milk

10:00 a.m. Snack
1 cup whole milk
2 slices toast with 2 teaspoons margarine and 2 Tablespoons jelly

2:00 p.m. Snack
6 graham crackers
1 cup grape Kool-Aid

Evening Snack
1 small apple
1 cup whole milk

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Resources for the Physician

Blackburn, G.L., et al.: "Nutritional and Metabolic Assessment of the Hospitalized Patient." *Journal of Parenteral and Enteral Nutrition*, 1:11-22, 1977.

An excellent and practical article.

Butterworth, C.E.: "The Skeleton in the Hospital Closet." *Nutrition Today*, 9:4-8, March-April, 1974.

Butterworth, C.E. and Blackburn, G.L.: "Hospital Malnutrition and How to Assess the Nutritional Status of a Patient." *Nutrition Today*, 10:8-18 March-April, 1975.

Kaminski, M.V. and Winborn, A.L.: *Nutritional Assessment Guide* Chicago, Midwest Nutrition, Education, and Research Foundation, 1978.

A superb 20-page pocket handbook on the "how to ' of nutritional assessment.

Answers

1. Medical history and physical examination information of significance for nutritional status assessment include the following:
   - Diagnosis of chronic active Crohn's disease.
   - 10 to 15 watery stools daily.
   - Weight loss of 35 pounds within 6 months.
   - Current weight (125 pounds) below "ideal" (172 pounds).
   - Poor musculature and adipose tissue stores.
   - Anorexia.
   - Dry, sallow, wrinkly skin.
   - Loose dentures, some chewing difficulty.

2. Skinfold measurement, arm circumference measurement, and calculation of arm muscle circumference measurement would be of assistance to you in assessing Mr. C.M.'s body composition and body fat stores. Sites for determining skinfold measurements include the back (scapular area), chest, and triceps; the triceps measurement is the best and easiest measurement to obtain.

3. Desirable weight range is 154 to 170 pounds, or an average of 162 pounds. Another way to calculate ideal body weight is to use the rule of thumb as follows:

   For males, 106 pounds for the first 5 feet in height plus 6 pounds for each additional inch over 5 feet (therefore, for Mr. C. M., this would be 106 + (6 × 11) = 172 pounds, or a range of 167 to 177 pounds which is a figure somewhat higher than standard tables).

4. Mr. C.M. would be diagnosed as having kwashiorkor-marasmus mix malnutrition because both anthropometric measures and visceral protein levels are below normal.

5. From evaluating this patient's dietary intake, you see that he meets the Daily Food Guide recommendations except for the number of servings from the vegetable group. Yet you know from the history and physical exam that the patient is malabsorbing food and nutrients and is losing weight. You correctly assess that the high-fat diet he consumes may be contributing to his malabsorption and steatorrhea. You, therefore, correctly advise the patient to decrease his margarine consumption and change his dairy product consumption from whole milk to 2% milk or skim milk or products made from these milks. This is an attempt to decrease the calcium-fat soap malabsorption, to decrease the oxalate absorption, and to decrease the risk for development of oxalate renal stones. With decreased diarrhea and steatorrhea, his food intake will ultimately provide him with a higher caloric intake. You also correctly advise Mr. C.M. to continue the small frequent feedings and suggest he take 1 to 2 multivitamin and mineral supplements daily supplying 100% to 200% of the Recommended Daily Allowances.

Resources for the Patient

The ·reful selection and use of accurate nutrition-related materials can be a very ben·ial and simple method of relating nutrition information to the patient. These materials can be obtained from a variety of sources including national offices and local chapters of the following agencies and associations:

Administration on Aging
Office of Human Development
U.S. Department of Health, Education, and Welfa·e
Washington, DC 20201

American Association for Health, Physical Education, and Recreation
1201 Sixteenth Street, NW
Washington, DC 20016

The American Cancer Society, Inc.
777 Third Avenue
New York, NY 10017

The American Diabetes Association
Publication Department
600 Fifth Avenue
New York, NY 10020

The American Dietetic Association
Publication Department
620 North Michigan Avenue
Chicago, IL 60611

The American Heart Association
44 East 23rd Street
San Francisco, CA 94120

The American Medical Association
Order Departmer
535 North Dearborn Street
Chicago, IL 60610

Consumer and Food Economics Research Division
Agricultural Research Service
U.S. Department of Agriculture
Washington, DC 20250

Extension Service/Home Economics
U.S. Department of Agriculture
Washington, DC 20250

Food and Drug Administration
Public Health Service
U.S. Department of Health, Education, and Welfare
5600 Fishers Lane
Rockville, MD 20852

Food and Nutrition Information and Educational Materials Center
National Agriculture Library
Room 304
Beltsville, MD 20705

National Dairy Council
111 North Canal Street
Chicago, IL 60606

National Institutes of Health
U.S. Department of Health, Education, and Welfare
8600 Rockville Pike
Bethesda, MD 20014

National Library of Medicine
Literature Search Program
Reference Section
U.S. Department of Health, Education, and Welfare
8600 Rockville Pike
Bethesda, MD 20014

The National March of Dimes Foundation
Professional Education Department
P.O. Box 2000
White Plains, NY 10602

Our Baby's First Seven Years
5841 Maryland Avenue
Chicago, IL 60637

Society for Nutrition Education
National Nutrition Education Clearing House
2140 Shattuck Avenue, Suite 1110
Berkeley, CA 94704

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

Appendix A

Anthropometric Skinfold Thickness Measurement

Types of Calipers

A suitable caliper for the measurement of skinfold thickness is designed so that the instrument has a standard contact surface, or "pinch" area (20 to 40 millimeters^2). Caliper measurements can be read with an accuracy of 0.1 millimeter. They exert a constant pressure (10 grams/millimeters^2) through the whole range of skinfold thicknesses at all distances of separation of the jaw.[9*] In practice, 3 instruments are most often used for measuring skinfolds:

1. The Harpenden calipers[26] (Figure 2–3).
2. The Lange calipers, Cambridge Scientific Laboratories, Cambridge, MD.[27]
3. The US AMRNL calipers.[28]

The skinfolds measured with these instruments consist of a double layer of skin and subcutaneous fat. The most appropriate body "pinch" sites depend on the purpose for the measurements, the age of the population examined (fat distribution varies with age, even in childhood), the sex of the subject, and the ease in locating the site.[9] Since subcutaneous fat stores are not uniform over all the body, the problem is to select 1 or 2 easily accessible sites that may be expected to give an approximate practical indication of caloric reserves. For this purpose, the triceps skinfold is the most practical measurement for all age groups.[9] Therefore, the following section describes the skinfold technique for measuring the triceps skinfold. Other sites for measurement and standards can be found in Consolazio's text, *Physiological Measurement of Metabolic Functions in Man.*[7]

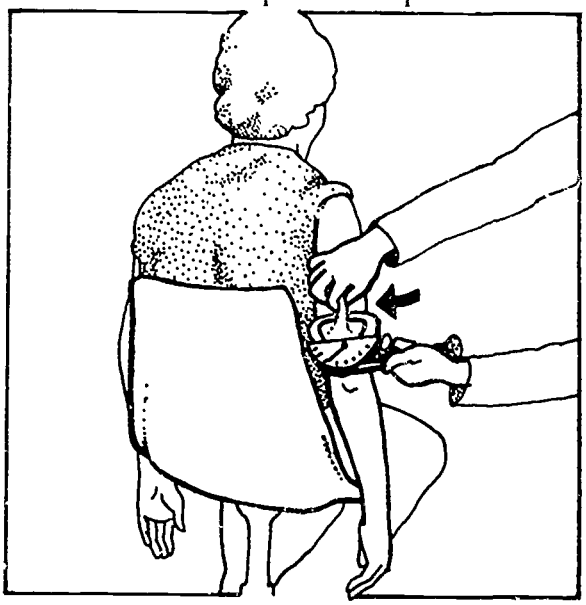
Technique

Dependent on medical status, the subject should be standing or sitting erect for the triceps skinfold measurement, with the arm to be measured free of any inhibitive clothing. The decision of whether to measure the right or left arm depends on the standard chosen for the comparison measurement. Although it would be ideal to routinely perform anthropometric measurements on both arms and utilize inter-arm mean values, in practice, measurements from one arm seem adequate for clinical nutritional assessment.[30]

The adult triceps skinfold standards chosen for this module are found in Table 2–10. They were originally obtained from the *National Health Survey*, United States, 1960-1962, and were performed on the *right arm*.[11]

Since the fat distribution of the upper arm is not uniform in thickness, the triceps site is carefully selected at the midpoint of the dorsal right (or left) arm, between the tip of the acromial process of the scapula and the olecranon process of the ulna (Figure 2–4). The technique is the same for either the left or right arm.

Figure 2–3 Measurement of Triceps Skinfold with Harpenden Calipers



*The superior *reference* numbers refer to the References preceding this appendix

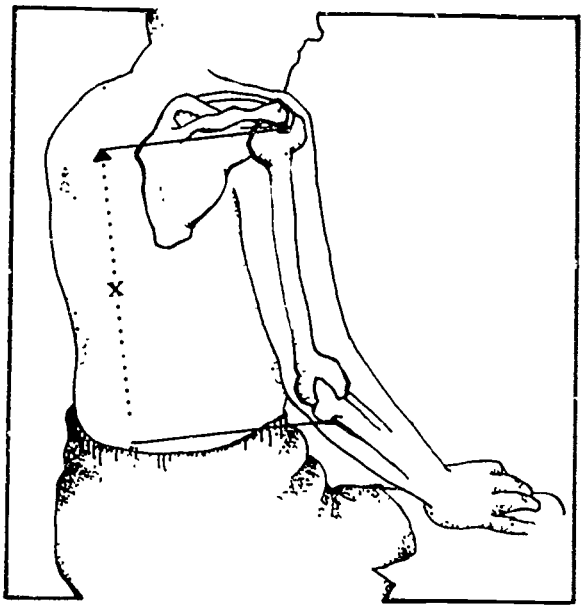
Table 2–10 Right Arm Skinfold, Average, and Selected Percentiles for Adults, by Age and Sex: United States, 1960-62

Sex, average, and percentile	Total 18–79 years	18–24 years	25–34 years	35–44 years	45–54 years	55–64 years	65–74 years	75–79 years
	Measurement in centimeters[b]							
MEN								
Average right arm skinfold	1.3	1.1	1.4	1.4	1.3	1.2	1.2	1.1
Percentile[a]								
99	4.1	3.7	4.5	4.0	3.8	3.3	3.2	3.0
95	2.8	2.6	3.3	2.9	2.8	2.4	2.7	2.0
90	2.3	2.4	2.6	2.4	2.2	2.0	2.2	1.7
80	1.8	1.7	2.0	1.9	1.8	1.6	1.7	1.5
70	1.5	1.3	1.6	1.6	1.5	1.4	1.4	1.3
60	1.3	1.1	1.4	1.4	1.3	1.3	1.3	1.1
50	1.1	0.9	1.2	1.2	1.1	1.2	1.1	1.0
40	1.0	0.8	1.0	1.1	1.0	1.0	1.0	0.9
30	0.8	0.7	0.8	1.0	0.9	0.9	0.8	0.8
20	0.7	0.6	0.7	0.8	0.7	0.8	0.7	0.7
10	0.6	0.5	0.5	0.6	0.7	0.6	0.6	0.6
5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4
WOMEN								
Average right arm skinfold	2.2	1.9	2.1	2.3	2.4	2.5	2.4	2.0
Percentile[a]								
99	4.6	4.3	4.7	4.6	4.8	4.7	4.7	3.9
95	3.8	3.2	3.7	3.9	4.0	4.0	3.6	3.3
90	3.4	2.8	3.2	3.5	3.6	3.7	3.4	3.1
80	3.0	2.4	2.8	3.0	3.2	3.2	3.0	2.7
70	2.6	2.1	2.4	2.7	2.8	2.9	2.7	2.5
60	2.4	2.0	2.2	2.5	2.6	2.7	2.5	2.3
50	2.2	1.7	2.0	2.3	2.4	2.5	2.4	2.2
40	2.0	1.6	1.9	2.1	2.2	2.3	2.2	2.0
30	1.8	1.5	1.7	1.8	2.0	2.1	2.0	1.7
20	1.6	1.3	1.5	1.6	1.8	1.9	1.7	1.4
10	1.3	1.1	1.2	1.4	1.5	1.6	1.5	1.0
5	1.1	0.9	1.0	1.2	1.2	1.4	1.2	0.7
1	0.8	0.6	0.7	1.0	0.8	1.0	0.8	0.3

[a]Measurement below which the indicated percent of persons in the given age group falls.
[b]To convert to mm, multiply values by 10.

From Stout, H.W., Damon, A. et al., *Skinfolds, Body Girths, Biacromial Diameter, and Selected Anthropometric Indices of Adults United States, 1960-1962* (Vital and Health Statistics Series 11, National Health Survey No 35) Washington, DC, United States Department of Health, Education, and Welfare, Public Health Service, 1970.

Figure 2–4 Assessing Midpoint of Upper Arm (Halfway Between the Acromial Process of the Scapula and the Olecranon Process of the Ulna)



This midpoint can best be determined by having the subject bend the arm at the elbow and hold the forearm relaxed against the body. The upper arm's length is then measured, using a flexible steel or fiberglass metric tape, between the two reference points; the midpoint, or halfway point, is then marked on the back of the subject's arm with a pen or marker. With the subject's arm now hanging relaxed, the investigator grasps the back arm skinfold firmly between the thumb and index finger of the left hand, pinches, and lifts it slightly. The skinfold held should include 2 thicknesses of skin, but not muscle or fascia. When in doubt, have the subject flex the muscle underlying the skinfold and take the measurement. The calipers are applied 1 centimeter below the fingers holding the fold, at a depth about equal to the skinfold. The fold is gently held throughout the measurement, and the caliper is read to the nearest 0.5 millimeter, counting to 3 after it is applied to the fold before reading.

Figure 2–3 illustrates the technique. Triplicate measurements of each skinfold are recommended with both the caliper and the finger-thumb grasp being released between measurements.[8,9] The *mean* of the measurements can then be compared to the standards shown in Table 2–10.[11]

The percentile groups in Table 2–10 provide a reference point for determining how the patient's skinfolds relate to a "normal" population. The measurement of body skinfolds is not easy and requires supervised practice and repetition to obtain reliable and reproducible results.

Standards

Arm anthropometric measures are not available for all age groups and have not been updated in recent years. Current standards being used for nutritional assessment are generally those of Blackburn et al.[16] which are adapted from Jelliffe: WHO.[9] Other standards have been developed by Consolozio[7] Frisancho,[10] and Selzer et al.[29]

A recent study by Burgert and Anderson of both right and left arm triceps skinfold and upper arm circumferences in 91 healthy adult men and women found significant variation between Jelliffe's standards and their own measurements.[30] Other limitations of the WHO standards are also discussed in the article. For these reasons, this module utilizes the values for triceps skinfold thickness and arm circumference that are related to age and sex-specific population percentiles. They are contained in Table 2–10.[11] Because the National Health Survey did not report population percentiles for arm-muscle circumference, Burgert and Anderson recommend using the arm-muscle circumference percentiles that are presented in the United States Ten-State Nutrition Survey (Table 2–11)[3,10] for persons less than 45 years old. Although both of these surveys reported right arm measurements only, Burgert and Anderson's data suggest that it is appropriate to consider those measurements equivalent to left arm measurements for heterogenous groups of men or women in nutritional assessment.[30]

Table 2–11 Percentiles for Upper Arm Diameter and Upper Arm Circumferences for Whites of the Ten-State Nutrition Survey of 1968-1970

Age midpoint, years*	Arm Muscle-Right Arm diameter percentiles, mm					circumference percentiles, mm				
	5th	15th	50th	85th	95th	5th	15th	50th	85th	95th
Males										
0.3	26	30	34	40	42	81	94	106	125	133
1	32	34	39	44	46	100	108	123	137	146
2	35	37	40	44	46	111	117	127	138	146
3	36	38	42	46	48	114	121	132	145	152
4	38	39	43	48	50	118	124	135	151	157
5	39	41	45	50	53	121	130	141	156	166
6	40	43	47	51	53	127	134	146	159	167
7	41	43	48	52	55	130	137	151	164	173
8	44	46	50	55	59	138	144	158	174	185
9	44	46	51	58	64	138	143	161	182	200
10	45	48	53	59	64	142	152	168	186	202
11	48	50	55	62	67	150	158	174	194	211
12	49	52	58	66	70	153	163	181	207	221
13	51	54	62	71	77	159	169	195	224	242
14	53	58	67	74	84	167	182	211	234	265
15	55	59	70	80	86	173	185	220	252	271
16	59	65	73	83	89	186	205	229	260	281
17	66	69	78	86	92	206	217	245	271	290
21	69	74	82	91	97	217	232	258	286	305
30	70	77	86	94	100	220	241	270	295	315
40	71	76	85	96	101	229	239	270	300	318
Females										
0.3	27	29	33	37	40	86	92	104	115	126
1	31	32	37	41	43	97	102	117	128	135
2	34	36	40	44	46	105	112	125	140	146
3	34	37	41	44	46	108	116	128	138	143
4	36	38	42	46	48	114	120	132	146	152
5	38	40	44	48	51	119	124	138	151	160
6	38	41	45	49	53	121	129	140	155	165
7	39	42	47	52	56	123	132	146	162	175
8	41	44	48	53	59	129	138	151	168	186
9	43	45	50	56	62	136	143	157	176	193
10	44	47	52	58	62	139	147	163	182	196
11	44	48	55	62	67	140	152	171	195	209
12	48	51	57	64	68	150	161	179	200	212
13	49	53	59	66	71	155	165	185	208	225
14	53	56	61	70	74	166	175	193	221	234
15	52	55	62	70	74	163	173	195	220	232
16	54	47	64	72	83	171	178	200	227	260
17	54	56	62	71	77	171	177	196	223	241
21	54	58	65	73	80	170	183	205	229	253
30	56	60	68	78	87	177	189	213	245	272
40	57	61	69	80	89	180	192	216	250	279

From U.S. Department of Health, Education, and Welfare. "Ten-State Nutrition Survey, 1968-1970." DHEW Publication No. (H.M.S.) 72-8130 — 72-8134, 1972.

Appendix B

Arm-Muscle Circumference

Poor muscle development and muscle wasting are cardinal features of all forms of protein-calorie malnutrition, especially those of early childhood. In older children and adults, muscle mass is also related to general exercise and to special increased use of certain muscle groups [9] Although muscle mass can be assessed by various methods (body radioactive potassium and 24-hour creatinine excretion), the most practical field method of assessing muscle mass is the direct physical anthropometry of a limb.

Technique

The mid-upper-arm circumference is the most useful and accessible measurement site. The upper arm is generally not clinically edematous in the malnourished individual.

The arm measured should be the same as the one chosen for skinfold measurements and the standard chosen for comparison. The example in this module is performed on the right arm (Figure 2–5).

The right arm is measured at its midpoint, which is selected in the same way as for the triceps skinfold and Figure 2–4. A metric flexible steel or fiberglass tape is recommended. The tape is placed gently, but firmly, around the arm which is hanging freely at the subject's side to avoid compression of the soft tissue (Figure 2–5). The measurement is read to the nearest 0.1 centimeter. Next, the overlying subcutaneous fat is measured in the triceps region with skinfold calipers as described in Appendix A.

Conversions

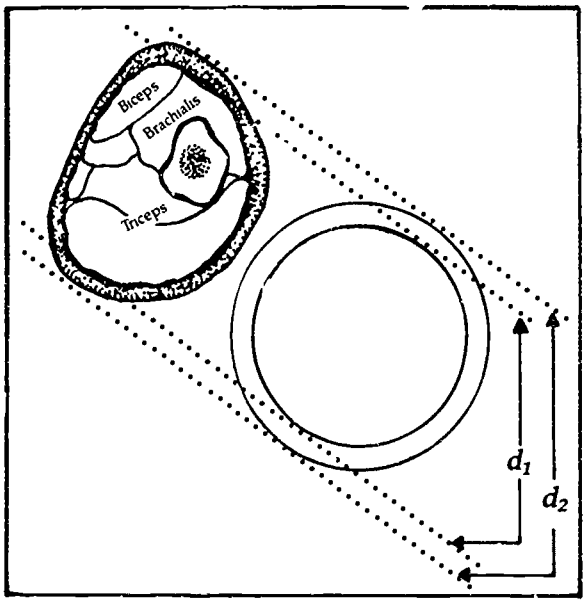
From these 2 measurements, it is possible to calculate the inner circle, which is composed principally of muscle, with a small central core of bone. It is usually assumed that the bone is relatively constant in size, and the calculated value is termed the "mid-arm circumference."[9] The formula for the calculation of the mid-arm-muscle circumference (Figure 2–6) relates well with the more general manifestations of protein-calorie malnutrition. Also, it is an attempt to assess a body-wide tissue by a measurement at a single site, which may be affected unequally in different muscle groups. Nevertheless, the arm-muscle circumference does represent a practical gauge of muscle tissue that can be easily obtained.[9] (See Figure 2–7.)

Figure 2–5 Measurement of Mid-Upper-Arm Circumference

Figure 2–6 Arm-Muscle Circumference Formula

$$\text{Arm muscle circumference (cm)} = \text{Mid-Arm Circumference (cm)} - \left[0.314 \times \text{Triceps Skinfold (mm)}\right]$$

Figure 2–7 Calculation of Mid-Upper-Arm-Muscle Circumference



C_1 = arm circumference
S = triceps skin-fold
d_1 = arm diameter
d_2 = muscle diameter

Then skin-fold $S = 2 \times$ subcutaneous fat $= d_1 - d_2$
and arm circumference $C_1 = \pi d_1$.
Now, muscle circumference $C_2 =$
$\pi d2 = \pi [d_1 - (d_1 - d_2)] = \pi d_1 - \pi(d_1 - d_2)$
Hence, $C_2 = C_1 - \pi S$.

Example

Mr. H., 62 years old, has chronic emphysema and is dependent on daily oxygen use. He states his appetite is poor and he often tires before finishing his meals. He has 2+ pedal edema due to congestive heart failure. Therefore, it is difficult to evaluate his weight status.

Values

Mid-Arm. Circumference	= 26.0 centimeters, or 260 millimeters
Triceps Skinfold	= 10.8 millimeters
AMC	= 26.0 − (0.314 × 10.8) = 26.0 − 3.3912 = 22.61 centimeters, or 226.1 millimeters

In comparing Mr. H.'s triceps skinfold of 10.8 millimeters with the standards in Table 2–10, we find him between the 50th and 60th percentile for his age group. His arm-muscle circumference of 226.1 millimeters, when compared with the standards in Table 2–11, places him between the 5th and 15th percentile for age group 40 standard. Values for age 41 and above are not available. If available, these measurements would most likely indicate that Mr. H. is depleted of lean body tissue (muscle mass), as well as somewhat marginal for fat stores. Aggressive nutritional intervention would be indicated before his situation deteriorates further.

Appendix C

Table 2–12 Ideal Weight and Urinary Creatinine for Height

Height	Medium Frame Ideal Weight	Total Mg Creatinine 24 hours	Mg Creatinine/ Cm Body Height/ 24 hours
For Women			
4'10" 147.3 Cm	101.5 Lbs 46.1 Kg	830	5.63
4'11" 149.9	104 47.3	851	5.68
5' 0 152.4	107 48.6	875	5.74
5' 1" 154.9	110 50	900	5.81
5' 2" 157.5	113 51.4	925	5.87
5' 3" 160	116 52.7	949	5.93
5' 4" 162.6	119.5 54.3	977	6.01
5' 5" 165.1	123 55.9	1006	6.0[illegible]
5' 6" 167.6	127.5 58	1044	6.23
5' 7" 170.2	131.5 59.8	1076	6.32
5' 8" 172.7	135.5 61.6	1109	6.42
5' 9" 175.3	139.5 63.4	1141	6.51
5'10" 177.8	143.5 65.2	1174	6.60
5'11" 180.3	147.5 67	1206	6.69
6' 0" 182.9	151.5 68.9	1240	6.78
For Men			
5' 2" 157.5 Cm	124 Lbs 56 Kg	1288	8.17
5' 3" 160	127 57.6	1325	8.28
5' 4" 162.6	130 59.1	1359	8.36
5' 5" 165.1	133 60.3	1386	8.40
5' 6" 167.6	137 62	1426	8.51
5' 7" 170.2	141 63.8	1467	8.62
5' 8" 172.7	145 65.8	1513	8.76
5' 9" 175.3	149 67.6	1555	8.86
5'10" 177.8	153 69.4	1596	8.98
5'11" 180.3	158 71.4	1642	9.11
6' 0" 182.9	162 73.5	1691	9.24
6' 1" 185.4	167 75.6	1739	9.38
6' 2" 188	171 77.6	1785	9.49
6' 3" 190.5	176 79.6	1831	9.61
6' 4" 193	181 82.2	1891	9.80

Somatic Proteins % Deficit

Severe	Moderate	Mild
>30	>15–30	>5–15

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Some Abbrevations Used in the Nutrition in Primary Care Series

ATP	adenosine triphosphate
c	cup
cc	cubic centimeter
CNS	central nervous system
FDA	Food and Drug Administration
gm	gram
IBW	ideal body weight
IU	International Units
kcal	kilocalorie
kg	kilogram
lb	pound
lg	large
MCV	mean corpuscular volume
MDR	minimum daily requirement
med	medium
meq	milliequivalent
mg	milligram
MJ	megajoule
ml	milliliter
oz	ounce
RDA	Recommended Dietary Allowances
RE	retinol equivalents
sl	slice
sm	small
Tbsp	Tablespoon
TPN	total parenteral nutrition
tsp	teaspoon
USDA	United States Department of Agriculture