Part I
Fundamentals of Nutrition Assessment

1 Overview of Nutrition Assessment in Clinical Care

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OBJECTIVES

- Recognize the value of nutrition assessment in the comprehensive care of ambulatory and hospitalized patients.
- Obtain an appropriate patient history, including medical, family, social, nutrition/dietary, physical activity, and weight histories; use of prescription and over-the-counter medicines, dietary and herbal supplements; and consumption of alcohol and other recreational drugs.
- Demonstrate how to interpret physical findings that reflect nutritional status, including body mass index, waist circumference, growth and development, and signs of nutritional deficiency.
- Describe the diagnosis, prevalence, health consequences, and etiology of obesity and malnutrition.
- Identify the most common physical findings associated with vitamin/mineral deficiencies or excesses.
- List the laboratory measurements commonly used to assess the nutritional status of patients.

Source: Objectives for chapter and cases adapted from the *NIH Nutrition Curriculum Guide for Training Physicians*. (www.nhlbi.nih.gov/funding/training/naa)

Nutrition Assessment in Clinical Care

Nutrition assessment is the evaluation of an individual's nutritional status based on the interpretation of clinical information. Nutrition assessment is important because obesity and malnutrition are common in the clinical setting. The purpose of nutrition assessment is to:

- accurately evaluate an individual's dietary intake and nutritional status,
- determine if medical nutrition therapy and/or counseling is needed,
- monitor changes in nutritional status, and
- evaluate the effectiveness of nutritional interventions.

Accurate nutritional assessment leads to correct diagnosis and treatment. Many patients can benefit from medical nutrition therapy (MNT) using established evidence-based protocols.

Integrating Nutrition into the Medical History and Physical Examination

The following illustrates how nutrition can be integrated into all components of the clinical assessment, including the medical history, diet history, review of systems, physical examination, laboratory data, and treatment plan.

Medical Nutrition & Disease: A Case-Based Approach, Fifth Edition. Edited by Lisa Hark, Darwin Deen, and Gail Morrison.

Medical History

Past Medical History

Standard past medical history including immunizations, hospitalizations, surgeries, major injuries, chronic illnesses, and significant acute illnesses may have nutritional implications. Detailed information should be obtained about current or recent medication use including vitamins, minerals, laxatives, topical medications, over-the-counter medications, and products such as nutritional or herbal supplements which patients frequently fail to report as medications. Nutritional supplements include any products that may alter caloric, vitamin, or protein intake. Whether the patient has any known food allergies (i.e., peanut, gluten) or suffers from lactose (milk) intolerance is also important.

Family History

In assessing risk for future diseases, patients are asked to identify their parents, siblings, children, and partner, give their respective ages and health status, and indicate familial occurrences of disease or cause of death of any deceased family members. Family history of diabetes, cancer, heart disease, thyroid disease, obesity, hypertension, osteoporosis, food allergies, eating disorders, or alcoholism should be ascertained. Food sensitivity may be based on inherited immune system characteristics and family history of food intolerance should be assessed.

Social History

The diet history is typically obtained as part of the patients' social history because socioeconomic factors such as who the patient lives with and what resources they have available influence food selection and preparation. Pertinent non-medical information recorded in the social history includes the patient's occupation, daily exercise pattern, and marital and family status. Information should be solicited regarding the patient's education, economic status, residence, emotional response and adjustment to illness, and any other information that might influence the patient's understanding of his or her illness and adherence to a nutritional therapy. Details concerning the duration and frequency of the patient's use of substances such as alcohol, tobacco, illicit drugs, and caffeine are also documented. These data can be extremely useful when formulating the treatment plan. Economic limitations that influence access to an adequate diet, difficulties shopping for or preparing food, participation in feeding programs (e.g. Women, Infants, and Children (WIC), Meals on Wheels) are relevant aspects of the nutritional assessment.

The Importance of Taking a Diet History

The purpose of obtaining dietary information from patients is to assess their nutritional intake and establish a baseline from which to negotiate changes. Infants, children, adolescents, pregnant women, older adults, and patients with a family history of or who have diabetes, hypertension, heart disease, hyperlipidemia, obesity, eating disorders, alcoholism, osteoporosis, gastrointestinal or renal disease, cancer, or weight loss or gain should consistently be asked about their eating habits, even during routine visits. Relative strengths for each method of collecting dietary information are described in this section. In addition, patients' past and/or current dietary patterns, such as vegetarian or kosher diet practices, cultural background, and social situations should be considered during the interview. Family members who purchase and prepare foods should be invited for the interview process whenever possible. Diet-related questions may take a few minutes, if properly directed (See Table 1-1). Registered dietitians typically collect more detailed information from a diet history and make this information available to the physician, nurse practitioner, or physician assistant. This history may include information on food preferences, portion sizes, frequency of eating out, and emotional responses to eating. The detailed intake information can be used to determine calories, fat, protein, sodium, and fiber intake along with adequacy of vitamin and mineral intake can serve as a basis for counseling.

Table 1-1 Key Diet History Questions for Brief Intervention

Questions for All Patients
- How many meals and snacks do you eat every day?
- Do you feel that you eat a healthy balanced diet? Why or why not?
- What do you like to drink during the day, including alcohol? How many glasses?
- How often do you eat fruits and vegetables?
- How often do you eat dairy products? Low-fat or regular type?
- How often do you eat out? What kinds of restaurants?
- Do you usually finish what is on your plate or leave food?
- How often do you exercise, including walking?

In addition to the questions above:
Questions for Patients with Hyperlipidemia (Chapter 6)
- How often do you eat fatty meats? (hot dogs, bacon, sausage, salami, pastrami, corned beef)
- How often do you eat fish? How is it prepared?
- What types of fats do you use in cooking and baking?
- What do you spread on your bread?
- What type of snacks and desserts do you eat?

Questions for Patients with Hypertension (Chapter 6)
- Do you use a salt shaker at the table or in cooking?
- Do you read food labels for sodium content? (<400 mg/serving permitted)
- How often do you eat canned, smoked, frozen, or processed foods?

Questions for Patients with Diabetes (Chapter 8)
- What times do you take your diabetes medication (including insulin)?
- What times do you eat your meals and snacks?
- Do you ever skip meals during the day?
- How many servings of starchy foods such as breads, cereals, rice, pastas, corn, peas, or beans do you eat during a typical day?

Source: Lisa A. Hark, PhD, RD. 2014. Used with permission.

24-Hour Recall

Purpose This informal, qualitative, questioning method elicits all foods and beverages the patient has consumed in the preceding 24 hours. This method is recommended for follow-up visits for patients with diabetes because of the ability to assess the timing of meals, snacks, and insulin injections.

Questions "Starting with the last thing you ate please describe everything that you ate or drank within the past 24 hours (meals and snacks), including quantities, and how you prepared these foods." Family members are usually consulted if the patient is a child or unable to convey adequate detail. Patients can be asked to write down what they ate the day before while they are waiting to be seen. Hospitalized patients can be monitored through calorie counts reported by the nursing or dietary staff, who can record the daily amounts of food and drink the patient consumes. Keep in mind that the 24-hour recall method, when used alone, may underestimate or overestimate a person's usual caloric intake because the patient's recollection may not reflect long-term dietary habits. It may be helpful to add the question, "Is this fairly typical or was there something unusual about yesterday?" Use caution generalizing this information.

Usual Intake/Diet History

Purpose Similar to the 24-hour recall, a usual intake/diet history is a retrospective method to obtain dietary information by asking the patient to recall his or her normal daily intake pattern, including amounts of foods consumed. This method is suggested for older adults who may

frequently skip meals, or for interviewing pediatric patients whose diets may not be varied. This approach provides more information about usual intake patterns than others and tends to reflect long-term dietary habits with greater accuracy.

Questions "Please tell me what you usually eat and drink during the day for meals and snacks?" As a busy clinician, this question may be all that you will have time to ask, but it can serve as a screening mechanism to identify patients who need further screening with a registered dietitian. When using this approach it is important to be flexible. Begin by asking patients to describe their usual intake and if they cannot recall their usual diet, ask what they ate and drank the day before (a switch to the 24-hour recall method). You can then ask if these 24 hours are typical. Also bear in mind that some patients tend to report having eaten only those foods that they know are healthy. It is also important to ask patients if they have changed their diet for health reasons or because of a health professional's advice.

Food Frequency Questionnaire

Purpose The food frequency questionnaire is another retrospective approach used to determine trends in a patient's usual consumption of specific foods.

Questions Patients are usually asked several key questions regarding the frequency of intake of particular foods. Frequencies have been created to identify daily, weekly, or monthly consumption patterns and are especially good for specific nutrients (e.g., fiber, iron, or saturated fat). Patients can be asked these questions during the history, or these items can be added to the written form for new patients that can be mailed to them prior to their visit or completed while they are in the waiting room. For the clinician, questions can be geared toward the patient's existing medical conditions, which is why this method is effective for patients with diabetes, heart disease, hypertension, or osteoporosis and can be used for evaluating current intake of, for example, fruits, vegetables, dairy products, or processed foods.

Three-Day Food Record

Purpose Unlike the retrospective tools mentioned earlier, a food record is ideally completed prospectively and daily as patients consume their usual diet and reviewed by the clinician at the medical visit. More accurate results can be obtained by collecting data over a longer period (e.g., 7 days).

Questions Patients are asked to record information on meals, food items, quantity consumed, preparation methods, etc., and details such as activities while eating, mood, hunger level, etc., can also collected. This method is preferred for active patients who may be trying to adhere to a new dietary regimen (e.g., a weight loss diet). Three-day records are the most accurate reflection of patients' diets but it is difficult for most patients to keep a written log, including portion sizes, of everthing they ate and drank over three days.

Review of Systems

This subjective reexamination of the patient's history is organized by body systems. It differs from the past medical history by concentrating on symptoms, not diagnoses, and by emphasizing current more than past information. All positive and negative findings are listed. Nutrition questions vary according to the patient's age. One goal of this part of the history is to determine whether any dietary changes have occurred in the patient's life, either voluntarily or as a consequence of illness, medication use, or psychological problems. Examples within the review of systems that may have nutritional implications (and their potential significance) include weakness and fatigue (anemia), clothes tighter or looser (weight gain or weight loss), post-meal cramping or diarrhea (lactose

intolerance), chronic headaches, fatigue, gastrointestinal symptoms (gluten sensitivity), constipation (low fluid or fiber intake), amenorrhea (anorexia nervosa), or changes in appetite.

Physical Examination

The physical examination begins with the patient's vital signs (blood pressure, heart rate, respiration rate, temperature), height, weight, body mass index (BMI), and general appearance. For example, "On examination, she is a well-developed, athletic woman." When terms such as obese, overweight, undernourished, thin, well-nourished, well-developed, or cachectic (profound, marked state of ill health and malnutrition) are used, they should be supported by findings in the physical examination and noted in the problem list.

Body Mass Index (BMI)

To calculate BMI using the metric system:

$$\textbf{BMI} = \frac{\textbf{weight (kg)}}{\textbf{height (m}^2\textbf{)}}$$

To calculate BMI using English units:

$$\textbf{BMI} = \frac{\textbf{weight (lbs)}}{\textbf{height (in}^2\textbf{)}} \times \textbf{703}$$

Body mass index provides a more accurate measure of total body fat (adiposity) than body weight alone. The BMI is also more accurate than the older height–weight tables, which were based on a homogeneous population, primarily Caucasian, with higher than average socioeconomic status. BMI has also been shown to more estimate obesity than bioelectrical impedance tests. BMI values associated with the lowest mortality increase slightly as people age. However, BMI may overestimate body fat in very muscular people and underestimate body fat in some underweight people who have lost lean tissue, such as the elderly. Classifications of underweight, normal weight, overweight, and obesity are shown in Table 1-2. Health professionals should routinely assess height, weight, and BMI, and evaluate growth and development in infants, children, and adolescents.

Diagnosis and Assessment of Overweight and Obesity

Body Mass Index (BMI)

According to the National Heart Lung and Blood Institute's (NHLBI) *Clinical Guidelines*, many people with a BMI of 25 kg/m^2 or greater begin to experience negative health effects, such as elevated low-density lipoprotein cholesterol (LDL-C) and total cholesterol levels, high blood pressure, and glucose intolerance. These guidelines define overweight individuals as those with a BMI of 25

Table 1-2 Classifications of BMI

Underweight	$<$18.5 kg/m^2
Normal weight	18.5–24.9 kg/m^2
Overweight	25–29.9 kg/m^2
Obesity (Class 1)	30–34.9 kg/m^2
Obesity (Class 2)	35–39.9 kg/m^2
Extreme obesity (Class 3)	$\geq$40 kg/m^2

Source: National Heart, Lung, and Blood Institute, NIH. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults*. 1998. Used with permission.

to 29.9 kg/m^2 and obese individuals as those with a BMI of 30 kg/m^2 and above. The NHLBI *Clinical Guidelines* classify BMI as shown in Table 1-2. BMI values can be determined from height and weight measurements as shown in Figure 1-1.

Waist Circumference

Waist circumference is an independent measure of risk in normal weight and overweight individuals. Excess fat located in the abdominal area (termed visceral adipose tissue) is reflected by waist circumference measurement. Waist circumference is a predictor of morbidity, and is considered an independent risk factor for diabetes, dyslipidemia, hypertension, and cardiovascular disease when BMI is not markedly increased. In patients with a BMI greater than 35 kg/m^2, there is little additional risk from elevated waist circumference, as severe risk is already present. Therefore, measuring waist circumference is recommended in patients with a BMI less than 35 kg/m^2. The waist circumference measurement is particularly important for patients with a family history of diabetes and those who may be borderline overweight.

In order to obtain an accurate waist circumference measurement, patients should be standing in only their underwear. A horizontal mark should be drawn just above the uppermost lateral border of the right iliac crest, which should then be crossed with a vertical mark in the midaxillary line. The measuring tape is placed in a horizontal plane around the abdomen at the level of this mark on the right side of the trunk. The plane of the tape should be parallel to the floor and the tape should be snug but not tight. Patients should be advised to breathe normally while the measurement is taken. Waist circumference values greater than 102 cm (40 inches) in men and greater than 88 cm (35 inches) in women are considered indicators of increased risk, although these values may differ for different ethnic groups. Waist circumference is one of the diagnostic criteria of metabolic syndrome (Chapter 1: Case 1). In patients trying to lose weight by exercising, waist circumference may decrease without significant weight loss.

Percent Weight Change

Weight loss is very common in hospitalized patients and those residing in chronic care facilities. Weight loss is also frequently seen in older adults or those with decreased changes due to chronic illnesses such as cancer, gastrointestinal problems, or secondary to surgery, chemotherapy, or radiation therapy. If weight loss is identified in the medical history or review of systems, it is essential to take a diet and weight history and determine the percent weight change over that period of time using the patient's current body weight and usual weight. Severity of weight loss is defined by percent change in a defined period of time (Table 1-3).

$$\textbf{Percent weight change} = \frac{\text{Usual Weight} - \text{Current Weight}}{\text{Usual Weight}} \times 100$$

Physical Examination Findings

Nutrition-oriented aspects of the physical examination focus on the skin, hair, eyes, mouth, nails, extremities, abdomen, skeletal muscle, and fat stores. Areas to examine closely for muscle wasting include the temporalis muscles, thenar, hypothenar, and interosseous muscles on the hands. The skeletal muscles of the extremities are a less sensitive indicator of malnutrition. Subcutaneous fat stores should be examined for losses due to a sudden decrease in weight or for excess accumulation in obesity. Isolated vitamin deficiencies such as scurvy or pellagra are rarely seen in modern clinical practice. At the present time, the most commonly encountered nutritional problem seen in clinical practices in the United States and many developed countries is obesity and its associated complications. Specific clinical signs that are attributable to nutrient deficiencies and significance on physical examination are shown in Table 1-4. Combined nutrient deficiencies are still seen in those with disordered intake such as alcoholics or patients receiving chemotherapy.

Body Mass Index Chart

in/cm	lbs/kg 100/45	105/48	110/50	115/52	120/55	125/56	130/59	135/61	140/64	145/66	150/68	155/70	160/73	165/75	170/77	175/79	180/82	185/84	190/86	195/89	200/91	205/93	210/95	215/98	220/100	225/102	230/104	235/107	240/109	245/111	250/114
5'0"/153	20	21	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
5'1"/155	19	20	21	22	23	24	25	26	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	43	44	45	46	47
5'2"/158	18	19	21	22	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	36	37	37	38	39	40	41	42	43	44	45	46
5'3"/160	18	19	20	21	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	35	36	37	38	39	40	41	42	43	43	44
5'4"/163	17	18	20	21	21	21	22	23	24	25	26	27	27	28	29	30	31	32	33	33	34	35	36	37	38	39	39	40	41	42	43
5'5"/165	17	17	19	20	20	21	22	22	23	24	25	26	27	27	28	29	30	31	32	32	33	34	35	36	37	37	38	39	40	41	42
5'6"/168	16	17	19	19	19	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34	35	36	36	37	38	39	40	40
5'7"/171	16	16	18	19	19	20	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34	34	35	36	37	38	38	39
5'8"/173	15	16	17	18	18	19	20	21	21	22	23	24	24	25	26	27	27	28	29	30	30	31	32	33	33	34	35	36	36	37	38
5'9"/176	15	16	17	18	18	18	19	20	21	21	22	23	24	24	25	26	27	27	28	29	30	30	31	32	32	33	34	35	35	36	37
5'10"/178	14	15	17	17	17	18	19	19	20	21	22	22	23	24	24	25	26	27	27	28	29	29	30	31	32	32	33	34	34	35	36
5'11"/181	14	15	16	17	17	17	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	29	29	30	31	31	32	33	33	34	35
6'0"/183	14	14	16	16	16	17	18	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	28	29	30	31	31	32	33	33	34
6'1"/186	13	14	15	16	16	16	17	18	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	32	32	33
6'2"/188	13	13	15	15	15	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	31	32
6'3"/191	12	13	14	14	15	16	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27	27	28	29	29	30	31	31
6'4"/193	12	13	13	14	15	15	16	16	17	18	18	19	19	20	21	21	22	23	23	24	24	25	26	26	27	27	28	29	29	30	30

Underweight	Normal	Overweight	Obese
<18.5	19–24.9	25–29.9	>30

Figure 1-1 BMI Values Based on Height and Weight

Table 1-3 Interpretation of Percent Weight Change

Time	Significant Weight Loss	Severe Weight Loss
1 week	1–2%	>2%
1 month	5%	>5%
3 months	7.5%	>7.5%
6 months	10%	>10%
1 year	20%	>20%

Table 1-4 Physical Examination Findings with Nutritional Implications

Exam	Nutritional implications
Vital signs	Blood pressure, height, weight, BMI, percent weight change
General	Wasted, cachectic, overweight, obese, muscle weakness, anorexic, waist circumference
Skin	Acanthosis nigricans (obesity, metabolic syndrome, insulin resistance, diabetes) Ecchymosis (vitamin K, C deficiency) Dermatitis (marasmus, niacin, riboflavin, zinc, biotin, EFA deficiency) Follicular hyperkeratosis (vitamin A deficiency) Petechiae (vitamin A, C, K deficiency) Pigmentation changes (niacin deficiency, marasmus) Pressure ulcers/delayed wound healing (kwashiorkor, diabetes, vitamin C, zinc deficiency) Psoriasiform rash, eczematous scaling (zinc deficiency) Purpura (vitamin C, K deficiency) Scrotal dermatosis (riboflavin deficiency) Pallor (iron, folic acid, vitamin B_{12}, copper, vitamin e deficiency) Thickening and dryness of skin (linoleic acid deficiency)
Hair	Dyspigmentation, easy pluckability (protein), alopecia (zinc, biotin deficiency)
Head	Temporal muscle wasting (marasmus and cachexia) Delayed closure of fontanelle (pediatric undernutrition or growth retardation)
Eyes	Night blindness, xerosis, bitot spots, keratomalacia (vitamin A deficiency) Photophobia, blurring, conjunctival inflammation, corneal vascularization (riboflavin deficiency), macular degeneration
Mouth	Angular stomatitis (riboflavin, iron deficiency) Bleeding gums (vitamin C, K, riboflavin deficiency) Cheilosis (riboflavin, niacin, vitamin B_6 deficiency) Dental caries (fluoride deficiency) Hypogeusia (zinc, vitamin A deficiency) Glossitis (riboflavin, niacin, folic acid, vitamin B_{12}, vitamin B_6 deficiency) Nasolabial seborrhea (vitamin B_6 deficiency) Papillary atrophy or smooth tongue (riboflavin, niacin, iron deficiency) Fissuring, scarlet or raw tongue (niacin, folate, B_{12}, B_6 deficiency)
Neck	Goiter (iodine deficiency) Parotid enlargement (marasmus, bulimia)
Thorax	Thoracic achitic rosary (vitamin D deficiency)
Abdomen	Abdominal obesity (metabolic syndrome, diabetes, heart disease) Diarrhea (niacin, folate, vitamin B_{12} deficiency, marasmus) Hepatomegaly/ascites (kwashiorkor, alcoholism)
Cardiac	Heart failure (thiamin, selenium deficiency, anemia)
Genital/urinary	Delayed puberty (marasmus, eating disorder, celiac disease) Hypogonadism (zinc deficiency)
Extremities	Ataxia (vitamin B_{12} deficiency, vitamin B_6 toxicity) Bone ache, joint pain (vitamin C deficiency) Bone tenderness, kyphosis (vitamin D deficiency)

Table 1-4 (*Continued*)

Exam	Nutritional implications
	Edema (thiamin or protein deficiency) Growth retardation, failure to thrive (energy deficiency) Hyporeflexia (thiamin deficiency) Bone tenderness, kyphosis (calcium, vitamin D deficiency) Muscle wasting and weakness (vitamin D, magnesium deficiency, marasmus) Tenderness at end of long bones (vitamin D deficiency) Squaring of shoulders—loss of deltoid muscles (kwashiorkor)
Nails	Spooning (koilonychias) (iron deficiency) Transverse lines (kwashiorkor, hypochacemia)
Neurological	Dementia, delirium, disorientation (niacin, thiamin, vitamin E deficiency) Loss of reflexes, wrist drop, foot drop (thiamin deficiency) Ophthalmoplegia (vitamin E, thiamin deficiency) Peripheral neuropathy (thiamin, vitamin E, vitamin B_{12} deficiency) Tetany (vitamin D, calcium, magnesium deficiency)

Source: Lisa A. Hark, PhD, RD and Darwin Deen, MD, MS. 2014. Used with permission.

Laboratory Data Used to Diagnose Nutritional and Medical Problems

No single blood test or group of tests accurately measures nutritional status. Therefore clinical judgment is important in deciding what tests to order based on the individual's history and physical findings. The following tests are grouped according to medical condition.

Alcoholism: Aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), thiamin, folate, and vitamin B_{12}.

Anemia: Complete blood count (CBC), serum iron and ferritin, total iron binding capacity (TIBC), transferrin saturation, mean corpuscular volume (MCV), reticulocyte count, red blood cell folate, and serum vitamin B_{12}.

Diabetes: Fasting serum glucose, hemoglobin A1C, insulin levels, C-reactive protein (CRP), serum, and urinary ketone bodies.

Eating Disorders: Potassium, albumin, serum amylase, thyroid studies, beta carotene aspartate amino transferase (AST), alanine aminotransferase (ALT), and anemia.

Fluid, Electrolyte, and Renal Function: Sodium, potassium, chloride, calcium, phosphorus, magnesium, blood urea nitrogen (BUN), creatinine, urine urea nitrogen, urinary and serum, oxalic acid, and uric acid.

Hyperlipidemia: Cholesterol, triglyceride, low density lipoprotein-cholesterol (LDL-C), high density lipoprotein-cholesterol (HDL-C), LPa, homocysteine, and thyroid stimulating hormone (TSH) (secondary cause).

Musculoskeletal pain, weakness: 25(OH) vitamin D, phosphate, parathyroid hormone (PTH).

Malabsorption: 24-hour fecal fat, barium imaging studies, electrolytes, albumin, serum triglycerides, and hydrogen breath test.

Metabolic Syndrome: Fasting serum glucose, lipid panel, and uric acid.

Refeeding Syndrome: Albumin, calcium, phosphorous, magnesium, and potassium.

Malnutrition: Protein Status

Clinically, visceral protein status may be depleted by increased protein losses in the stool and urine as a result of wounds involving severe blood loss, or by poor dietary protein intake. The following serum protein levels may prove useful in conjunction with other nutrition assessment parameters.

Once again, however, each of these tests has limitations because serum protein levels are affected not only by nutrition and hydration status, but by disease states, surgery, and liver dysfunction.

The half-life ($t_{1/2}$) of each protein is given because it allows use of these tests to monitor changes in protein nutrition over time:

- **Serum albumin** Serum albumin has a half-life of 18 to 20 days and reflects nutritional status over the previous 1 to 2 months. Levels may decrease with acute stress, overhydration, trauma, surgery, liver disease, and renal disease. False increases occur with dehydration. This test is not a good indicator of recent dietary status or acute changes in nutritional status (less than 3 weeks) given its long half-life. Significantly reduced levels of serum albumin (<3.5 mg/dL) have been associated with increased morbidity and mortality in clinical studies.
- **Serum transferrin** Serum transferrin has a half-life of 8 to 9 days. Changes in serum transferrin levels are influenced by iron status, as well as by protein and calorie malnutrition. Results of this test reflect intake over the preceding several weeks.
- **Serum prealbumin** With a half-life of 2 to 3 days, serum prealbumin reflects nutritional status as well as protein and calorie intake over the previous week. Prealbumin levels may be falsely elevated with renal disease or, as with albumin, reduced with severe liver disease.

Assessment and Problem List: Medical Nutrition Therapy

The healthcare professional clinically assesses the individual patient based on his/her history, review of systems, physical examination, and laboratory data.

Active problems are listed in order of their importance. Inactive problems are also recorded. Evidence of a nutrition disorder should be considered primary if it occurs in patients with no other etiology that explains signs and symptoms of malnutrition. A primary nutrition problem is usually the result of imbalances, inadequacies, or excesses in the patient's nutrient intake. Manifestations may include obesity, weight loss, malnutrition, or poor intake of vitamins or minerals such as iron, calcium, folate, vitamin D, or vitamin B_{12}.

Patients having normal weight and no other risk factors should be encouraged to maintain their weight. Overweight patients with co-morbidities, such as diabetes, hypertension, or heart disease, should be advised to lose weight by increasing their physical activity level and reducing their total calorie and saturated fat intake, using smaller portion sizes, and selecting healthier foods. Referral to a registered dietitian for additional counseling and support has been shown to be effective.

Secondary nutrition problems occur when a primary pathologic process results in inadequate food intake, impaired absorption and utilization of nutrients, increased loss or excretion of nutrients, or increased nutrient requirements. Common causes of secondary nutritional disorders include anorexia nervosa, malabsorption, trauma, acute medical illness, and surgery. Malnutrition may occur as a result of a chronic condition or an acute episode complicating an underlying disease. After assessing each problem, medical nutrition therapy should be recommended that includes both a diagnostic component and a treatment plan. Patient education is an essential part of medical nutrition therapy. Key dietary issues by age and disease are summarized in Table 1-5.

Estimating Energy and Protein Requirements

Resting Energy Expenditure (REE)

The amount of energy required to maintain vital organ function in a resting state over 24 hours is referred to as the resting energy expenditure (REE). Basal metabolic rate (BMR) is the minimum calorie requirement for an individual at a neutral environmental temperature while fasting. BMR is generally impractical to measure. REE is approximately 10 percent above BMR. Thus, the REE is used clinically for estimation of BMR. REE accounts for approximately 65 percent of total daily energy expenditure and varies considerably among individuals with different height, weight, age,

Table 1-5 Key Dietary Issues by Age and Disease

Age/Disease	Key Dietary Issue
Infants	Fluoride, iron, calories, protein, fat for growth and development
Children	Fluoride, iron, calcium, calories, protein, fat for growth and development
Teenagers	Iron, calcium, calories, protein for pubertal development (screen for eating disorders)
Pregnancy	Folate, iron, calcium, vitamin D, protein, appropriate weight gain
Alcoholism	Folate, thiamin, vitamin B_{12}, calories
Anemia	Iron, vitamin B_{12}, folate
Ascites	Sodium, protein
Beriberi	Thiamin
Cancer	Adequate protein, calories, and fiber
Celiac Disease	B complex, vitamins, vitamin D
COPD, Asthma	Vitamin D, calcium, weight loss, calories
Diabetes	Carbohydrates, saturated fat, cholesterol, calories, fiber
Heart Disease	Saturated fat, monounsaturated fat, cholesterol, sugar, fiber
Hyperlipidemia	Saturated fat, monounsaturated fat, cholesterol, sugar, fiber
Heart Failure	Sodium
Hypertension	Sodium, calcium, potassium, alcohol, sugar, total calories
Kidney Stones	Calcium, oxalate, uric acid, protein, sodium, fluid
Liver Disease	Protein, sodium, fluid
Malabsorption	Vitamins A, D, E and K
Obesity	Total calories, portion sizes, saturated fat
Osteoporosis	Vitamin D and calcium
Pellegra	Niacin
Renal Failure	Protein, sodium, potassium, phosphorous, fluid
Rickets	Vitamin D and calcium
Scurvy	Vitamin C
Vegetarian diet	Protein, vitamin B_{12}, iron, calcium

Source: Lisa A. Hark, PhD, RD and Darwin Deen, MD, MS. 2014. Used with permission.

Table 1-6 Definition of Energy/Calorie

Energy is expressed in kilocalories (kcal) and is produced by the oxidation of dietary protein, fat, carbohydrate, and alcohol.

- One gram of **protein** yields approximately 4 kcal.
- One gram of **carbohydrate** yields approximately 4 kcal.
- One gram of **fat** yields approximately 9 kcal.
- One gram of **alcohol** yields approximately 7 kcal.

A calorie is the amount of heat required to raise the temperature of 1 gram of water by 1 degree Celsius. A kilocalorie is the amount of heat required to raise the temperature of 1 kilogram of water by 1 degree Celsius.

body composition, and gender. REE significantly correlates with lean body mass. Regular physical activity, especially weight-bearing exercises, can increase muscle mass, and thus increase REE. Since REE decreases as people age due to the loss of lean body mass over time, regular exercise can play a significant role in maintaining REE, especially in older adults. The energy produced by the oxidation of dietary macronutrients is shown in Table 1-6. The Mifflin–St. Jeor equation to estimate energy requirement is shown in Table 1-7. Activity factors are added to the REE as necessary to calculate total daily caloric needs, which vary for active and inactive patients. Total energy expenditure (TEE) is equal to the REE times the appropriate physical activity factor. The physical activity factor for hospitalized patients or those confined to bed is 1.2; for non-hospitalized, sedentary patients, 1.3.

Table 1-7 Mifflin-St. Jeor Equation to Estimate Energy Requirement

Adults 19 years and older
Estimated Energy Requirement (kcal/day) = Total Energy Expenditure
Men
10 × weight (kg) + 6.25 × height (cm) − 5 × age (y) + 5
Women
10 × weight (kg) + 6.25 × height (cm) − 5 × age (y) − 161

Source: Mifflin, MD, St. Jeor ST, Hill LA, Scott, BJ, Daughtery SA, Koh YO. A new perspective equation for resting energy expenditure in healthy individuals. *Am J Clin Nutr*. 1990;(2):1241–-1247.

Protein Needs of Hospitalized or Critically Ill Patients

Protein requirements in a critically ill patient depend on the degree of catabolic stress the patient is experiencing. Guidelines are as follows:

- In unstressed well-nourished individuals, protein needs range from 0.8 to 1.0 g/kg body weight per day.
- In post-surgical patients protein needs range from 1.5 to 2.0 g/kg body weight per day.
- In highly catabolic patients (burns, infection, fever), protein needs can be over 2 g/kg body weight per day.

Malnutrition

According to the World Health Organization (WHO), malnutrition affects all age groups across the entire lifespan, from conception to older adults. Health consequences range from intrauterine brain damage and growth failure to reduced physical and mental capacity in childhood to an increased risk of developing diet-related chronic diseases later in life.

Insufficient food intake results in loss of fat, muscle, and ultimately visceral tissue. This reduction in tissue mass is reflected in weight loss. The smaller tissue mass reduces nutritional requirements, likely reflecting more efficient utilization of ingested food and reduction in work capacity at the cellular level. The combination of decreased tissue mass and reduction in work capacity impedes homeostatic responses, including responses to illness or surgery. The stress of critical illness inhibits the body's conservation response to malnutrition. In addition, undernourished individuals experience nutrient deficiencies and imbalances that exacerbate the reduction in cellular work capacity. Malnutrition is also associated with a decrease in the inflammatory response and immune function. These alterations result in increased morbidity and mortality among undernourished patients. Adequate nutrition is essential for reversing these physiological effects. Aggressive nutritional support, instituted early in critical illness, may reduce the adverse effects of malnutrition in the critically ill patient.

Etiology/Causes of Malnutrition

Decreased Oral Intake Poverty, poor dentition, gastrointestinal obstruction, abdominal pain, anorexia, dysphagia, depression, social isolation, and chronic pain are some of the many possible causes of decreased oral intake.

Increased Nutrient Loss Glycosuria, proteinuria, gastrointestinal bleeding, diarrhea, malabsorption, a draining fistula, or protein-losing enteropathy can result in nutrient losses.

Increased Nutrient Requirements Hypermetabolism state or excessive catabolic processes can result in increased nutrient requirements. Common examples of situations that can dramatically

affect nutrient requirements include surgery, trauma, fever, burns, hyperthyroidism, severe infection, malabsorption syndromes, cancer, chronic obstructive pulmonary disease (COPD), cardiac cachexia, critical illness, and HIV/AIDS. Pregnant women and children also experience increased nutritional requirements during growth and development.

Diagnosis of Malnutrition

Malnutrition is defined as a suboptimal or deficient supply of nutrients that interferes with an individual's growth, development, general health, or recovery from illness. A BMI of less than 18.5 kg/m^2 defines adults who are consistently underweight and at risk for malnutrition. Infants and children who fall below the 5th percentile for weight-for-age or BMI-for-age on the growth chart should also be evaluated further and followed closely. In acute malnutrition, a child's weight-for-age percentile on the growth chart falls first, followed by a decline in height growth. In extreme cases of malnutrition or starvation, a child's head circumference growth may also plateau. The importance of plotting pediatric growth parameters over time is paramount, as poor weight gain and/or weight loss are key to diagnosing malnutrition, failure to thrive, and other medical conditions associated with poor weight gain in the pediatric population, such as cystic fibrosis. Crossing growth percentile lines should always prompt close follow-up.

Marasmus results when the body's requirements for calories and protein are not met by dietary intake. Marasmus is characterized by severe tissue wasting, excessive loss of lean body mass and subcutaneous fat stores, and weight loss. Decreased protein intake is usually associated with decreased calorie intake, but can occur independently.

Kwashiorkor describes a predominant protein deficiency. Kwashiorkor is characterized by lethargy, apathy, irritability, retarded growth, changes in skin (dermatitis) and hair pigmentation, edema, and low serum albumin. Both marasmus and kwashiorkor are associated with weakness, weight loss, decline in functional status (increased difficulties with activities of daily living), impaired immune function with increased susceptibility to infection, and increased risk of morbidity and mortality.

Prevalence of Malnutrition

Children, older adults, and hospitalized and nursing home patients are particularly prone to malnutrition. According to WHO, 99 million children (17 percent) under 5 years of age were underweight in developing countries in 2011. This number is estimated to have declined from 28 percent in 1990. Fifty percent of deaths among children less than 5 years of age in developing countries are associated with malnutrition. One in three people are affected by vitamin and mineral deficiencies and one in four pre-school children suffer from malnutrition. One in six infants are born at low birth weight in developing countries.

Some degree of malnutrition occurs during most hospitalizations regardless of the type of injury or illness. The prevalence of malnutrition in the out-patient population has not been clearly determined. Risk factors for malnutrition include chronic diseases, use of multiple prescription medications, poverty, inadequate nutritional knowledge, homebound and/or non-ambulatory status, poor social support structure, major psychiatric diagnosis, and alcoholism. Malnutrition in nursing home patients has been reported in up to 50 percent of residents.

Food insecurity is defined by the United States Department of Agriculture (USDA) as lack of access to enough food to fully meet basic needs at all times due to lack of financial resources. Households that are insecure, even when hunger is not present, have such limited resources that they may run out of food or cannot afford balanced meals. Hungry households have been defined

as those that lack adequate financial resources to the point where family members, especially children, are hungry on a regular basis and the food intake of adults is severely reduced.

According to the USDA, an estimated 17 million (15 percent) of American households experienced food insecurity for at least some time during 2011. This represented 33.5 million adults and 16.7 million children. Approximately 8.6 million children (11.5 percent) lived in households in which one or more child was food insecure. Nationally, food insecurity was significantly higher for households with incomes near or below the Federal poverty line (35 percent), households headed by a single woman (37 percent) or man (24.9 percent), Black, non-Hispanic (25 percent) and Hispanic (26.2 percent) households, all households with children (21 percent) and households with children under age 6 (22 percent). Households with WIC-eligible incomes experience food insecurity more than those with higher income levels. Studies have shown that the federally funded WIC program is an effective means of decreasing rates of food insecurity while positively influencing nutrient intakes.

Unfortunately, with the shift from welfare to work, many low-income working families who are eligible for Federal assistance do not participate, leaving children more vulnerable to food insecurity than ever before. In 2011, 57 percent of food insecure households received assistance from one or more of the three largest Federal food and nutrition assistance programs. The Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program, provided benefits to 44.7 million people in the UnitedStates in 2011. This accounted for 40.1 percent of food insecure households.

Food insecurity and poor diet quality exist at unsettling levels throughout the United States despite attempts to create a food and nutrition safety net. Studies show that specific populations, including low-income women with children living in rural areas, are at increased risk for experiencing food insecurity. Providing nutrition education to all food assistance program participants, including information regarding the benefits associated with the recommended intake of fruits and vegetables as well as the availability and affordability of fresh produce, should be a priority.

Overweight and Obesity

Health Consequences of Overweight and Obesity

Obesity is a complex, multi-factorial disease that is becoming increasingly common among adults and children worldwide. Once considered a problem only in developed countries, overweight and obesity are now dramatically on the rise in developing countries as well, particularly in urban settings. Obese individuals have an increased risk of diabetes, coronary heart disease, hyperlipidemia, hypertension, stroke, gallbladder disease, sleep apnea, osteoarthritis, respiratory problems, and certain types of cancers (endometrial, breast, prostate, and colon), all of which increase their risk of mortality. According to the Centers for Disease Control and Prevention (CDC), seven out of ten deaths among Americans each year result from chronic diseases. Obesity-related conditions such as heart disease, type 2 diabetes, stroke, and certain types of cancer account for more than 50 percent of preventable deaths each year.

Recent studies show that overweight (BMI = 25.0–29.9) or class I obesity (BMI = 30.0–34.9) are not associated with excess mortality compared to normal BMI individuals (BMI = 18.5–24.9). However, class II/III obesity (BMI $\geq$ 35.0) is associated with significantly higher mortality, ranging from 40 percent among females to 62 percent among males relative to individuals with normal BMI. In considering attributable mortality risk, class II/III obesity (BMI $\geq$ 35.0) is responsible for approximately 4 percent of deaths among females and 3 percent among males. Obesity accounts for approximately 5 to 7 percent of national health expenditures in the United States. Recent studies demonstrate that across all payers, public and private, per capita medical spending for the obese was $1,723 higher per year (42 percent) than for an individual of normal weight and $266 higher per year for overweight individuals. The aggregate national cost of overweight and obesity was

approximately $114 billion dollars in 2012. Other studies indicate that obesity-related expenditures are expected to increase to 16 to 18 percent of healthcare spending by 2030.

Etiology of Overweight and Obesity

The etiology of obesity is believed to be due to a combination of biological and environmental factors. Biological factors that have been identified include an individual's genetic predisposition, the size and number of adipose cells, and REE. Environmental factors that have been identified as contributory to overweight and obesity include excessive caloric intake and inadequate physical activity. These are the most likely environmental factors associated with the significant increase in overweight and obesity seen in the United States. and developed countries over the past several decades. Recent research is examining the role of exposure to environmental toxins and the contribution of gut bacteria.

Genetics In humans, 426 variants of 127 different genes have been associated with obesity. According to the Human Obesity Gene Map, single mutations in 11 genes were strongly implicated in 176 cases of obesity worldwide. Additionally, 50 chromosomal locations have been mapped that contain genes that may be related to obesity. According to the CDC, "several independent population-based studies reported that a gene of unknown function, referred to as fat mass and obesity-associated gene (FTO), may be responsible for up to 22 percent of all cases of obesity. Interestingly, the FTO gene also shows a strong association with diabetes. The mechanism by which FTO operates is currently under investigation."

Family history reflects genetic susceptibility and environmental exposures shared by close relatives. Genetic studies over the past several decades investigating adopted twins and their biological and adoptive parents show that adoptees' weight correlates most strongly with their biological parents' weight. Additional research has shown that children with one overweight parent have a 40 percent chance of becoming overweight as adults. This risk increases to 80 percent if both parents are overweight. Regardless of the strong evidence for genetic influences on human obesity, genetics accounts for no more than one-third of the variance in body weight. Experts agree that since there has been no change in the gene pool over the past three decades, the dramatic increase in the prevalence of obesity in both children and adults in the United States. likely reflects environmental influences (epigenetic).

Adipose Cell Size and Number The size and number of fat cells have been studied for many years and vary between normal, overweight, and obese individuals. During infancy, adolescence, and pregnancy, fat cells normally increase in number. With modest weight gain, fat cells increase in size, and with significant weight gain, fat cells increase in both size and number. With weight loss, fat cells decrease in size but not in number. The lack of reduction in fat cell number may help explain why it is difficult for obese individuals to maintain weight loss for an extended period of time after a significant weight loss.

Excess Caloric or Energy Intake Humans require energy (calories) to support normal metabolic functions, physical activity, and growth and repair of tissues. According to the latest National Health and Nutrition Examination Survey III (NHANES), Americans are eating 220 more calories per day compared to 20 years ago. This increase in calories can be partially attributed to a combination of increased portion sizes or "super-size" servings and the increased frequency of eating outside the home, especially at fast-food restaurants. This calorie increase may also be secondary to increased body weight, which increases energy requirements.

Decreased Physical Activity The dramatic increase in sedentary activities and labor-saving devices (sitting at the computer, watching television, using the remote control, taking escalators,

elevators, or moving sidewalks, using drive-through windows to pick up food, and using garage door openers as examples) have reduced the amount of energy we expend as a society. According to the CDC, less than half (48 percent) of all adults met the 2008 Physical Activity Guidelines. Gender differences indicate that men (52 percent) were more likely than women (42 percent) to meet guidelines for aerobic activity. Ethnic differences also exist. More non-Hispanic white adults (23 percent) met the standard guidelines than non-Hispanic black adults (17 percent) and Hispanic adults (14 percent). Americans living in the South were more likely to be less physically active than individuals living in other United States regions. Less than 30 percent of high school students got at least 60 minutes of physical activity every day. In addition, the Behavioral Risk Factor Surveillance System indicates that participation in physical activity declines as people age.

Because regular physical activity modestly contributes to caloric expenditure, reduced abdominal fat, and increased cardio-respiratory fitness, it should be strongly encouraged, along with a reduced calorie diet, to improve the health of overweight and obese individuals. Recent studies from the National Weight Control Registry have indicated that regular physical activity is the single best predictor of long-term weight control in overweight and obese individuals who have lost weight.

Prevalence of Overweight and Obesity

According to the CDC, more than one-third of United States adults or 78 million Americans were obese in 2009–2010. Approximately 12.5 million (17 percent) United States children and adolescents were obese. Although obesity prevalence has not measurably increased in the past few years, levels are still high at 36 percent of United States adults aged 20 and over. Over the past decade obesity prevalence among men and boys in the United States has increased significantly but not among women and girls overall. Adults over the age of 60 were more likely to be obese than younger adults. Worldwide, obesity prevalence has more than doubled from 1980 to 2008. In 2008, the WHO estimated that more than half a billion adults worldwide were obese, approximately 205 million men and 297 million women. The prevalence of overweight and obesity were highest in the WHO Regions of the Americas (62 percent for overweight and 26 percent for obesity) and lowest in the WHO Region for South East Asia (14 percent overweight and 3 percent obesity). The CDC's Behavioral Risk Factor Surveillance System (BRFSS) shown in Figure 1-2 illustrates that

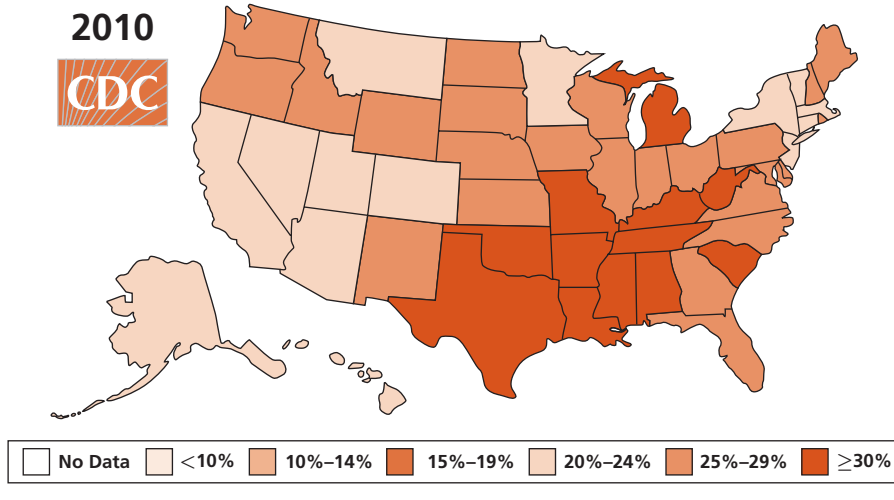
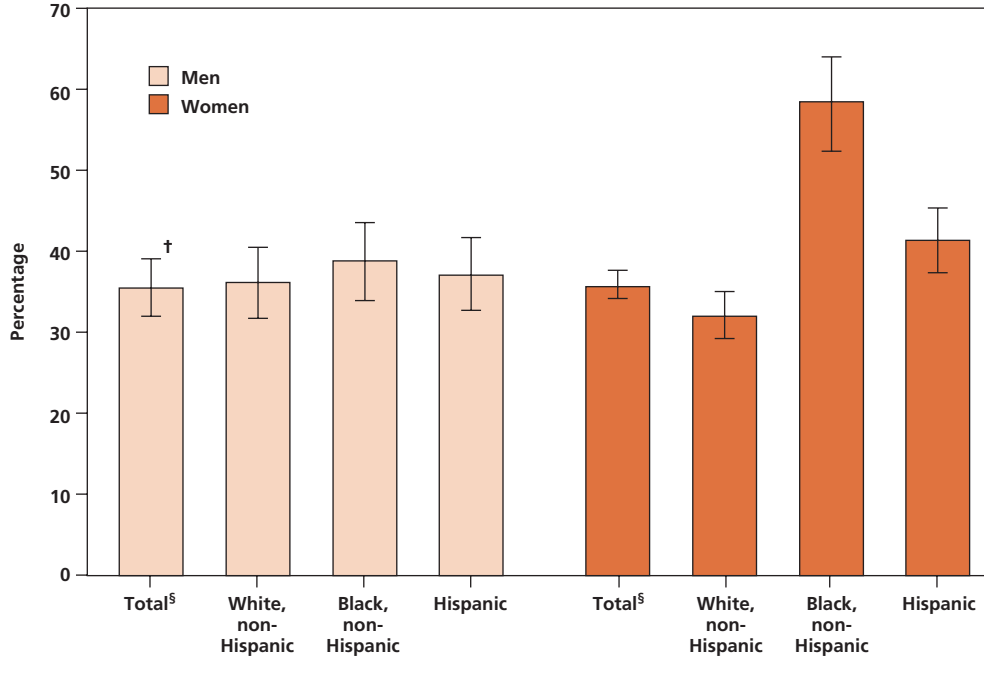


Figure 1-2 Prevalence of Overweight and Obesity Rates in the United States by State (2010)
Available from http://www.cdc.gov.

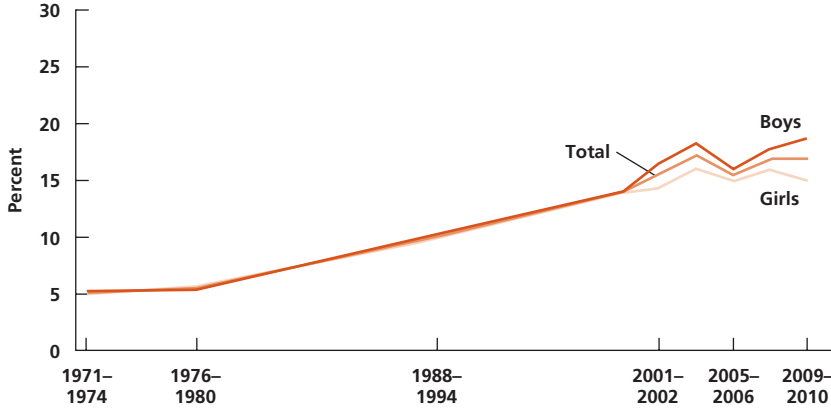


*** Defined as a body mass index (weight [kg] / height [m]2) ≥30.**
† 95% confidence interval.
§ Includes other races (i.e., Asians and American Indians/Alaska Natives) not shown separately because of small sample sizes, which affect reliability of estimates.

Figure 1-3 Prevalence of Obesity in Adults by Race/Ethnicity: 2009–2010
Source: Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity in the United States, 2009–2010. NCHS data brief no. 82. Hyattsville, MD: US Department of Health and Human Services, CDC, National Center for Health Statistics. 2012.

during the past 25 years there has been a dramatic increase in United States obesity rates. This United States map demonstrates this trend by mapping the increased prevalence of obesity across each of the states. In 1985, there were 13 states that had 10 percent or less prevalence of obesity; in 2010 no states had less than 20 percent prevalence of obesity. In 1985, no states had more than a 14 percent increase in prevalence of obesity. In 2010, 12 states had a prevalence of obesity equal to or greater than 30 percent. No state in the United States met *The Healthy People 2010* objective to lower obesity prevalence to 15 percent among adults and 5 percent among children.

Among women, the age-adjusted prevalence of overweight or obesity among racial and ethnic minorities is higher among non-Hispanic black and Mexican-American women than among non-Hispanic white women. For men, the difference is less pronounced, as shown in Figure 1-3. While *Healthy People 2020* has identified obesity reduction among children and adolescents as a chief objective, inadequate progress has been made toward this goal. For children and adolescents, overweight is defined as BMI above the 85th percentile and obesity is greater than the 95th percentile-for-age. Figure 1-4 demonstrates the increase in obesity that has occurred among children and adolescents since 1976. Figure 1-4 also shows how over the last decade obesity prevalence among boys in the United States has increased more significantly than among girls. More recent studies of smaller geographic regions (e.g., New York City) are showing some declines in rates of childhood obesity.



NOTE: Obesity is body mass index greater than or equal to the 95th percentile of the sex- and age-specific 2000 CDC growth charts.
SOURCES: CDC/NCHS. National Health and Nutrition Examination Surveys (NHANES) I–III: and NHANES, 1999–2000, 2001–2002, 2003–2004, 2005–2006, 2007–2008, and 2009–2010.

Figure 1-4 Trends in Obesity Among Children and Adolescents Aged 2–19 Years, by Sex: United States, 1971–1974 through 2009–2010.
Source: Fryar, CD, Carroll MD, Ogden CL. Prevalence of obesity among children and adolescents: United States, Trends 1963–1965 through 2009–2010.

Treatment (Case 1.1 and 1.2)

There is strong evidence that a weight loss of 10 percent of body weight will result in a reduction in blood pressure, fasting glucose, and lipid levels. This level of weight loss can also reduce an individual's risk of cancer. Treatment is particularly important for obese individuals who have three or more of the following risk factors: cigarette smoking, hypertension, high LDL-C levels, low HDL-C levels, elevated fasting glucose levels, and/or family history of diabetes, coronary heart disease, or cancer, and age over 45 and 55 years for men and women, respectively.

The USDA has developed My Plate based on the *Dietary Guidelines for Americans* (www.choosemyplate.gov). Nutritional guidelines originally were aimed at preventing malnutrition; recent guidelines have evolved to support overall good nutrition, and to prevent obesity. The MyPlate guidance system is intended to provide a framework for adults and children for determining what and how much to eat each day using the familiar image of a place setting for a meal. The ChooseMyPlate.gov website provides a multitude of well-organized information to help Americans make the best food choices. It also allows for the development of individualized dietary and physical activity plans.

Effective Counseling for Lifestyle and Behavior Change

Lifestyle and behavior changes often require many attempts, large and small, over many years. The first principle of behavior change is to understand the long-term nature of the needed changes, to encourage those who have not met goals or have relapsed, and for healthcare providers to not become discouraged with apparent lack of immediate success.

In making a change, people move through a series of steps: Precontemplation, Contemplation, Preparation, Action, Maintenance, and Relapse (Prochaska Stage of Change Model). This model is often used to clarify for people and their providers their readiness for change. Healthcare providers can provide information and motivational counseling to help patients move from one stage to another. Providers can help patients by considering their behavioral beliefs, such as personal per-

ceived risk of negative outcome from the behavior, normative beliefs (similar behavior by family members and individuals important to them), and efficacy expectations (they believe the change will make a difference and is personally achievable). People often need skills (e.g., label reading and menu planning) to help turn their intention to action. Providers who model or perform a specific behavior are more likely to help patients perform this behavior. Reviewing barriers to a change, the circumstances of previous behavior change and relapse, and motivations to change can also provide useful insights to patients.

Important questions that allow healthcare providers to assess patients' level of change include:

- How have you changed your diet or exercise since the last visit?
- What problems did you encounter in making these changes?
- How confident are you about sustaining these changes you have made?
- What additional changes would you like to make in your diet or exercise pattern to improve your health?
- How can I help you with these changes?
- What one behavior could you change that would result in the most significant change in your health?
- What one or two behaviors would you be unlikely to change now?

In conclusion, the value of nutrition assessment in the clinical care of both ambulatory and hospitalized patients cannot be overemphasized. Nutrition assessment during the medical history and physical examination to evaluate growth and development in children and documentation of signs of nutrient excess or deficiencies in children and adults should be routine in clinical care. Development of a realistic treatment plan that includes lifestyle counseling can help patients change their behaviors and lead healthier lives.

Case 1 **Obesity and Metabolic Syndrome**

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OBJECTIVES

- Identify methods to diagnose obesity and metabolic syndrome appropriately.
- Describe the metabolic and health consequences associated with being overweight or obese.
- Assess the patient's risk for metabolic complications associated with excess weight gain given the anthropometric and laboratory data, and usual diet of the patient.
- Describe the components of a successful weight management program, including specific nutrition, physical activity, and behavioral recommendations.
- Describe the efficacy of medications (over-the-counter and prescription) and surgical approaches to the treatment of obesity.

RS is a 44-year-old African–American woman who works as a management consultant. She presents to her family physician with elevated blood pressure and obesity. She has a history of dieting but has been unable to maintain a healthy weight. This is approximately the twelfth time in the past 15 years she has tried a weight-loss diet. RS states her weight problems began when she had her first child 18 years ago. Although she understands the medical consequences associated with being overweight, she is primarily motivated to lose weight for cosmetic reasons.

Past Medical History

RS has no past medical history of cardiovascular or gallbladder disease. (She has not had an EKG for the past 5 years). She takes no medications, vitamins, or herbal supplements although she states that she should be taking calcium. When asked about sleep disturbances, she admits to snoring at night, but denies waking up in the middle of the night or falling asleep during daytime activities.

Family History

The family history is positive for overweight and obesity. RS's brother and sister are overweight. Her father and another sister are normal weight. Her mother is obese, hypertensive, and had a myocardial infarction at the age of 67. RS states that her mother does not have diabetes although her blood glucose was elevated in a recent blood test.

Social History

RS does not smoke. She averages two to three 4-ounce glasses of wine per week. She eats three meals per day and admits to nibbling whenever food is available at work or when she is bored. She

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states she has no time to exercise due to her work and family schedule. RS is currently at her highest adult weight.

Obstetrical History

RS delivered three healthy, full-term children, who are now 18, 13, and 10 years old. She gained 35 to 40 pounds (16 to 18 kg) with each pregnancy and lost about 20 pounds (9 kg) after each birth. RS has never been able to reach her pre-pregnancy weight.

Review of Systems

Skin: No history of rashes or unusual skin pigmentation.
HEENT: No visual complaints.
Neurologic: No headaches, tremors, seizures, or depression.
Endocrine: Normal menstrual cycle; denies abnormal heat or cold intolerances.
Cardiovascular: Normal rate and rhythm; no orthopnea, or dyspnea.
Joints: No swelling, heat, or redness.

Physical Examination

Vital signs

Temperature: 98.4 °F (36.9 °C)
Heart rate: 88 BPM
Blood pressure: 135/88 mm Hg
Height: 5′3″ (160 cm)
Current weight: 208 lb (94.5 kg)
BMI: 36.8 kg/m^2
Waist circumference: 38 inches (96.5 cm)
Weight history: Her highest adult weight is her current weight while her lowest adult weight of 150 lb (68 kg) was before she had children at age 25. Her weight has averaged 175 lb (79.4 kg).

Exam

General: Obese woman in no acute distress; no cushingoid features, negative for hirsutism, no dorsal, cervical, or supraclavicular fat
Skin: No striae, no acanthosis nigricans
HEENT: Unremarkable
Neck: Nonpalpable thyroid
Chest: Clear
Heart: S_1 and S_2 normal rate and rhythm
Abdominal: Obese, no organomegaly
Extremities: No edema

Laboratory Data

Patient's Fasting Values	Normal Values
Glucose: 116 mg/dL	70–99 mg/dL
Potassium: 3.8 mEq/L	3.5–5.0 mEq/L
Cholesterol: 216 mg/dL	desirable $<$200 mg/dL
Triglycerides: 175 mg/dL	desirable $<$150 mg/dL
HDL-C: 42 mg/dL	desirable for female $\geq$50 mg/dL
Calculated LDL-C: 139 mg/dL	desirable $<$130 mg/dL

RS provides vague information on serving sizes particularly when she feels guilty about them. The following represents her usual diet:

Breakfast (home)	
Coffee	8 ounces (240 mL)
Half and half cream	1 ounce (30 mL)
Bagel	1 large
Cream cheese	2 Tbsp.
Orange juice	8 ounces (240 mL)
Lunch (office)	
Chef salad	2 cups
(Turkey, ham, cheese, boiled egg)	
French dressing	3 Tbsp.
Bread sticks	2 small
Iced tea (presweetened)	12 ounces (360 mL)
Snack (office)	
Pretzels	1.5 ounce bag
Diet soda	12 ounces (360 mL)
Dinner (home)	
Spaghetti	2 cups
Tomato sauce	½ cup
Beef meatballs	3 ounces (85 g)
Garlic bread	1 piece
Red wine	5 ounces (150 mL)
Snack (home)	
Vanilla wafers	10 small
Lemonade	12 ounces (360 mL)

Total calories: 2691 kcal
Protein: 94 g (14% of calories)
Fat: 90 g (30% of calories)
Saturated fat: 33 g (11% of calories)
Monounsaturated fat: 21 g (7% of calories)
Cholesterol: 334 mg
Carbohydrate: 355 g (53% of calories)
Dietary fiber: 13 g
Sodium: 4800 mg
Calcium: 601 mg

Case Questions

1. How are overweight and obesity clinically assessed in this patient?
2. What are the medical risks associated with obesity in this patient?
3. Does RS meet the criteria to diagnose metabolic syndrome?
4. What are the appropriate treatment goals for RS?
5. RS is interested in trying a high-protein, low-carbohydrate diet. Describe the biochemical and metabolic effects of high protein, low carbohydrate diets.
6. Is this popular diet appropriate for RS based on her medical history?
7. What dietary and exercise guidelines would you recommend for RS considering her diagnosis of metabolic syndrome and her current diet?
8. On a subsequent visit, RS is interested in medication for weight loss. Discuss the current criteria and options for pharmacologic therapy.

Answers to Questions: Case 1

Part 1: Assessment and Diagnosis

1. How are overweight and obesity clinically assessed in this patient?

Body mass index (BMI) is a useful clinical calculation for documenting obesity because it assesses the relative risk of excess weight. BMI is defined as weight/height^2 (kg/m^2) (Figure 1-1). The amount of intra-abdominal adipose tissue, independent of BMI, correlates strongly with increased risk of cardiovascular disease, stroke, dyslipidemia, hypertension, and type 2 diabetes in both men and women. Abdominal obesity can be assessed by measuring patient's waist circumference, in the horizontal plane around the abdomen at the level of the iliac crest.

RS is clinically assessed as having Class 2 obesity since she has a BMI of 36.8 kg/m^2. In addition, she has excess adipose tissue located in her abdomen, as indicated by her waist circumference of 38 inches (96.5 cm), increasing her risk for heart disease and diabetes.

2. What are the medical risks associated with obesity in this patient?

Obesity increases a person's risk of developing cardiovascular disease, dyslipidemia, hypertension, type 2 diabetes, osteoarthritis, gallstones, respiratory disease, cholecystitis, and certain types of cancer. Obesity also increases patient's risk during surgical procedures because increased subcutaneous fat can make surgery technically more difficult and prolongs the procedure. Post-operative complications are more common in obese patients.

Evidence exists to indicate that RS is experiencing some signs of physical stress related to obesity which include the following:

- RS complains of snoring, which combined with obesity, places her at risk for sleep apnea in the future.
- Borderline high LDL-C according to the Adult Treatment Panel (ATP) Guidelines from the National Cholesterol Education Program (NCEP) (Chapter 6).
- Elevated fasting glucose level, indicating impaired fasting glucose and suggesting impaired glucose tolerance and insulin resistance, although not frank diabetes. RS is at risk for type 2 diabetes due to the constellation of risk factors: obesity, abdominal fat distribution, sedentary lifestyle, and impaired glucose tolerance.
- Elevated blood pressure adding to her risk of disease according to the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-8) (Chapter 6).
- Elevated triglyceride level and a low HDL-C level for a woman.

3. Does RS meet the criteria to diagnose metabolic syndrome?

Recent attention regarding risk for coronary heart disease has focused on a cluster of metabolic abnormalities that arise primarily out of obesity. According to the NCEPATP III Guidelines, patients can be diagnosed with metabolic syndrome if they exhibit any three of the five conditions shown in Table 1-8. (Note differences in low normal ranges for HDL-C cholesterol for men and women.) RS has all five of the criteria for metabolic syndrome.

Table 1-8 Diagnosing Metabolic Syndrome: 3 or More of the Following 5 Criteria

Abdominal obesity	Waist circumference Men >40 inches Women >35 inches
Pre-hypertension	BP > 130/>85 mm Hg
Glucose intolerance	FBG > 110 mg/dL
High triglycerides	>150 mg/dL
Low HDL-C	Men <40 mg/dL Women <50 mg/dL

Source: Adult Treatment Panel (ATP) Guidelines. NCEP Report.

Part 2: Medical Nutrition Therapy

4. What are the appropriate treatment goals for RS?

The first line of treatment for patients with obesity and the metabolic syndrome is weight reduction and increased physical activity. However, one does not need to lose a lot of weight to be successful.

Weight Reduction Clinical research has demonstrated that obese individuals who achieve and maintain a 10 percent reduction in body weight, regardless of initial BMI, are likely to lower their blood pressure, serum glucose, and LDL-C and triglyceride levels, thereby reducing their risk of developing diabetes and cardiovascular disease. The Diabetes Prevention Program (DPP), a national study comparing lifestyle changes to medication, found that type 2 diabetes can be prevented or delayed with just a 5 to 7 percent weight loss due to lifestyle changes. For a more complete review of the DPP (see Chapter 8: Case 8.2).

Lifestyle modifications may also prevent the onset of hypertension as well as reduce elevated blood pressure. RS has a blood pressure of 135/88 mm Hg. According to JNC-7, she should begin an aggressive lifestyle modification program to lower her blood pressure to reduce the risk of cardiovascular disease.

A linear association has been demonstrated between excess body weight (BMI $> 27\,kg/m^2$) and severity of hypertension. A mean weight loss of 20 pounds (9.2 kg) is associated with a 6.3 mm Hg reduction in systolic BP and a 3.1 mm Hg reduction in diastolic BP. In addition, weight loss enhances the blood pressure lowering effect of anti-hypertension medications.

The incidence of other health problems associated with obesity, such as sleep apnea and osteoarthritis, also decrease with moderate weight loss. Thus, if RS were to lose 20 pounds (9.2 kg) or about 10 percent of her weight, it is likely that the clinical abnormalities associated with the metabolic syndrome will improve.

Increased Physical Activity Exercise has been shown to be the single best predictor of long-term weight maintenance and therefore should always be encouraged for weight loss. Patients who participate in regular exercise have lower blood pressure levels as well as a reduced risk of cardiovascular disease and osteoporosis compared to those who do not exercise. The CDC recommend a minimum of 30 minutes a day of physical activity, 5 days a week for adults. The Institute of Medicine (IOM) recommends adults to reach 1 hour a day of exercise, which is consistent with the CDC's recommendations for physical activity for children and teenagers. Current research indicates that this level of physical activity can be accumulated throughout the day. Both observational and interventional studies suggest that even brisk walking 3 hours per week can reduce the risk of cardiovascular disease and type 2 diabetes by at least 30 percent.

An active lifestyle has also been shown to prevent or delay the development of type 2 diabetes, since both moderate and vigorous exercise decrease the risk of impaired glucose tolerance and type 2 diabetes. It is likely that the beneficial effects of exercise on the prevention of cardiovascular disease are associated with improvements in the metabolic syndrome. In hypertensive patients with hyperinsulinemia, regular exercise has consistently demonstrated a reduction in blood pressure levels. Regular exercise has also been shown to reduce levels of triglyceride-rich very low density lipoprotein (VLDL) particles, and raise HDL-C levels.

5. RS is interested in trying a high-protein, low-carbohydrate diet. Describe the biochemical and metabolic effects of high-protein, low-carbohydrate diets.

High-protein, low-carbohydrate diets remain popular today: the most controversial being those that exclude almost all carbohydrate (<5 percent of total calories). These extremely low-carbohydrate diets, such as the Atkins diet, may consist of greater than 150 grams of protein, 100

grams of total fat (much of which is saturated fat), 500 mg cholesterol, and less than 28 grams of carbohydrate per day during the induction phase of the diet.

These diets cause the body to go into ketosis. Ketosis can be defined as an increased level of ketones in the blood. Ketones are acetoacetic acid and beta-hydroxybutyric acid, which form from the breakdown of free fatty acids. Ketosis also occurs during starvation, but due to lack of calories and protein, significant lean body mass is lost. In the weight-loss diets that try to promote ketosis, the dietary protein is excessive and therefore, lean body mass seems to be preserved (although research is sparse).

When ketone bodies build up in excessive amounts in the blood (ketonemia), they spill into the urine (ketonuria) and are excreted as sodium or potassium salts, resulting in a net loss of these two minerals. In addition, excess dietary animal protein may also lead to hyperuricemia (increased uric acid in the blood) and hyperuricosuria (increased excretion of uric acid in the urine). This increases the patient's risk of developing gout, uric acid kidney stones, and possibly bone loss. It is therefore critical to drink at least 64 ounces (1920 mL) of water per day on such a high-protein diet, and maintain an adequate electrolyte intake.

The question then is why do people lose weight on high-protein, low-carbohydrate diets? Most experts agree that when patients adhere to any weight-loss program, plan their meals, and focus on what and how much they are eating, they lose weight. In addition, when entire food groups, such as carbohydrates, are avoided, caloric intake is significantly reduced.

The rationale given for this low-carbohydrate, high-protein diet is that high-carbohydrate diets promote insulin resistance and cause obesity, but there is little convincing data for this. Insulin resistance does occur as a result of increased body weight, lack of exercise, or medical conditions such as type 2 diabetes. Protein also stimulates insulin secretion. Consuming more calories than your body requires from any food source potentially leads to weight gain if not balanced with increased exercise.

6. Is this popular diet appropriate for RS based on her medical history?

Given the cardiovascular concerns and the lack of data from well-controlled studies, a ketogenic weight-loss diet does not seem to be appropriate for RS. If she feels that she is eating too many carbohydrates from starches and simple sugars, suggest she become more aware of serving sizes, eat more vegetables and fruit, and ingest her carbohydrates from predominantly whole grains.

On a ketogenic diet, when carbohydrates are reduced to 28 grams per day, fat and protein intake are significantly increased. Depending on the choice of protein-containing foods, a high saturated fat diet may result. It is well established from epidemiological data and clinical trials that a high saturated fat intake increases serum LDL-C levels and therefore the risk of cardiovascular disease. The current ATP Therapeutic Lifestyle Changes Diet advocates less than 7 percent of the total calories coming from saturated fat, less than 200 milligrams of cholesterol and up to 20 percent of calories from monounsaturated fat per day (Chapter 6).

In addition, in order to keep carbohydrates low enough so that ketosis occurs, fruits, fruit juices, grains and dairy products are severely limited or avoided. Therefore these diets may be lacking in vitamins (A, B, C, D) and minerals (calcium, magnesium). Patients are advised in these ketogenic diet books to take many vitamin and mineral supplements.

7. What dietary and exercise guidelines would you recommend for RS considering her diagnosis of metabolic syndrome and her current diet?

Considering the fact that RS has tried unsuccessfully to diet twelve times over the past 15 years, it is important to assess what RS feels is her biggest vulnerability and also what lifestyle changes she is willing to incorporate. RS needs to focus on decreasing her total caloric intake and increasing her level of physical activity to lose weight and improve her metabolic syndrome.

Dietary Goals Specifically, RS would benefit from decreasing her consumption of saturated fat, simple carbohydrates, sodium and low-fiber foods intake. The current IOM report recommends 45 to 65 percent of total calories coming from carbohydrates and 20 to 35 percent from fat.

Because of the beneficial effects of increasing monounsaturated fat (MUFA) on triglyceride and HDL-C levels, RS could replace saturated fat with MUFA by using olive oil on her salad instead of French dressing and substituting low-fat cream cheese for the full-fat varieties. Snacking on hummus and raw carrots rather than pretzels, crackers, or cookies should also be suggested. She could also choose carbohydrate-containing, high-fiber foods such as fresh fruits, vegetables, and whole grain breads instead of bagels and pasta. RS needs to be counseled on reducing her serving size of pasta. She can add cooked frozen vegetables to her spaghetti to fill her up at dinner. Water and other non-caloric drinks should be substituted for sugar-sweetened drinks or fruit juice, as these drinks are contributing a significant number of empty calorie carbohydrates to her diet.

As shown in the revised menu, we recommend that RS substitute a small amount of peanut butter, a good source of MUFA and protein, rather than butter or cream cheese at breakfast. We also suggest she skip the cheese and egg yolk on the Chef's salad at lunch. Turkey, boiled ham, and egg whites are good sources of lean, low fat protein. If RS skips the garlic bread with dinner and limits her pasta to one cup cooked, she will be successful in decreasing calories, carbohydrate, saturated fat, and cholesterol. By adding vegetables, RS will improve the nutritional value of her diet while keeping total calories low. Finally, RS should be advised to take a calcium supplement (500 mg per day) since her calcium intake is far below her daily requirement of 1200 mg per day.

An alternate diet would be the Dietary Approaches to Stop Hypertension (DASH) diet. It is an excellent diet evaluated in a multi-center randomized, controlled trial which assessed the effects of dietary patterns on blood pressure, supports eating plenty of fruits, vegetables, and dairy foods for patients with high blood pressure. This trial enrolled 459 adults with mean base-line blood pressure levels of 131.3/84.7 mm Hg. Subjects were randomized to the control diet rich in fruits and vegetables with an average fat content or a combination diet with low-fat dairy and reduced total and saturated fat. Results showed a 5.5 mm Hg greater decrease in systolic pressure and 3.0 mm Hg greater decrease in diastolic pressure with the intervention diet as compared to the control diet. The average sodium intake was 3000 mg/day. Reduction in blood pressure began within 2 weeks and was maintained for the duration of the study. Further blood pressure reductions were achieved with sodium restriction (see Chapter 6: Case 6.2).

Physical Activity Goals

RS states that she does not have time to exercise due to her work and children's schedule. She currently works as a management consultant and travels several times a month. Therefore, in order to realistically encourage RS to increase her activity, it would be helpful to address these time barriers and to help her identify strategies to achieve increased physical activity. When she is traveling and does not have child care responsibilities, she could walk if she brings her exercise clothes and sneakers. When she is at home, she might be able to take a walk at night after dinner, or she could walk during her lunch break at work. In RS's case, she can benefit from using a pedometer that measures the number of steps taken each day. Metabolic fitness goals could be set at 5000 steps (or 30 minutes) per day, which can be gradually achieved over time. Keeping a record of her exercise may help RS stick with her commitment.

Realistic Weight Goals

The healthcare provider should discuss the appropriate rate of weight loss. A safe rate of weight loss is 1 to 2 pounds or 1 percent of body weight per week. RS's current weight is 208 pounds

(94.3 kg), and she is 63 inches (160 cm) tall. If RS is able to adhere to these dietary recommendations and increase her physical activity, she should be able to reduce her weight by 10 to 20 pounds (4.5 to 9.0 kg) over a period of 6 months. Studies have shown that weight loss slows or stops after about the 24th week of most diets. This "plateau" occurs because the calories consumed and energy expended are now sufficient to maintain, rather than allow for additional weight loss.

After attaining this goal, a new weight goal can be negotiated. Since RS would like to lose more, it is helpful to reiterate how much healthier she will be when she meets her first goal, and the fact that she is very successful if she maintains that weight loss. A potential next goal of 175 pounds (79.4 kg) can be set.

Recommended revised diet for weight loss:

Breakfast (home)

Coffee	8 ounces (240 mL)
Whole grain bread	1 slice
Peanut butter	1 Tbsp.
Low fat milk (1%)	4 ounces (120 mL)
Banana	1 small

Lunch (office)

Chef salad (no cheese)	2 cups
(turkey, ham, egg whites, tomato, raw broccoli)	
Olive oil	2 Tbsp.
Balsamic vinegar	2 Tbsp.
Diet soda or water	12 ounces (360 mL)

Snack (office)

Hummus	4 Tbsp.
Raw carrots	2 ounces (57 g)
Water	8 ounces (240 mL)

Dinner (home)

Spaghetti	1 cup
Mixed vegetables	10 ounces (283 g)
Lean beef meatballs	3 ounces (85 g)
Water	8 ounces (240 mL)

Snack (home)

Fat-free yogurt	8 ounces (240 mL)

Total calories: 1506 kcal
Protein: 78 g (20% of calories)
Fat: 59 g (34% of calories)
Saturated fat: 11 g (7% of calories)
Monounsaturated fat: 29 g (17% of calories)
Carbohydrate: 178 g (46% of calories)
Dietary fiber: 34 g
Sodium: 1934 mg
Calcium: 785 mg

Part 3: Pharmacotherapy Options

8. On a subsequent visit, RS is interested in medication for weight loss. Discuss the current criteria and options for pharmacologic therapy.

Pharmacological interventions to facilitate weight loss include enhancing satiety, decreasing fat absorption, and decreasing appetite. Three medications for weight loss are currently approved by the FDA for long-term use: Xenical (orlistat), Qsymia (topiramate and phentermine) and Belviq (lorcacerin). It is important to note that although most people consider stopping the drug after weight loss has resulted, this generally precipitates a regain of weight. Similarly, it would be inappropriate to stop a cholesterol lowering medication after blood cholesterol has been reduced or to discontinue a hypertension medication because blood pressure has normalized.

However, weight reduction with these medications is modest (7 to 11 pounds or 3 to 5 kg) over a 1-year period. Orlistat can be obtained over-the-counter under the name Alli, in a 60-mg dose. Other over-the-counter weight-loss dietary supplements are available but their safety and efficacy are not assured by clinical trials.

Xenical (orlistat) Orlistat's activity occurs in the small intestine and promotes weight loss by inhibiting gastric and pancreatic lipases, thus partially blocking the hydrolysis of triglycerides. Thirty percent of ingested fat is unabsorbed and excreted in the stool. Patients are required to follow a low-fat diet ($\leq$30 percent) in order to minimize side effects, specifically steatorrhea, associated with fat malabsorption. Orlistat is prescribed at a dose of 120 mg TID with meals containing fat. Because fat-soluble vitamins may also be malabsorbed, a multivitamin should be prescribed once per day to be taken at least two hours before or after the medication. Xenical is contraindicated for pregnant and lactating women and those with chronic malabsorption syndromes and cholestasis. In a 2-year study, patients given Xenical lost more weight, maintained more weight loss and reduced serum cholesterol, LDL-C, and blood pressures compared with those subjects taking a placebo. In a meta-analysis of 15 studies, orlistat reduced weight by 2.9 kg more than placebo.

It is incumbent upon the physician to bring the patient back for a follow-up visit within a month in order to assess the effectiveness of the medication as well as any side effects. One criterion of success for either medication is a 4 pound (1.8 kg) weight loss in the first month. If this has not occurred it is important for the physician and patient to re-evaluate the effectiveness of the medication for improvement in behavior, adherence, etc.

Qsymia (topiramate and phentermine) This is a fixed-dose combination of the sympathomimetic amine phentermine and the antiepileptic drug topiramate. It suppresses appetite and promotes satiety. Phentermine is a sympathomimetic amine and topiramate is an anti-epileptic drug whose mechanism of action in the appetite/satiety chain is unclear. Patients in a randomized controlled study for 1 year lost 5.1% on low dose and 10.9% in high dose as compared to placebo loss of 2.1 percent (LOCF). The drug can cause fetal harm and should not be taken during pregnancy. The drug is contraindicated also in glaucoma, hyperthyroidism, and known sensitivity to sympathomimetic amines. The most commonly observed side effects include paresthesia, dizziness, dysgeusia, insomnia, constipation, and dry mouth. Depression and suicidal thoughts can occur, in which cases the drug should be stopped. Phentermine has known potential for abuse.

Belviq (lorcacerin) This is a selective agonist of the serotonin (5-hydroxytyptamine) 2C (5-HT2c) receptor. Weight loss in a 2-year randomized controlled trial was 5.8 kg for drug vs 2.5 kg for placebo (LOCF). Response to therapy should be evaluated by week 12. If a patient has not lost at least 5 percent of baseline body weight, Belviq should be discontinued. The most common adverse reactions leading to discontinuation were headache, depression and dizziness. Belviq is classified as Schedule IV drug of the Controlled Substances Act, suggesting some abuse potential.

Case 2 **Obesity and Bariatric Surgery**

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OBJECTIVES

- Describe the indications for bariatric surgery. Enumerate the commonly used bariatric operations, and provide an overview of the mechanisms by which these surgeries produce weight loss.
- Describe the components of a successful surgical weight management program, and review the efficacy of surgical approach to the treatment of obesity and its co-morbidities.
- Describe the nutritional and clinical management of bariatric patients after surgery.

CG is a 49-year-old Caucasian woman with a past medical history significant for class III obesity, diabetes mellitus, obstructive sleep apnea (OSA), hypertension, and dyslipidemia who presents to her primary care provider to ask if bariatric surgery could be an option for her. CG feels that her health is deteriorating, and she believes that the current medical treatments are not controlling her health problems. CG was told at a previous visit 3 months ago that insulin therapy needed to be initiated to better manage her diabetes, but she was very reluctant to start it. She also rejoined a low-calorie diet program at the University Weight Management Clinic. In spite of CG's motivation, she was only able to lose 4 pounds during these 3 months, and her blood glucose levels have not improved. She was also given an appetite suppressant, but was forced to stop after 2 weeks due to heart palpitations and an increase in her systolic blood pressure of 8 mmHg.

CG also complains of increased daytime sleepiness and fatigue, worsening shortness of breath, and edema of both lower extremities. She was diagnosed with OSA 8 years ago and was placed on a Continuous Positive Airway Pressure (CPAP) Device. The pressure of her CPAP machine has been gradually titrated up. Two weeks ago she saw her pulmonologist who increased the CPAP pressure to 20 cm H_2O.

Past Medical History and Medications

- Obesity; CG has been "heavy" all her life and had enrolled in numerous weight-loss programs with only minor success.
- Type 2 diabetes for 17 years. She is treated with sitagliptin and metformin HCl extended-release (Janumet®) 50/1000 mg twice a day, glipizide 40 mg/day, and pioglitazone 30 mg/day which was added 6 months ago. Her last A1C, 2 months ago, was 9.3%.
- Sleep apnea for 5 years. She is treated with CPAP 20 cm H_2O.
- Hypertension for 15 years. She is treated with lisinopril 80 mg/day, labetalol 900 mg twice/day, amlodipine 10 mg once a day, and hydrochlorothiazide 25 mg/day.
- Hyperlipidemia for 17 years. She is treated with atorvastatin 80 mg/day.
- Gastro-esophageal reflux disease (GERD) diagnosed 14 years ago, treated with omeprazole 40 mg/day.

Medical Nutrition & Disease: A Case-Based Approach, Fifth Edition. Edited by Lisa Hark, Darwin Deen, and Gail Morrison.

- Severe degenerative joint disease affecting both knees for the past 6 years. She is currently treated with acetaminophen/hydrocodone, with only minimal pain relief.
- Laparoscopic cholecystectomy for symptomatic gallstones 10 years ago.
- Hepatomegaly and non-alcoholic fatty liver disease (NAFLD) diagnosed 2 years ago.

Family History

CG's family history is positive for overweight and obesity, hypertension, diabetes mellitus, stroke, and coronary artery disease. CG's one brother and mother are both obese; her father and a sister are overweight. Her mother has diabetes and hypertension, and had a myocardial infarction at the age of 69. Her father is hypertensive and had a stroke at the age of 68. Her brother has diabetes type 2.

Social History

CG never smoked. She drinks two glasses of wine on the weekends. She does not use illegal drugs. It was recommended that she follow a diabetic diet, but she feels she is not adhering well. She states she has no time to exercise due to her work schedule and cannot do much because of the pain in her knees. She works at a loan office; she is happily remarried and has two children from her first marriage.

Diet History

Breakfast: She eats breakfast only 3 to 4 times per week at work, which consists of a breakfast pastry or one large bagel with 2 Tbsp. regular cream cheese; coffee, (24 ounces), with flavored creamer.
Snack: medium apple or banana.
Lunch: On workdays, she eats fast food 2 to 3 times a week (¼ lb hamburger or crispy chicken sandwich, medium French fries, 24 ounces diet soda). She packs her lunch on other workdays and usually brings a frozen dinner.
Snack: Candy bar. At least 1 day a week she will drink a 16 ounces sweetened chai tea latte drink.
Dinner: Home-cooked meals 3 to 4 times/week, consisting of a 4 to 6 ounces selection of meat, baked or broiled; 1 to 1½ cups of pasta or rice from a box mix; ½ cup vegetables with butter, usually corn or green beans; water for beverage.
Snack: 2 to 3 medium commercial cookies or 1 cup ice cream without toppings.
Bedtime snack: 1½ cup Honeynut Cheerios with 2 percent milk.

No nocturnal eating.

On non-working days CG typically eats two meals. She eats a later breakfast, grazes in the afternoon on cheese and crackers. She usually goes out to dinner one night on the weekend and has two glasses of wine with dinner.

Diet Quality

Estimated resting energy expenditure (REE) using Mifflin–St. Jeor equation for females is 1987 kcal/day. Estimated activity factor for sedentary level of activity is 1.2. Total energy needs for weight maintenance is 2384 kcal/day.

Review of Systems

General: Fatigue.
Skin: Venous stasis dermatitis involving both ankles.
HEENT: No visual complaints; last diabetic eye exam 10 months ago showed mild non-proliferative diabetic retinopathy.
Neurologic: Occasional headaches responding to Tylenol, no tremors, seizures, or depression.

Endocrine: Irregular menstrual cycles, last mensus was 10 months ago, denies abnormal heat or cold intolerances.
Gastrointestinal: Heartburns, normal bowel movements.
Cardiovascular: No palpitations, no orthopnea, no chest pain; the patient had a stress echocardiogram 6 months ago when she presented to ER with chest pain (CP); the test showed no ischemia and a normal left ventricular ejection fraction, and the CP was determined to be due to GERD.
Joints: Pain in both knees; patient had an intrarticular steroid injection in her right knee 2 months ago.

Physical Examination

Vital signs

Temperature: 98.4 °F (36.9 °C)
Heart rate: 80 BPM
Blood pressure: 145/98 mm Hg
Height: 5′8″ (173 cm)
Current weight: 294 lb (134 kg)
BMI: 44.7 kg/m^2
General: Obese woman in no acute distress; Pickwickian body habitus, no Cushingoid features
HEENT: No palpable thyroid; no acanthosis nigricans
Respiratory: Lungs clear to auscultation bilaterally
CV: Distant heart sounds, regular rhythm, no murmur heard
Abdominal: Abdomen soft, normal bowel sounds, difficult deep palpation due to subcutaneous adipose tissue
Extremities: 2+ pitting edema involving both ankles
Skin: Brownish pigmented skin of both ankles

Laboratory Data

Patient's Fasting Values	Normal Values
Glucose: 196 mg/dL	70–99 mg/dL
Potassium: 3.8 mEq/L	3.5–5.0 mEq/L
Cholesterol: 216 mg/dL	Desirable <200 mg/dL
Triglycerides: 308 mg/dL	Desirable <150 mg/dL
HDL-C: 42 mg/dL	Desirable ≥50 mg/dL
LDL-C: 112 mg/dL	Desirable <100 mg/dL
Hemoglobin A1C 9.4%	<7.0%
Thyroid-stimulating hormone (TSH): 3.4	0.5–5.0 μU/mL
Free thyroxin (T4): 1.8 ng/dL	0.9–2.4 ng/dL
AST (SGOT): 48 IU/L	0–40 IU/L
ALT (SGPT): 69 IU/L	0–55 IU/L

A stress echocardiogram 2 weeks ago shows no left ventricular wall motion abnormalities; left ventricular ejection fraction of 60 percent; right atrial and ventricular enlargement, diagnosed as pulmonary hypertension.

Case Questions

1. Does CG meet the criteria for bariatric surgery?
2. What are the commonly performed types of bariatric surgery?
3. What are the expected benefits and risks of bariatric surgery?
4. There are several bariatric surgeons in the area where CG lives. She is asking her primary care physician to help her choose "the best." What is the most appropriate advice to give CG?

5. Describe the pre-surgical nutritional evaluation of CG for bariatric surgery.
6. Should CG lose weight before bariatric surgery?
7. What are the nutritional implications following bariatric surgery?
8. CG undergoes laparoscopic RYGB. No surgical and peri-operative complications occur. Outline the nutritional and medical management of this patient for the first 3 months following the surgery.
9. CG comes to the Bariatric Center for her 6-month follow-up visit complaining of nausea, shaking, diaphoresis, and diarrhea after eating. What is the most likely cause of these symptoms and how should she be treated?
10. Outline the long-term nutritional and medical management for patients who undergo bariatric surgery.

Answers to Questions: Case 2

Part 1: Screening and Procedure Options

1. Does CG meet the criteria for bariatric surgery?

The indications for the surgical management of obesity are outlined in the 2013 AHA/ACC/TOS *Guidelines for the Management of Overweight and Obesity in Adults*. Adults with a BMI 40 or 35 kg/m^2 with co-morbid conditions (diabetes, sleep apnea, obesity-related cardiomyopathy, or severe joint disease) may be candidates for bariatric surgery. In addition, they must have acceptable risk for surgery and have failed previous non-surgical weight loss interventions. It is also very important that potential patients understand the role of bariatric surgery in treating obesity, and display commitment to enduring lifestyle changes and adherence to nutritional recommendations. Contraindications to bariatric surgery include patients with untreated major depression or psychosis, binge eating disorders, ongoing drug and alcohol abuse, severe cardiovascular diseases with prohibitive operative risks, severe coagulopathy, or inability to comply with nutritional requirements, specifically life-long vitamin supplementation. Age alone should not preclude surgical treatment for obesity in adult men and women. Review of the literature shows that bariatric surgery in adolescents (age 12–18) is safe and is associated with significant weight loss, correction of obesity co-morbidities, and improved self-image and socialization. There is emerging data that patients with BMI of 30–34.9 kg/m^2 with diabetes or metabolic syndrome may benefit from bariatric surgery although current evidence is limited by the number of subjects studied and lack of long-term data.

CG has a BMI of 44.7 kg/m^2, which indicates she is a candidate for bariatric surgery. In addition, she has significant co-morbidities: diabetes mellitus (poorly controlled on oral medication), uncontrolled hypertension, sleep apnea, and debilitating degenerative joint disease. Possible secondary causes for obesity (hypothyroidism and Cushing syndrome) have been excluded by clinical evaluation and blood work. She has diligently undergone multiple lifestyle and pharmaceutical interventions, with modest and transitory success. She has no history or current use of illicit drugs or alcohol dependence, and she appears to have a good family support system. In addition, the psychological evaluation also showed that CG has no signs of depression or eating disorders, and that she is very motivated to proceed with the surgery. Her operative risk assessment indicates she is an acceptable candidate for bariatric surgery.

2. What are the commonly performed types of bariatric surgery?

The types of bariatric surgery are classified based on whether they encompass primarily restrictive or malabsorptive procedures (Table 1-9). The restrictive procedures limit caloric intake by decreasing the stomach's capacity. Currently, the two commonly used restrictive procedures in the United States are the laparoscopic adjustable gastric band (AGB) (as shown in Figure 1-5) and vertical sleeve gastrectomy (VSG) (Figure 1-6). The laparoscopic adjustable gastric band compartmental-

Table 1-9 Types of Bariatric Procedures

Restrictive
- Laparoscopic adjustable gastric band
- Vertical banded gastroplasty
- Intragastric balloon

Primary Restrictive with a malabsorptive component
- Roux-en-Y gastric bypass

Malabsorptive
- Biliopancreatic diversion with duodenal switch
- Jejunoileal bypass
- Biliopancreatic diversion

Source: Doina Kulick MD, FACP and Vicki Bovee, MD. 2014. Used with permission.

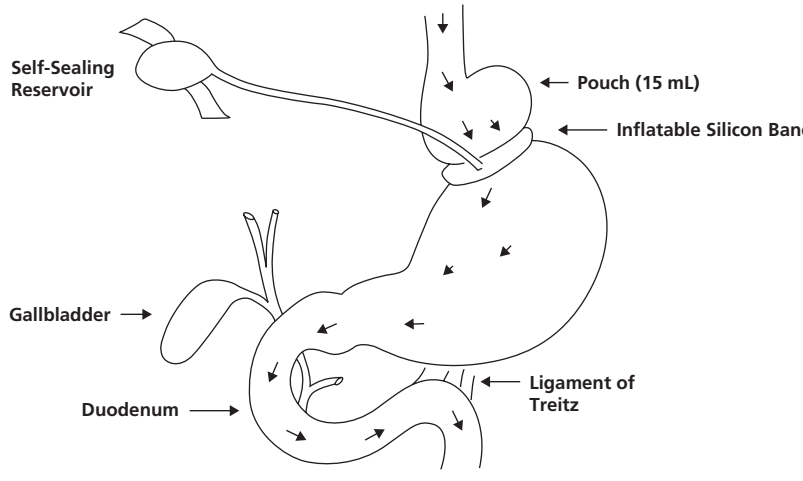

Figure 1-5 Laparoscopic Adjustable Gastric Banding (LAP-BAND). An Inflatable Silicone Band is Placed Around the Gastric Cardia to Achieve a 15-mL Gastric Pouch with an Adjustable Outlet that is Determined by the Volume of Fluid Inserted into the Band Reservoir. The Reservoir is Placed in the Subcutaneous Tissue of the Upper Abdomen, and can be Easily Accessed with a Syringe, Under Local Anesthesia (the Small Arrows Show the Path of the Ingested Food)
Source: Doina Kulick, MD, FACP. 2014. Used with permission.

izes the upper stomach by placing a tight, adjustable prosthetic band around the entrance to the stomach. The band consists of a hollow silicone ring, and is placed just a few centimeters below the cardia of the stomach, creating a 15 mL gastric pouch. The band is connected to an infusion port placed in the subcutaneous tissue of the upper abdominal wall. The port may be accessed with relative ease by a syringe and needle, under topical anesthesia. Injection of saline into the port leads to reduction in the band diameter, which results in an increased degree of gastric restriction. VSG is a partial gastrectomy, in which the majority of the greater curvature of the stomach is removed and a tubular stomach is created (Figure 1-6). Although VSG is a restrictive procedure, changes in gastric motility and fewer ghrelin-producing cells (ghrelin is a a gut hormone involved in regulating food intake) left after partial gastrectomy may affect weight loss outcomes.

Other procedures have both restrictive and malabsorptive components. Roux-en-Y gastric bypass (RYGB) is a classic example (Figure 1-7): a small (<30 mL) proximal gastric pouch is created by separating it from the stomach remnant; the small intestine is then cut at a distance of 30–50 cm distal to the Ligament of Treitz and the distal limb of the intestine (jejunum) is connected to the

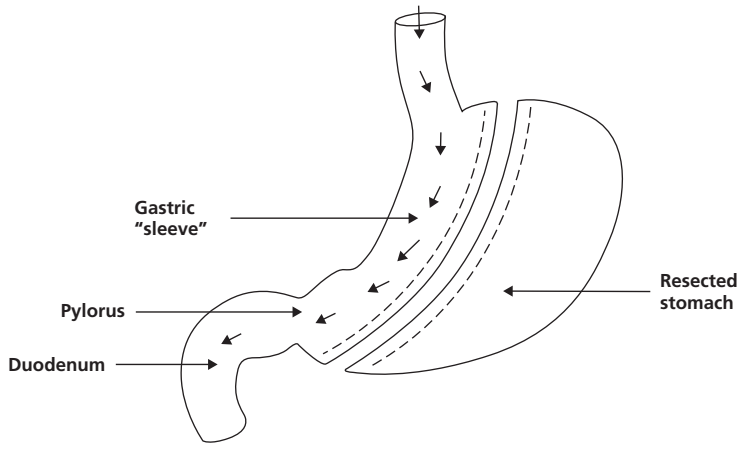

Figure 1-6 Vertical Sleeve Gastrectomy (VSG). The majority of the greater curvature of the stomach is removed and a tubular stomach is created. The tubular stomach has a small capacity, is resistant to stretching due to the absence of the fundus, and has few ghrelin producing cells (a gut hormone involved in regulating food intake).
Source: Doina Kulick, MD, FACP. 2014. Used with permission.

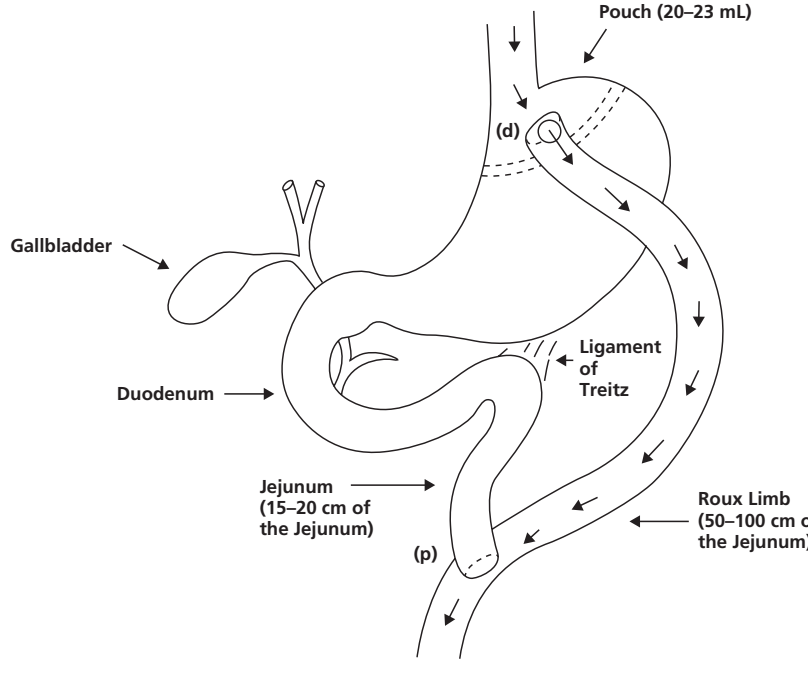

Figure 1-7 Roux-en-Y Gastric Bypass: The Stomach is Stapled Just Beneath the Gastroesophageal Junction. The Small Bowel (jejunum) is Divided Approximately 30 cm Distal to Ligament of Treitz. The Distal Cut End of the Small Bowel (d) is Anastomosed to the Proximal Gastric Pouch. The Proximal Cut End of the Small Bowel (p) is Anastomosed to the Limb 40 cm Distal to the Gastrojejunostomy (the Small Arrows Show the Path of the Ingested Food)
Source: Doina Kulick, MD, FACP. 2014. Used with permission.

small pouch; the proximal limb (the duodenum and the first 15 to 20 cm of the jejunum) continues the gastric remnant and will be anatomized with the distal limb 50 to 100 cm from the proximal end of the distal limb. Even though RYGB is primarily a restrictive operation in which the small gastric pouch limits food intake, the small bowel reconfiguration produces mild malabsorption, by bypassing the rest of the stomach, the duodenum and first 15 to 20 cm. of the jejunum. There are

also neuronal and gut hormonal changes, all of which provide additional mechanisms to facilitating weight loss. RYGB is still the most common bariatric surgery performed in the United States, and is considered the "gold standard".

The malabsorptive techniques produce primarily a decrease in the efficiency of nutrient absorption by shortening the length of the functional small intestine. Even though these procedures promote significant weight loss, the nutritional and metabolic complications – such as protein-caloric malnutrition and various micronutrient deficiencies – often offset the benefits of weight loss. All the procedures mentioned can be performed by minimally invasive techniques. The laparoscopic approach offers the advantages of decreased post-operative pain, shorter hospital stay, and decreased rates of wound infection and hernia formation. Currently there are no guidelines for choosing the most appropriate type of surgical procedure for the patient. The choice is based on clinical judgment, patient and surgeon preferences, patient's surgical risk, and reimbursement issues. After discussing it with her physician, nutrition specialist, and the bariatric surgeon, CG chooses to undergo RYGB (Table 1-9).

3. What are the expected benefits and risks of bariatric surgery?

Bariatric surgery is not a cure for obesity, but it is the most effective modality currently available for weight management, and was proven in prospective studies to reduce morbidity and mortality in obese patients. Data reported from the Swedish Obese Subjects (SOS) study, a large prospective observational study of more than 2000 patients who underwent bariatric surgery, showed that mortality hazard ratio (HR) at 10 years was 0.71 following bariatric surgery compared with matched obese controls. After a 20-year follow-up, the same cohort demonstrated that HR for cardiovascular death (including stroke and myocardial infarction) among surgical subjects compared with obese controls was only 0.47. In another cohort of patients who underwent RYGP, all-cause mortality was reduced by 40 percent 7 years after surgery, compared with the control group, and cause-specific mortality in the surgery group decreased by 56 percent for coronary artery disease, by 92 percent for type 2 diabetes mellitus, and by 60 percent for cancer.

When comparing the three most common bariatric procedures for percentage of excess weight loss, RYBG performs the best, the ABG the least, and VSG has intermediate outcomes. For example, a study found that at 1-year follow-up, the percentage of excess weight loss was 70 percent for the RYGP, 49 percent for VSG, and, and 38 percent AGB groups.

In general, after RYGB, patients lose an average of ½ to 1 lb (0.22–0.45 kg) per day for the first 3 months, ¼ to ½ pound (0.11–0.22 kg) daily from 3 to 9 months, and ¼ pound (0.11 kg) daily thereafter for up to 12 to 18 months.

You could inform CG that she could expect to lose approximately 90 to 100 pounds (or one-third of her pre-operative weight) within 12 to 18 months after undergoing the RYGB procedure. This weight loss would bring her body weight to 196 pounds (BMI $< 30\,kg/m^2$), which is a change in classification from class III obesity to overweight. Her diabetes mellitus, hyperlipidemia, hypertension, and OSA would likely also improve following bariatric surgery.

Bariatric surgery is the best long-term treatment for severe obesity; however, it carries risks of complication and potential mortality. Despite the known complications of bariatric surgery, overall mortality has improved significantly over the past two decades. The overall 30-day mortality for bariatric surgical procedures is <1 percent. The most common causes of early mortality are pulmonary emboli and complications related to surgical leaks.

4. There are several bariatric surgeons in the area where CG lives. She is asking her primary care physician to help her choose "the best." What is the most appropriate advice to give CG?

A successful long-term outcome of bariatric surgery is dependent on the patient's understanding of the role of bariatric surgery in weight management and their commitment to a lifetime of dietary

and lifestyle changes. Bariatric surgery is only a point in the continuum of care for obesity and the patient will need adequate support. Thus CG should be advised to seek a bariatric surgeon who operates as part of an experienced and knowledgeable multidisciplinary team of healthcare providers. This team will provide the pre-operative and post-operative education and health care. Usually the team consists of the following health professionals:

Obesity specialist An internist, endocrinologist, or a physician nutrition specialist who has a special interest and training in obesity. This physician, in close collaboration with the other health professional team members, coordinates the peri-operative care in order to optimize patient's co-morbidities and reduce the surgical risk. The physician adjusts medical treatments in accordance with the rapidly changing metabolic status following surgery (especially for the procedures containing a malabsorptive component). This physician may also follow-up with patients annually, often in close collaboration with patients' primary care physicians.

Bariatric Surgeon A bariatric surgeon is a surgeon with special training in bariatric surgery, who has substantial experience with the procedure, but also with the pre- and post-operative management of severely obese patients. Bariatric surgery is considered one of the most challenging procedures performed by general surgeons. Recent studies evaluating outcomes after bariatric surgical procedures found that the surgeon's experience inversely correlated with the incidence of post-operative complications. The more experience they had, the lower the post-operative complications.

Registered Dietitian A required member of the bariatric team. As mentioned, bariatric surgery does not cure obesity, but significantly facilitates a patient's adherence to long-lasting dietary changes. Thus the decision to operate must include an assessment of patients' dietary habits, and their ability to comply with the post-operative dietary regimen. A dietitian performs a pre-op dietary assessment and provides instructions to help patients initiate dietary changes consistent with surgery. In anticipation of surgery, the dietitian helps patients prepare their kitchens with the needed appliances (e.g., food processor, blender, and standardized measuring cups and spoons) and appropriate foods for a transition diet upon discharge from the hospital. The dietitian also provides counseling for patients as they advance their diet during the early (3 months) post-operative period, and periodically thereafter, especially when patients have difficulties in meeting nutritional goals.

Psychologist Psychological testing is a recommended part of the pre-operative assessment. Almost half of the patients referred for bariatric surgery may present with one of the following diagnoses: somatization, social phobia, obsessive–compulsive disorder, substance abuse/dependence, binge-eating disorder, night eating syndrome, post-traumatic stress disorder, generalized anxiety disorder, and depression. The psychologist may use various psychological tests and tools (the Beck Depression Inventory or the Minnesota Multiphasic Personality Inventory, the Boston Interview for gastric bypass, or the structured clinical interview with the Weight and Lifestyle Inventory from the University of Pennsylvania) to reveal potential problems, and help patients adopt the lifestyle behavior changes needed for a successful long-term surgical outcome.

Primary care physician (PCP) The PCP needs to become an active member of the team in the peri-operative stage, and most importantly facilitate long-term care of patients who undergo bariatric surgery. Often it is the PCP who will see patients annually for their post-op evaluation, review laboratory data, and will refer patients to the obesity specialist and dietitian whenever appropriate follow-up is indicated.

Part 2: Pre-Surgery Nutrition Assessment

5. Describe the pre-surgical nutritional evaluation of CG for bariatric surgery.

CG was evaluated and approved for surgery and her operative risk was assessed as being moderate. A comprehensive nutritional evaluation of CG shows the following: CG has been "heavy" all her life, and is now at the highest weight of her adult life. Her lowest adult body weight was 150 pounds at the age of 20, just before she got married (when she underwent a 16-week low-calorie diet program). She has gained weight progressively since that time during her pregnancies and family/social stressor events. CG has enrolled in numerous commercial and medically supervised weight loss programs (more than a dozen times over last 34 years) with only minor and transitory success.

CG's food history reveals that because of her work schedule, she frequently eats out, most often at fast food restaurants. To improve adherence to dietary recommendations after surgery, it is critical to have an understanding of meal patterns, eating habits, and typical foods consumed. With this information, plus an estimation of nutrient intake, the dietitian can work with the patient to develop pre-operative goals that will set a foundation for her post-operative eating plan.

CG's diet is deficient in dairy foods, vegetables, and fruits. She appears to consume adequate protein and grains; however, she eats sweets in excess. She has roughly two glasses of wine per week and her other drinks are usually calorie free. She has chai tea latte once a week. CG does not drink sufficient amounts of water. She takes a daily vitamin/mineral supplement. She is not participating in any intentional physical activity at this time due to knee pain. In addition to the lack of physical activity, she states that her biggest challenges in managing her weight are her sweet tooth, eating when bored, and not enough time for meal planning and preparation may negatively impact her long-term success.

However, CG's high intake of high-fat foods and sweets, grazing and meal skipping pattern, emotional eating, and time or schedule constraints for meal planning and preparation may negatively affect her long-term success.

The dietitian's recommendation is that CG is a candidate for gastric surgery but adherence to post-operative dietary changes may be difficult. Together, CG and the dietitian have developed a pre-operative nutrition plan until a surgery date has been scheduled when further guidelines will be provided. Immediate goals are:

- Reduce intake of high-fat foods.
  - Use of meal replacement shake for breakfast.
  - Pack lunch or choose lower fat, fast food options at lunch.
- Reduce intake of sweets.
  - Afternoon snack of fresh fruit or protein-based food.
  - Replace evening snack with a meal replacement shake.
- Take prescribed dietary supplements as directed per dietary assessment and nutrient screening blood testing.

6. Should CG lose weight before the surgery?

Regarding the recommendation for pre-operative weight loss, the obesity specialist and the bariatric surgeon both agree that CG would benefit from preoperative weight loss. Preoperative weight loss can reduce liver volume and may help improve the technical aspects of bariatric surgery in patients with an enlarged liver or fatty liver disease, as is the case with our patient. The patient had recently undergone a low-calorie diet program plus pharmacotherapy with unsatisfactory weight loss. It is possible that the recently added medication to her diabetic treatment, pioglitazone (which is known to produce water retention), could have tempered her weight loss. Two to four weeks of a very low calorie diet (VLCD; 800 calories) would be a reasonable pre-op weight loss treatment for CG.

The physician nutrition specialist prescribed a liquid meal replacement diet consisting of 800 calories per day. Attention was given to the macronutrient composition, and she was provided with an adequate amount of daily proteins and essential fatty acids. She was also recommended to take a daily multivitamin and two tablets of fiber supplements. The pioglitazone and glipizide were discontinued at the beginning of the VLCD. She remained on sitagliptin/ metformin, and supplemental short-acting insulin was added as need (prn). She was instructed to monitor her blood glucose three times a day. On this regimen, CG lost 23 pounds by the end of the fourth week.

Part 3: Post-Surgical Assessment and Medical Nutrition Therapy

7. What are the nutritional implications following bariatric surgery?

The nutritional goals following bariatric surgery are to produce a significant caloric deficit, while maintaining an adequate intake of essential macronutrients and micronutrients. Usually the more significant the component of malabsorption, the greater the success of weight loss; however, nutritional deficiencies follow the same trend.

Proteins are absorbed mainly in the jejunum and mid ileum, sites commonly bypassed by many bariatric procedures that have a malabsorptive component. Nonetheless, restrictive procedures could also lead to protein malnutrition due to significantly reduced food intake. The clinical signs of protein malnutrition are edema, alopecia, and low serum albumin level (<3.5 g/dL). Testing patient's serum albumin concentration is an effective and convenient method to monitor protein status. The incidence of protein malnutrition in purely restrictive procedures is very low (<2 percent), and has been found in 13 percent of patients after RYGB.

Iron deficiency is a common nutritional problem following RYGB surgery. Decreased ability to convert the dietary Fe^{3+} into the more absorbable Fe^{2+} form (due to low gastric acid production) and the bypassing of the duodenum and proximal jejunum (main sites of iron absorption) are the mechanisms leading to iron deficiency. Up to 50 percent of patients who have undergone RYGB have iron deficiency 4 years post-op, and it is two times more common in females compared to males. The prevalence of iron deficiency is even higher in jejuno–ileal bypass and duodenal switch. Measurement of serum ferritin is the single best diagnostic test for iron deficiency and is the first test to show abnormal results. Occurrence of microcytic anemia is usually a late finding and denotes severe iron deficiency.

Calcium and Vitamin D deficiencies are also commonly encountered after bariatric surgery. Calcium absorbs primarily in the duodenum and proximal jejunum, and absorption is facilitated by the presence of gastric acid secretion and vitamin D. Calcium status can be monitored by total serum calcium concentration, but calcium levels may be artificially low in the setting of hypoalbuminemia. Vitamin D is primarily absorbed in the jejunum and ileum. Being liposoluble, the absorption of vitamin D requires adequate mixing and action of pancreatic and biliary secretions. Even before surgery, up to 25 percent of obese patients have subclinical calcium deficiency (elevated PTH, with normal calcium), and 50 percent are vitamin D deficient. After surgery, the procedures with a malabsorptive component result in significantly more calcium and vitamin D deficiency compared to the restrictive procedures. The best marker for vitamin D deficiency is serum 25-hydroxy vitamin D. Low vitamin D and calcium levels trigger secondary hyperparathyroidism, which can be assessed by measuring PTH, which will be increased. All these nutritional and metabolic changes accelerate bone loss after bariatric surgery.

Vitamin B_{12} and Folic Acid Vitamin B_{12} is almost entirely absorbed in the terminal ileum in the presence of the intrinsic factor which is secreted from the antrum of the stomach. Adequate gastric

and pancreatic enzyme secretion and mixing are also required to release vitamin B_{12} from food and then from binding protein, so that vitamin B_{12} is available to bind to intrinsic factor for absorption in the ileum. The human body stores substantial amounts of vitamin B_{12} (about 2000 μg), but at 3 years post-op, approximately one-third of patients who have had a gastric bypass present with vitamin B_{12} deficiency.

Folic acid deficiency is less common, because it is absorbed throughout the small intestine and deficiency is largely due to severely reduced dietary intake. Purely restrictive procedures are generally not associated with vitamin B_{12} or folic acid deficiencies. Serum levels of vitamin B_{12} and folic acid are used to monitor nutritional status of these vitamins. The use of methylmalonic acid to detect vitamin B_{12} deficiency is not routinely recommended.

Thiamin is absorbed primarily in the duodenum, mostly in the more acidic environment of its proximal portion. The pathogenesis of thiamin deficiency is believed to be due to decrease in acid production (resulting from a decreased gastric capacity) and restriction of food intake, in the context of profuse and protracted vomiting. Symptomatic thiamin deficiency in bariatric patients is rare, but can occur even in the case of a restrictive procedure. The clinical presentation of thiamin deficiency most often consists of Wernicke's encephalopathy: altered mental status, ataxic gait, double vision, nystagmus, and acute polyneuropathy with paralysis. Clinical recognition of this syndrome may be lifesaving, since the symptoms respond very well to prompt intravenous administration of thiamin. Deficiency of thiamin can be confirmed by measuring serum thiamin levels, or the erythrocyte thiamine transketolase (ETKA) (which is the most reliable method, but not often used in practice).

Other Vitamins and Minerals Low serum levels of vitamin A, K, and E have been documented after bariatric surgery, but clinical manifestation of such deficiencies has not yet been described. No clinical complications due to lack of vitamin C, magnesium, and selenium have been reported. Cases of zinc deficiency were found to occur following malabsorptive procedures, and usually manifest as alopecia. It is important to emphasize to patients that nutritional deficiencies following bariatric surgery can be avoided or corrected by routine monitoring, adequate nutrition, and long-term supplementation.

8. CG undergoes laparoscopic RYGB. No surgical and peri-operative complications occur. Outline the nutritional and medical management of this patient for the first 3 months following the surgery.

After surgery, CG was advised to follow a full-liquid diet for the first week while at home. She was instructed to keep the volume small, no more than ¼ cup per meal, and to try to eat five to six times per day. Week two post-operatively, CG was instructed to begin adding pureed foods with an emphasis on including higher protein foods. Meal volume remained small and she was advised to slowly increase the volume of food. She was advised to begin adding semi-solid/soft foods into her diet as tolerated, usually about 14 to 21 days after surgery, and reminded to chew each small bite thoroughly. Foods not well tolerated during the first few months after surgery are red meat, chicken and turkey, white flour products, foods high in sugar and fat, and most raw fruits and vegetables.

The guidelines for continued weight loss were reviewed: keep portions small, no beverages while eating and 30 minutes after eating, a minimum intake of 60 grams protein per day, eat at scheduled times and avoid grazing, and include physical activity most days of the week. At her 3-month post-operative visit, she was eating approximately ½ to 1 cup of food per meal, averaging 50 to 60 g of protein every day and 48 ounces of water. She had not yet tried to eat red meat or raw vegetables. She stated that even though she was not hungry, she still felt the desire to eat more food than she could tolerate.

9. CG comes to the Bariatric Center for her 6-month follow-up visit complaining of nausea, shaking, diaphoresis, and diarrhea after eating. What is the most likely cause of these symptoms and how should she be treated?

The symptoms described at this visit are suggestive of dumping syndrome. Dumping syndrome occurs initially in 70 to 76 percent of patients with RYGB. The clinical manifestations of dumping include GI and vasomotor symptoms. Dumping syndrome can be divided into early and late phases depending on the relation of symptoms to the time elapsed from meal intake. Symptoms of early dumping occur within 10 to 30 minutes after eating. They result from accelerated gastric emptying of hyperosmolar content into the small bowel, followed by fluid shifts from the intravascular compartment into the intestinal lumen. These events are believed to be responsible for GI symptoms such as nausea, bloating, abdominal cramps, and explosive diarrhea. The majority of patients have early dumping. Late dumping occurs 1 to 3 hours after eating, and it is characterized predominantly by systemic vascular symptoms including flushing, dizziness, palpitations, and lightheadedness. Physical examination of these patients may reveal profound orthostatic changes. Late dumping occurs in approximately one-quarter of patients with dumping syndrome. Late dumping is considered to be the consequence of hypoglycemia from an exaggerated release of insulin.

An important element of the history that needs to be obtained from any patient presenting with these symptoms is a detailed food history, with particular attention to the intake of foods with a high content of sugar and/or fat. Our patient admitted that she had been snacking on her favorite cookies for the past month. Dumping syndrome usually responds to dietary interventions: reduction of carbohydrate intake, with preference for complex, rather than simple carbohydrates, avoidance of liquids for at least 30 minutes after a solid meal, and small portion size. In very rare cases, drug therapy may be required (octreotide). CG responded well to dietary interventions.

10. Outline the long-term nutritional and medical management of patients who have undergone bariatric surgery.

For her long-term diet, CG should continue to spend at least 20 to 30 minutes at each meal, taking her time to eat. She should slowly sip her fluids between meals (8 ounces of fluids over 30–40 minutes), but not during her meals or 30 minutes after eating. Food and liquids should continue to be low in fat and sugar. She was advised to eat at least 60 g of protein daily. Protein intake after bariatric surgery should be individualized, and guided by the dietician considering gender, age, and weight; a minimal protein intake of 60 g/d and up to 1.5 g/kg ideal body weight per day is considered adequate; higher amounts of protein intake up to 2.0 g/kg ideal body weight per day may be recommended on an individualized basis. Protein-rich foods include lean meat, low-fat milk and dairy products, beans, peas, lentils, eggs, and protein supplements if needed. Vitamins and minerals should be taken regularly.

During the first year following bariatric surgery CG was seen at 1, 3, 6, and 12-months. She should be monitored on an annual basis by an obesity specialist or her primary care physician. Visits with a dietitian or behavioral therapist should be recommended whenever patients have difficulty maintaining their dietary goals or regain weight. One year after her surgery CG lost 101 lb, which was what was initially predicted. Her BMI is 27.8 kg/m^2. Her annual visits focus on building long-term healthy dietary behavior, continuing physical activity, and monitoring and correcting potential nutritional deficiencies.

Routine blood tests for her annual post-operative visits include a CBC, chemistry panel including liver enzymes, lipid panel, A1C, ferritin, iron, TIBC, TIBC saturation, vitamin B_{12}, 25(OH) vitamin D, and intact PTH. A DEXA scan and other lab tests may be indicated. Our patient, who was perimenopausal before surgery, has not had a period for the last 16 months, and is considered post-menopausal. This status, along with rapid weight loss, increases her risk of osteoporosis, and most clinicians would agree that she should have a DEXA scan.

Evaluation of her co-morbidities and adjustment of medical management should be done as part of the continuum of care. Her medications were drastically reduced: she is taking Metformin, 1000 mg once daily, and her A1C is 6.9 percent. She no longer requires hydrochlothiazide or labetalol to control her blood pressure, and her amlodipine was reduced to 5 mg once daily. She only needs half of the pre-operative dose of atorvastatin to keep her lipid panel at the ideal level. Her CPAP machine was adjusted to 10 cm H_2O, which represents a significant improvement from the pre-operative status; she no longer has lower extremity edema or shortness of breath. She has been able to discontinue her GERD medication without return of symptoms, and her liver enzymes have normalized. She hopes that by losing more weight, she will be able to discontinue using her CPAP device. CG should remain for the rest of her life on the following daily nutritional supplements:

- Two multivitamins/minerals tablets each containing iron, folic acid, and thiamin.
- Vitamin B_{12} at a dosage of 500 μg to 1000 μg daily sublingual (or orally, if determined to be adequately absorbed to maintain B_{12} levels in the normal ranged). Sometime subcutaneous, or intramuscular route may be needed.
- Calcium citrate 1200 to 1500 mg/day (depending on dietary calcium intake).
- Vitamin D_3, 2000 to 3000 IU/day; (titrated to therapeutic 25- hydroxyvitamin D levels $>$30 ng/ml).
- Iron 45 to 60 mg ferrous sulfate.
- Thiamin supplementation should be included as part of routine multivitamin with mineral preparation. In bariatric patients at risk for thiamin deficiency (patients with rapid weight loss or protracted vomiting) supplementation with oral or intravenous thiamin, 100 mg/daily should be given until risk factors subsided. Patients with thiamin deficiency (suspected or established) should be treated with intravenous thiamin, 500 mg/day, for 3 to 5 days, followed by 250 mg/day for 3 to 5 days or until resolution of symptoms; then to consider treatment with 100 mg/day, orally, usually indefinitely or until risk factors have resolved.
- Folic acid supplementation (400 mg/day) should be part of a routine mineral-containing bariatric multivitamin preparation.
- Routine supplementation with zinc, selenium, and copper in addition to the amount found in the bariatric multivitamins–minerals preparation is not recommended.

It is important to mention that many of these recommendations are based mainly on expert opinion, and more clinical studies in this area are needed.

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