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Utilization of Nutrition-Focused Physical Assessment in Identifying Micronutrient Deficiencies

Dema Halasa Esper, MS, RDN, LD[1]

Abstract

Heightened interest in and utilization of parts of the nutrition-focused physical assessment (NFPA) have increased with recent guidelines in defining malnutrition and the call to awareness among healthcare practitioners to recognize, document, and intervene in malnourished patients. Furthermore, an increased prevalence of nutrient deficiencies has been reported in surgical weight loss patients, those with various acute and chronic diseases, and the elderly requiring physical assessment and examination skills to identify these deficiencies. The registered dietitian nutritionist (RDN) can use the NFPA to note physical findings to use along with the other domains in the nutrition assessment to determine the nutrition-related diagnosis, while other nutrition professionals can use the NFPA findings to determine a differential diagnosis. This article outlines the NFPA and how to determine physical findings related to micronutrient deficiencies, which can have a profound impact on overall nutrition status. (*Nutr Clin Pract*. 2015;30:194-202)

Keywords

avitaminosis; vitamin deficiency; micronutrient deficiency; nutrition assessment

The usage and application of the nutrition-focused physical assessment (NFPA) can be used in various settings to support best practice in patient care. The NFPA is part of the nutrition care process and model (NCPM), a framework for nutrition care planning in 4 separate and consecutive steps: nutrition assessment, diagnosis, intervention, and monitoring and evaluation.[1] Its usage and application have been used in various settings; however, the scope of this article is to discuss how the NFPA is an integral part of nutrition assessment and how it can be used in identifying physical findings related to micronutrient deficiencies. Furthermore, other disciplines can utilize and tailor these physical findings within their assessment of patients.

The historical interest in using physical assessment skills in clinical settings heightened when it was reported that hospitalized patients in medical and surgical intensive care units (ICUs) experienced increased morbidity and mortality related to poor nutrition status prior to and/or during hospitalization.[2,3] This awareness of the adverse effects of "undernutrition" led to the need for screening and assessment tools to identify patients with existing malnutrition and/or the risk of becoming malnourished. The development of a bedside nutrition assessment tool, the Subjective Global Assessment (SGA), emerged as a result of this medical conundrum and was one of the first assessment tools to incorporate a patient-generated subjective scoring system that rated nutrition status based on the patient's history and physical examination.[4,5] Unlike traditional assessment components based solely on anthropometric and biochemical markers, this tool outlined a rating scale based on the changes in dietary intake, weight, gastrointestinal (GI) signs related to nutrition, functional capacity, disease severity, and assessment of subcutaneous fat loss, muscle wasting, and edema. This led clinicians to perform a brief bedside physical examination among hospitalized patients, which later transitioned into multiple other practice settings and patient populations. The SGA has been validated in various disease states for its specificity and sensitivity in detecting nutrient deficiency and malnutrition risk.[6–8]

Surrogate biochemical markers, previously used in assessing nutrition status, are not reliable markers of nutrition; rather, they are indicative of the presence of inflammation, disease severity, and morbidity and mortality risk (eg, serum albumin, transferrin, and prealbumin).[9,10] Furthermore, with a new etiology-based definition of malnutrition, physical findings reflecting changes in body composition (eg, muscle mass wasting, loss of subcutaneous fat, and fluid accumulation) are delineated as part of the 6 characteristics of malnutrition.[11] Clinicians need to perform a brief physical examination to identify regions of the body with these associated macronutrient deficiencies and rate the findings as normal, mildly to moderately depleted, or severely depleted. These physical indices can be incorporated into an NFPA by having the clinician perform a

From [1]Youngstown State University, Department of Human Ecology, Food and Nutrition, Youngstown, Ohio.

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Corresponding Author:
Dema Halasa Esper, MS, RDN, LD, Youngstown State University, Department of Human Ecology, Food and Nutrition, One University Plaza, Youngstown, OH 44555, USA.
Email: dhesper@ysu.edu

Table 1. Diseases and Conditions Associated With Possible Micronutrient Deficiencies.[12–21]

Condition/Disease	Fat-Soluble Vitamins	Water-Soluble Vitamins	Minerals/Trace Elements
Alcoholism	X	X	X
Anemia	X	X	X
Anorexia, nausea, dysphagia		X	X
Bariatric surgery	X	X	X
Bowel resection	X	X	X
Chronic pancreatitis	X	X	X
Coronary artery disease/heart failure		X	
Crohn's disease	X	X	X
Cystic fibrosis	X		
Diabetes mellitus	X	X	X
Dumping syndrome	X	X	X
Gastrointestinal bleeding		X	X
Human immunodeficiency virus/AIDS	X	X	
Impaired wound healing	X	X	X
Inflammatory bowel disease	X	X	X
Liver and biliary disease	X		X
Organ transplants	X	X	X

Table 2. Domains Included in Nutrition Assessment.[22,24]

Food/Nutrition-Related History	Anthropometric Measurements	Biochemical Data, Test, and Procedures	Nutrition-Related Physical Findings	Client Histories
Obtain data regarding dietary restriction, food allergies/intolerances, eating patterns, and other factors that influence nutrient intake; assess medication and supplement usage	Obtain and measure height, weight, BMI, circumferences, and BIA; assess quantity of weight loss and/or gain and velocity of growth/length over time	Review laboratory and medical test(s) and procedures (eg, electrolytes, gastric emptying time, indirect calorimetry) nutrition-associated medical and surgical history	Use system-based examination of each region of the body to assess for physical findings related to nutrition	Obtain pertinent data relating to psychosocial, socioeconomic, functional, and behaviors that influence nutrition-related health

BIA, bioelectrical impedance analysis; BMI, body mass index.

full head-to-toe assessment and thoroughly evaluating and examining each body system for physical findings associated with nutrition-related problems. The SGA and the malnutrition guidelines do not include a rating scale or physical examination for micronutrient assessment; however, micronutrient deficiencies can contribute to and become apparent during acute disease–related malnutrition, chronic disease–related malnutrition, and starvation-related malnutrition.[12,13] A list of common diseases and conditions associated with micronutrient deficiencies is outlined in Table 1.[12–21]

The etiology of micronutrient deficiencies can be multifactorial (eg, inadequate intake, malabsorption, increased nutrient requirement, drug interaction or shortage, disease process, or famine/natural disasters).[13–17] The scope of this article is to discuss physical findings associated with these deficiencies. The practitioner performing the NFPA can employ critical thinking and professional judgment to establish the etiology by evaluating all 5 domains within nutrition assessment as outlined in Table 2.[22] Nutrition-related physical findings can correspond with the subjective and objective data collected within these domains. The registered dietitian nutritionist (RDN) is the professional who assesses the imbalance between nutrient requirements and intake (energy, protein, and micronutrients) and how its cumulative deficit can affect overall health. Furthermore, the NCPM's standardized language outlines physical findings specific for the clinician to use within nutrition assessment (Figure 1).[23] These findings can be incorporated within documentation to communicate possible micronutrient deficiencies to the healthcare team.

Defining Nutrition-Focused Physical Assessment

It is important to define what entails an NFPA when observing for abnormal clinical and physical findings in each region of the body. According to the recent practice paper from the

	NCPT Code	ANDUID
NUTRITION-FOCUS PHYSICAL FINDINGS (PD)		
Findings from a nutrition-focused physical exam, interview, or the medical record including muscle and subcutaneous fat, oral health, suck/swallow/breathe ability, appetite, and affect.		
Nutrition-focused physical findings (1.1)		
❑ Overall appearance	PD-1.1.1	10362
(specify) _____		
❑ Body language	PD-1.1.2	10363
(specify) _____		
❑ Cardiovascular-pulmonary	PD-1.1.3	10364
(specify) _____		
❑ Extremities, muscles and bones	PD-1.1.4	10365
(specify) _____		
❑ Digestive system (mouth to rectum)	PD-1.1.5	10366
(specify) _____		
❑ Head and eyes	PD-1.1.6	10367
(specify) _____		
❑ Nerves and cognition	PD-1.1.7	10368
(specify) _____		
❑ Skin	PD-1.1.8	10369
(specify) _____		
❑ Vital signs	PD-1.1.9	10370
(specify) _____		

Figure 1. Nutrition care process terminology (NCPT) terms used for physical findings for both nutrition assessment and monitoring and evaluation. Adapted with permission from the Academy of Nutrition and Dietetics, Nutrition Care Process Terminology Reference Manual (eNCPT). http://ncpt.webauthor.com. Accessed February 2, 2015.

Academy of Nutrition and Dietetics, nutrition assessment uses critical thinking and observation skills in identifying physical findings via a system-based examination similar to the sequence and content of a physician-based examination as outlined below.[22]

Components of a system-based evaluation and examination of each region of the body are as follows:

- General inspection
- Vitals
- Skin
- Nails
- Head/hair
- Eyes/nose
- Mouth
- Neck/chest
- Abdomen
- Musculoskeletal

When employing the NFPA, evaluation and examination of micronutrient deficiencies can be identified using the same head-to-toe approach. The basic examination uses the techniques of inspection, which employs a critical eye to examine color, shape, texture, and size of the individual, and palpation, which requires the use of touch with the tips and pads of fingers to evaluate and assess texture, size, tenderness, mobility, and temperature. The data from this examination can be used along with the other domains in a nutrition assessment to critically interpret and identify nutrition-related problems.

When collecting data from all 5 domains in the nutrition assessment, the RDN is synthesizing and integrating all of the data provided and collected to ultimately determine the nutrition-related diagnosis. However, verification of these findings can also be reviewed and discussed within the healthcare team, as other disciplines perform a physical examination in the context of identifying medical diagnosis/diagnoses, which is not equivalent to the nutrition diagnosis. Monitoring and evaluation follow, providing critical data on whether the intervention corrected the nutrition-related problem. The RDN can use changes in nutrition-related physical findings to indicate how medical nutrition therapy can affect nutrition outcomes, which supports healthcare outcome data. Furthermore, by employing the NFPA, the RDN will not only gather pertinent information from the medical chart and tests but also use the patient interview and the examination to correlate the information to assess for possible clinical and physical findings.[22,24]

Physical Findings Related to Micronutrient Deficiencies

Micronutrient deficiencies are often reported as a single or multiple-nutrient deficiencies based on region, stage of life cycle, and/or disease state. Globally, micronutrient deficiencies (single and multiple) affect 2 million persons, not only in developing countries, and the most prevalent single-nutrient deficiencies are iron, vitamin A, and iodine.[25] Micronutrient deficiencies can play a role in the development and/or progression of acute or chronic diseases and can also be associated with adverse changes in overall health.[26] Due to the rise in the aging population, individuals are living longer with associated chronic diseases and conditions as access to and advances in medical technology (eg, noninvasive surgeries, organ transplantation, cancer treatment options, obesity treatments [medically and surgically], nutrition support modalities) increase.[19,26,27,28] Despite these advances, micronutrient deficiencies are prevalent, and practitioners should be vigilant in assessing for declining nutrition status, even in the absence of malnutrition and adequate total caloric intake.

Vitamins are essential organic substances that are required in small amounts in the diet and contribute to energy-facilitated chemical reactions, including metabolism, growth, and the maintenance of cellular integrity.[18,29] Biochemical laboratory tests can be used to assess micronutrient status by measuring nutrient levels or metabolites in blood, urine, or body tissue.[30] The results of these biochemical tests provide a qualitative and quantitative measurement of the nutrient in that particular tissue or fluid sample; however, the results may fail to reflect

overall body storage in relation to excess or deficiency.[30] Hence, recognizing clinical and physical changes in regions of the body affected by nutrient availability can be an alternative, cost-effective approach to identifying micronutrient deficiencies. The associated clinical and physical changes as a result of micronutrient deficiencies are outlined in Table 3.

However, some of these findings can be nonnutrition related and can be considered during the process of assessment.[21,31]

Skin, Nails, Hair/Head, and Eyes

Skin

The skin is the heaviest organ of the body and accounts for 16% of body weight.[31] Its major function is to keep the body in homeostasis, as well as provide boundaries for body fluid, protect the underlying tissues, regulate body temperature, and synthesize vitamin D. Nails and hair are considered accessory structures of the skin that aid in keeping the skin from dryness through oil and fluid production, as well as sharing vascular and nutrient supplies.[31] There are 3 layers to skin: the epidermis, dermis, and hypodermis (subcutis). The top layer of skin (epidermis) depends on the layers underneath for nutrition, vascular support, and moisture.

When observing the skin, the clinician should inspect the entire skin surface for changes in color, texture, temperature, moisture, lesions, and mobility and turgor. Coloring of the skin is affected by the amount of blood flow, thickness, and melanin in skin.[31] Skin color changes may be noticed on the lips/tongue, mucous membranes, fingernails, and palms of hands and feet. The physical finding of pallor (unusual lightness of skin color compared with a normal hue) can be noted in the overall appearance, lower eyelid (conjunctiva), nail beds, and tongue. These physical findings correlate with iron and/or B-complex vitamin deficiencies, as they are involved in hematologic processes. Conditions that cause a reduced amount of hemoglobin in the blood due to anemia can lead to paleness in skin or mucous membranes and can occur in the following conditions: alcoholism, long-term parenteral nutrition (PN) support, and patients with partial gastrectomies.[18] Biotin deficiency, a water-soluble vitamin, can present with similar physical finding; however, this deficiency is commonly seen in patients receiving PN without biotin and individuals consuming a raw egg diet over an extended period.[18,19]

Pigmentation of the skin (hypo/hyperpigmentation) can also be noted as a physical finding on the face, hands/fingers, chest cavity, and legs and feet. Depigmentation of skin and hair (whitish, gray coloring) is a physical finding that can result from copper deficiency; however anemia, neutropenia, and ataxia are more common manifestations of copper deficiency.[19] Although not clinically seen often, an increased risk is associated with poor intake, decreased absorption, or increased losses from the GI tract (eg, alcoholic patients, copper-free PN solutions, celiac, bariatric surgery/intestinal resection, chronic diarrhea, and those receiving hemodialysis).[18,19]

Inspection of skin texture changes can be noted on the face, arms/hands, chest, and legs. Hemorrhages around the hair follicle (perifollicular hemorrhage) and reddish-purple spots (petechiae and purpura) are likely to appear in the presence of severe vitamin C deficiency. This is due to a defect in collagen synthesis, resulting in weakened capillary walls and cells (Figure 2).[32] These findings are likely to appear on the arms and legs and are discolorations on the skin that do not blanch when pressure is applied. Petechiae are smaller in size than purpura, but both are round, flat, and irregular in size. Those whose diets lack fruits and vegetables, who abuse alcohol or drugs, and who smoke are at risk of this vitamin deficiency.[25,26]

Ecchymosis (bruising) occurs when blood escapes into the tissue from ruptured blood vessels and appears as a reddish or purplish patch on the skin. This physical finding can relate to vitamin K deficiency, as its primary function is in the maintenance and proper function of clotting factors that are vital to normal blood clotting. Vitamin K deficiency is rare as the most significant source is synthesized in the body by the GI bacteria. However, occurrence is likely in conditions of fat malabsorption and due to some medications that interfere with vitamin K's synthesis and function in the body.

In vitamin A deficiency (VAD), cell differentiation and maturation are impaired, and changes in skin and mucosa membranes occur. The epidermis cells flatten and appear dry, rough, and hard. The epithelium cells produce keratin, a hard, inflexible protein around the hair follicle that can result in the skin taking on a "goose flesh" appearance.[18,20] Vitamins A and K are fat-soluble vitamins that depend on dietary fat for absorption and are stored in the liver. The following diseases can affect the risk for fat-soluble vitamin deficiencies due to impaired absorption and/or fat emulsification and micelle formation: GI and liver dysfunction, malabsorptive syndromes, cystic fibrosis, malnutrition, and alcoholism.[19,21,25,33]

Furthermore, the physical findings of scaly, dry skin and seborrheic dermatitis are other skin texture changes that can be noted during general inspection of the face, arms, chest, and legs. Seborrheic dermatitis (red, inflamed spots on the skin) is a physical characteristic seen in B-complex vitamin deficiencies, including riboflavin, niacin, vitamin B_6, and biotin. Vitamin B deficiency rarely occurs alone and is often accompanied by other B-complex vitamin deficiencies.[18] For example, Figure 3 illustrates a pellagra-like dermatitis due to niacin deficiency resulting from both poor intake and impaired nutrient absorption; however, laboratory testing also indicated a decrease in plasma pyridoxine, riboflavin, and serum zinc levels.[34] Populations at risk for these B-complex deficiencies include underdeveloped populations, alcoholics, patients with chronic diarrhea and malabsorptive disorders, burn patients, elderly patients, and PN-dependent patients.[18,19,21,25,33]

Reddish scaly rash on the skin, particularly the face, neck, and hands, is a physical finding noted in zinc deficiency. Zinc is required as a component of various enzymes in the maintenance of the structural integrity of proteins and plasma concentrations, and zinc levels can remain stable even in the

Table 3. Clinical and Physical Findings Related to Micronutrient Deficiencies.[18,19,25,26,28,30,32,35,36]

Region of Body	Assessment/ Examination	Abnormal Findings	Possible Vitamin/ Mineral Deficiencies	Comments
Skin	Inspect and palpate for color, moisture, texture, temperature, and lesions	Pallor, cyanosis	Iron, folate or B_{12}, biotin, copper	Skin should be smooth, uniform in color and appearance. Iron is involved in the transport and storage of oxygen; copper is involved in iron metabolism and melanin pigment formation. Vitamin A regulates epithelium cell integrity. Vitamin K is vital in blood clotting; vitamin C is necessary for collagen synthesis.
		Yellowing coloring	Carotene or bilirubin (excess related)	
		Dermatitis, red scaly rash or follicular hyperkeratosis	B-complex vitamins (riboflavin, niacin, vitamin B_6), vitamins A and C, and zinc	
		Bruising, petechiae, unhealed cuts/wounds	Vitamins K and C and zinc	
Nails	Inspect and palpate for color, shape, and texture	Pallor or white coloring; clubbing, spoon-shape, or transverse ridging/banding	Iron, protein	Nail bed should be free of splints, uniform in shape, rounded, and smooth. Color and shape changes can reflect other medical conditions. The nail is made from the protein, keratin. Low protein intake can affect nail growth and texture.
		Excessive dryness, darkness nails, curved nail ends	Vitamin B_{12}	
Head/hair	Inspect and palpate the scalp/hair for quantity, distribution, and texture	Dull/lackluster, banding/ sparse; alopecia; depigmentation of hair	Protein and energy, biotin, copper	Scalp should appear normal in color and texture with no diffused hair patches. Hair color and texture should appear uniform, thick, firm, and not easily plucked. Protein and biotin are needed to maintain hair growth.
		Scaly/flaky scalp	Essential fatty acid deficiency	
		Corkscrew, coiled hairs	Vitamin C	
Eyes	Inspect for changes in vision; color of the conjunctiva and sclera	Vision changes, particularly at nighttime; dryness, foamy spots on eyes (Bitot's spots)	Vitamin A	The eyes should appear bright with smooth cornea, along with pink and moist membranes. Rhodopsin, the eye pigment responsible for vision in dim light, along with tear production and debris removal, is vitamin A dependent.
	Palpate the eye for dryness, and cracks	Itching, burning, corneal inflammation	Riboflavin and niacin	
		Pallor conjunctiva; yellowish icterus	Iron, folate, B_{12}	
			Carotene or bilirubin in excess	
Extra/intraoral cavity	Inspect the lips and corners of the mouth and inside the oral cavity: tongue, gums, and papillae	Corners of the mouth are swollen (angular stomatitis) and vertical cracks of the lips (cheilosis)	B-complex vitamins (riboflavin, niacin, vitamin B_6)	The extraoral cavity should be without cracks and sores, appearing smooth in color. The intraoral cavity should appear free of swelling around the gum and tongue. B-complex vitamins and vitamin C aid in cellular synthesis, function, and integrity, and deficiencies of these micronutrients can affect cellular turnover and collagen synthesis in the oral cavity. Anemia can cause low hemoglobin levels, resulting in pallor coloring within the mucous membrane.
		Magenta color, beefy red tongue (glossitis) and atrophied papillae	Riboflavin, niacin, folate, B_{12}, iron, protein	
		Pallor and generalized inflamed mucosa	Iron, B_{12}, folate, B-complex	
		Bleeding gums and poor dentition	Vitamin C	
		Distorted or diminished taste (hypogeusia)	Zinc	
Neck/chest	Inspect and palpate the neck and chest	Distended neck veins	Fluid overload	Not necessarily part of micronutrient deficiencies assessment; however, this region of the body can provide information regarding muscle and fluid status.
		Enlarged thyroid	Iodine	
		Muscle and fat wasting with prominent bony chest region	Calorie and protein depletion	
Musculoskeletal/ lower extremities	Inspect and palpate arm, finger, wrist, shoulder, legs for range of motion, swelling and ankles for fluid accumulation	Poor muscle control (ataxia), numbness/ tingling	Thiamine, B_{12}, copper	Generalized muscle mass, strength, stability, movement, and balance can be assessed via various functional tests (eg, handgrip, gait speed, and bioelectrical impedance analysis). Edema rating scale can be used to assess fluid accumulation along with skin turgor test.
		Swollen and painful joints; epiphyses at wrist	Vitamins C and D	
		Rickets, knock knees, bowleg	Vitamin D, calcium	

Figure 2. Hyerkeratosis (a) and perifollicular-based hemorrhage with red to purple spots (b) (petechiae and purpura) are physical findings related to vitamin C deficiency. Reprinted with permission from Walters RW, Grichnik JM. Follicular hyperkeratosis, hemorrhage, and corkscrew hair. *Arch Dermatol*. 2006;142:658.

Figure 3. Pellagrous dermatitis related to niacin deficiency. Adapted with permission from Ashouria N, Mousdicas N. Pellegra like-dermatitis. *N Engl J Med*. 2006;354(15):1614.

absence or increase of zinc intake.[28] Zinc deficiency can affect hair and nails as well, as zinc is mostly found in skeletal muscle vs plasma. Other manifestations of zinc deficiency include diarrhea, depression, depressed immune function, decreased appetite, and impaired taste. These changes can appear in a relatively short period of time in the presence of low serum zinc levels.[26]

Nails

Inspection and palpation of the nail should be performed to assess for color, capillary refill, and texture. The nail plate gets its pink color from the vascular nail bed, to which the nail plate is firmly attached.[31] If the color of the nail bed changes to either a whitish or bluish hue, anemia or cyanosis may be present. Capillary refill time is a short test done by pressing on the nail bed to see if the pinkish color returns within 2 seconds. Slow capillary refill of greater than 2 seconds may indicate impaired peripheral vascular flow or dehydration. Texture changes of thinness, brittleness, and rigidity can relate to iron deficiency anemia and to suboptimal dietary protein. The nail will appear concave and flat, similar to a spoon-shaped fingernail. This condition is known as koilonychias.[26] Iron deficiency can develop due to inadequate intake, increased demand, impaired absorption, and/or drug and nutrient interactions.[25] A diagnosis of iron deficiency based on biochemical data can be challenging, as iron depletion occurs in stages, and hematologic indices (eg, serum ferritin, hemoglobin, hematocrit, mean corpuscular volume) may not indicate iron depletion until the last stage. Early functional and physiologic consequences can occur prior to the diagnosis of iron deficiency anemia; however, physical changes may become prevalent as iron deficiency anemia progresses. Also, excessive dryness, darkened nails, and rounded or curved nail ends can be a clinical finding of vitamin B_{12} deficiency.[35]

Hair/Head

Inspection and palpation of the head, scalp, and hair should be performed to assess for quantity, distribution, and texture. Looking for hair loss and diffuse and/or patchy areas on the scalp and head may assist in assessing hair quality. These physical findings can relate to protein deficiencies or malnutrition, as well as biotin and zinc deficiency. The water-soluble vitamin biotin is needed for hair growth and can relate to the clinical finding of sparse hair (alopecia). Furthermore, the physical finding of corkscrew hair at the base of the follicle is indicative of vitamin C deficiency (Figure 4). Little is known about the role of vitamin C in the hair follicle, but it is speculated that the hairs actively cycling during the lowest ascorbic acid levels are the ones that experience hair shaft and hemorrhagic complications.[32]

Eyes

The most readily recognized symptom of vitamin A deficiency is excessively dry eyes (xeropthalmia). During the patient interview, note if changes in night vision, dryness, and/or inability to produce tears are physical findings mentioned. The most common consequence of vitamin A deficiency is night blindness and the presence of foamy, superficial patches on the bulbar conjunctiva known as Bitot's spots.[18–20] Cornea softening (kerotomalacia) around the eye lens can appear in the late,

Figure 4. Corkscrew hair at the base of the follicle is indicative of vitamin C deficiency. Reprinted with permission from Walters RW, Grichnik JM. Follicular hyperkeratosis, hemorrhage, and corkscrew hair. *Arch Dermatol*. 2006;142:658. Copyright © 2006 American Medical Association. All rights reserved.

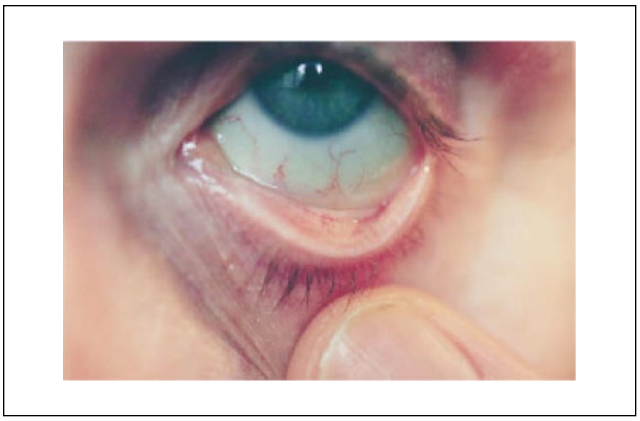

Figure 5. Conjunctiva that appears pale in color compared with a pink hue indicates iron deficiency. Reprinted with permission from Sheth TN, Detsky AS. The relation of conjunctival pallor to the presence of anemia. *J Gen Intern Med*. 1997;12(2):102-106.

more severe stage of vitamin A deficiency prior to blindness. This physical finding would appear in the medical history, as the RDN is unable to diagnose this medical condition. If any of these physical findings are present, blood tests (assessed by serum retinol or retinol binding protein) can determine if a possible VAD is present. Last, a penlight can be used to inspect the eyes for color changes in the conjunctiva and sclera to assess for the appearance of pallor compared with a pink hue (Figure 5), which can be indicative of iron deficiency.[36]

Mouth

Vitamin and mineral deficiency can manifest within the oral cavity in a relatively short period of time because of the 3- to 7-day turnover rate of most oral mucosal cells.[37] However, cellular changes can also occur from periodontal disease, infections, viruses, and injury or trauma and should also be considered when noting physical changes in the oral cavity.[37,38] Inspection and palpation are used when assessing and examining the mouth, lips, mucosal lining, gums, and tongue. Observe and assess for color, cracking, texture, moisture, and lesions. Often, physical signs of bilateral cracks and redness at the corners of the lips/mouth (angular fissures/stomatitis) can signify B-complex vitamin deficiencies (riboflavin, niacin, vitamin B_6, and iron).[37,38] Also, the appearance of dry, swollen, ulcerated lips (cheilosis) can occur as a result of inadequate riboflavin and niacin, which is also noted in Figure 3. Each of these vitamins is involved in maintaining optimal cell function and integrity, and deficiency of one B-complex vitamin can affect the possible risk of another. For example, riboflavin enzymes are involved in the metabolism of niacin, folate, and vitamin B_{12}, and riboflavin deficiency can perpetuate the deficiency of these other B-vitamins.[20] Color changes of magenta can signify riboflavin, niacin, and folate deficiencies while pallor can relate to iron and vitamin B_{12} deficiencies associated with the lips and tongue. A beefy, red tongue (glossitis) and atrophied papillae can be noticeable findings as well in these micronutrient deficiencies.[30] The physical finding of inflammation inside the intraoral mucosa and gums can be related to vitamin C deficiency and likely occurs in patients who have delayed wound healing, medical and surgical stress, and poor intake and GI malabsorption. Last, if changes in taste and dryness are reported, the possibility of a zinc deficiency can be investigated, since zinc deficiency can affect cellular structure and regulatory functions.[25] Other possible causes (disease related and pharmacologic) of vitamin deficiencies in the oral cavity are beyond the scope of this article and can be referenced elsewhere.[38]

Neck/Chest and Musculoskeletal

This region of the body may not be commonly associated with micronutrient deficiencies, but the following are physical findings that may be noted when performing the NFPA. In the neck area, the presence of venous distention along the carotid arteries can be a physical finding related to fluid status (volume overload). The assessment of iodine status is noted via physical examination of the neck since an anterior mass may be indicative of an enlarged thyroid relating to iodine deficiency, but this would also be confirmed through biomarker testing.

Assessment of functional status and changes in musculoskeletal can be included in the nutrition assessment using the following measurement approaches: muscle mass (bioelectric impendence analysis), muscle strength (handgrip strength), and physical performance (gait speed).[11,39] These tests are usually performed in determining sarcopenia and malnutrition, mostly relating to macronutrient deficiencies. Furthermore, visual inspection and rating of muscle groups around the following areas are used when assessing for malnutrition: clavicles, shoulders, scapula, interosseous, thigh, and calf regions.[11]

Table 4. Steps to Performing a Basic NFPA.[22,31]

Step[a,b]	Description[c]
General survey	Overall appearance—alertness, demeanor, facial expression, body habitus, and size (eg, wasting, cachectic, obese).
Skin	Inspect the entire skin surface in good light and throughout the exam. Observe for color: hyper/hypopigmentation; redness, pallor, cyanosis, yellowing. Assess for moisture (dryness/sweating), texture (roughness and smoothness), temperature, lesions, and turgor.
Head/hair	Inspect the scalp and hair for quantity, distribution, texture, color, easily plucked. While palpating the head assess and rate temporalis muscle.
Eyes	Ask if changes in dryness or night vision are noted. Observe the color of sclera and conjunctiva, and inspect the cornea for white foamy spots. Assess fullness and color around the orbital region.
Mouth	Observe for moisture, swelling, color, dentition, lesions around the extra/intraoral cavity—lips, corners of the mouth, tongue, mucous membrances, gums, and teeth. Ask if taste changes are present.
Neck/upper body	Inspect the neck for venous distention or masses. Assess for muscle and subcutaneous fat loss in these regions: clavicles, shoulders, scapula, fat overlying the ribs, and triceps.
Hand/nails	Inspect the hand and nails for color, texture, shape, and lesions. Palpate the interosseous muscle for fullness and distribution.
Musculoskeletal/ lower extremity	Observe overall muscle appearance—ask if strength/movement, swollen or painful joints are present. Observe for bowlegs and/or knocked knees; inspect and palpate the shape and size of quadricep and calf muscles; rate fluid accumulation around ankles with edema rating scale.

[a]Inspection and palpation are used in the steps of the nutrition-focused physical assessment. The order can be subject to the clinician's preference.
[b]Vitals and abdominal assessment can also be incorporated in the steps above.
[c]The use of disposable gloves and penlight is suggested during the examination.

A common reported finding due to micronutrient deficiency is an uncoordinated gait (ataxia) seen in thiamine and copper deficiencies. Thiamine deficiency is possible in malabsorption disorders, weight loss surgeries, inadequate intake, and in those with recurrent vomiting.[12,15,16] Alcoholics are at great risk for thiamine deficiency since the alcohol impairs thiamine absorption and increases excretion in the urine, leading to the risk of severe thiamine deficiency called Wernicke-Korsakoff syndrome—disorientation, loss of memory, and staggering gait.[12,18,19]

In addition, swollen and painful joints, rickets, and bowlegs can be related to the following vitamin deficiencies, respectively: vitamin C, vitamin D, and calcium. Adequate dietary calcium and vitamin D are commonly required throughout the life cycle, and deficiency can affect bone health, physical performance, mobility, and risk for fall and fractures.[12,26-27]

Surveillance of micronutrient deficiencies is incorporated into the NFPA, allowing practitioners to relate physical findings to possible nutrition-related problems. The steps to incorporate micronutrient assessment along with the assessment and examination of macronutrient deficiencies when identifying malnutrition are outlined in Table 4.

Summary

The global effort in recognizing, diagnosing, and treating malnutrition, along with reimbursement for related care, requires that all healthcare providers become more vigilant and proactive in providing successful recognition and intervention to prevent and/or delay malnutrition in all care settings.[40] Physicians, nurses, and other health professionals use physical examination within patient care to assess and diagnose medical diseases/conditions, and RDNs can use NFPA to provide yet another layer of unique data to evaluate nutrition-related problems and plan more effective nutrition interventions as a result of these data. NFPA techniques take into consideration factors such as overt physical signs of nutrition deficiencies of macro/micronutrients when employing a head-to-toe physical assessment and examination.

Furthermore, with healthcare reimbursement being reduced, clinicians will need to exhibit nutrition care plans that show cost-saving measures. The impetus of incorporating the NFPA into dietetic practice, which is recognized within the scope of practice of RDNs, comes from using the NCPM, as well as the need to expand professionals skills to be competitive in an evolving healthcare environment.[41–44] Incorporating the NFPA into dietetics education and supervised practice and internships, along with training current practitioners in the field, will elevate the role of the RDN in the diagnosis and treatment of nutrition-related problems. This will promote the acceptance of physical assessment skills as a standard of practice among all dietetic practitioners. Most important, performance of NFPA as part of nutrition assessment can enhance patient trust and satisfaction, aid in reimbursement, and direct nutrition-specific outcomes, all contributing to the value and professional recognition of the RDN.[45]

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References

1. Hammond MI, Myers EF, Trostler N. Nutrition care process and model: an academic and practice odyssey. *J Acad Nutr Diet*. 2014;114(12): 1879-1894.
2. Butterworth CE Jr. The skeleton in the hospital closet. *Nutr Today*. 1974;9:4-8.
3. Mullen JL, Gertner MH, Buzby GP, Goodhart GL, Rosato EF. Implications of malnutrition in the surgical patient. *Arch Surg*. 1979;114:121-125.
4. Baker JP, Detsky AS, Wesson DE, et al. Nutrition assessment: a comparison of clinical judgment and objective measurement. *N Engl J Med*. 1982;306(16):969-974.
5. Detsky AS, McLaughlin JR, Baker JP, et al. What is subjective global assessment of nutritional status? *JPEN J Parenter Enteral Nutr*. 1987;11(1):8-13.
6. Bauer J, Capra S, Ferguson M. Use of the scored patient-generated subjective global assessment (PG-SGA) as a nutrition assessment tool in patient with cancer. *Eur J Clin Nutr*. 2002;56:779-785.
7. Wakahara T, Shiraki M, Murase K, et al. Nutritional screening with subjective global assessment predicts hospital stay in patients with digestive disease. *Nutrition*. 2007;23:634-639.
8. Steiber A, Leon JB, Secker D, et al. Multicenter study of the validity and reliability of subjective global assessment in the hemodialysis population. *J Ren Nutr*. 2007;17:336-342.
9. Shenkin A. Serum prealbumin: is it a marker of nutritional status or of malnutrition? *Clin Chemistry*. 2006:52(12):2177-2128.
10. Fuhrman P, Charney P, Mueller CM. Hepatic proteins, and nutrition assessment. *J Am Diet Assoc*. 2004;104:1258-1264.
11. White J, Guenter P, Jensen G, et al. Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identifications and document of adult malnutrition (undernutrition). *J Acad Nutr Diet*. 2012;112:730-773.
12. Mozaffarian D. *The Truth About Vitamins and Minerals: Choosing the Nutrient You Need to Stay Healthy*. Boston, MA. Harvard Medical School; 2010.
13. Yetley E. Multivitamin and multimineral dietary supplements: definitions, characterization, bioavailability, and drug interactions. *Am J Clin Nutr*. 2007;85(suppl):269S-276S.
14. A.S.P.E.N. Parenteral nutrition trace element product shortage considerations. *Nutr Clin Pract*. 2014;29(2):249-251.
15. Saltzman E, Karl JP. Nutritional deficiencies after gastric surgery. *Annu Rev Nutr*. 2013;33:183-203.
16. Soleymani T, Tejavanija S, Morgan S. Obesity, bariatric surgery, and bone. *Curr Opin Rheumatol*. 2011;23:396-405.
17. Amagai T, Ichimaru S, Tai M, Ejiri Y, Muto A. Nutrition in the greater East Japan earthquake disaster. *Nutr Clin Pract*. 2014;29(5):585-594.
18. Clark SF. Vitamins and trace elements. In: Mueller CM, ed. *The A.S.P.E.N. Adult Nutrition Support Core Curriculum*. 2nd ed. Silver Spring, MD: American Society for Parenteral and Enteral Nutrition; 2012:121-151.
19. Vanek VW, Borum P, Buchman A, et al. A.S.P.E.N. position paper: recommendations for changes in commercially available parenteral multivitamin and multi-trace elements products. *Nutr Clin Pract*. 2012;27(4):440-491.
20. Kupka R, Villamor E, Fawzi W. Vitamins. In: Duggan C, Watkins JB, Walker WA, eds. *Nutrition in Pediatrics*. Shelton, CT: People's Medical Publishing House; 2009:99-114.
21. Fuhrman MP, Parker M. Micronutrient assessment. *Support Line*. 2004;26(1):17-24.
22. Practice paper of Academy of Nutrition and Dietetics: critical thinking of nutrition assessment and diagnosis. 2013. www.eatright.org/members/practicepapers. Accessed January 6, 2015.
23. Academy of Nutrition and Dietetics. Nutrition care process terminology reference manual (eNCPT). http://ncpt.webauthor.com. Accessed December 1, 2014.
24. Lacey K, Pritchett E. Nutrition care process and model ADA adopts road map to quality care and outcomes management. *J Am Diet Assoc*. 2003;103(8):1061-1072.
25. Caballero B. International nutrition. In: Duggan C, Watkins JB, Walker WA, eds. *Nutrition in Pediatrics*. Shelton, CT: People's Medical Publishing House; 2009:121-126.
26. Montgomery SC, Streit SM, Beebe ML, Maxwell PJ. Micronutrient needs of the elderly. *Nutr Clin Pract*. 2014;29(4):435-444.
27. Litchford Demarest M. Counteracting the trajectory of frailty and sarcopenia in older adults. *Nutr Clin Pract*. 2014;29:428-434.
28. Heron M. *Deaths: Leading Causes for 2010*. National Vital Statistics Reports. Hyattsville, MD: National Center for Health Statistics; 2013.
29. Otten JJ, Hellwig JP, Meyers LD, eds. *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington, DC: National Academies Press; 2006.
30. Lee RD, Nieman DC. *Nutritional Assessment*. 6th ed. New York, NY: McGraw-Hill; 2013.
31. Bickley LS. *Bates' Guide to Physical Examination and History Taking*. 10th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2009.
32. Walters RW, Grichnik JM. Follicular hyperkeratosis, hemorrhage, and corkscrew hair. *Arch Dermatol*. 2006;142:658.
33. Misra S, Kirby DF. Micronutrient and trace element monitoring in adult nutrition support. *Nutr Clin Pract*. 2000;15:120-126.
34. Ashouria N, Mousdicas N. Pellegra like-dermatitis. *N Engl J Med*. 2006;354(15):1614.
35. Wikipedia. Nail. http://en.wikipedia.org/wiki/Nail_(anatomy). Accessed January 17, 2015.
36. Sheth TN, Detsky AS. The relation of conjunctival pallor to the presence of anemia. *J Gen Intern Med*. 1997;12(2):102-106.
37. Tougher-Decker R, Mobley C. Position of the academy of nutrition and dietetics: oral health and nutrition. *J Acad Nutr Diet*. 2013;113:693-701.
38. Rigassio Radler D, Lister R. Nutrient deficiencies associated with nutrition-focused physical findings of the oral cavity. *Nutr Clin Pract*. 2013;28:710-721.
39. Beasley JM, Skikany JM, Thomson CA. The role of dietary protein intake in the prevention of sacropenia of aging. *Nutr Clin Pract*. 2013;28:684-690.
40. de van der Schueren M, Elia M, Gramlich L, et al. Clinical and economic outcomes of nutrition interventions across the continuum of care. *Ann Acad Sci*. 2014;1321:20-40.
41. Academy of Nutrition and Dietetics. Scope of practice in nutrition and dietetics. *J Acad Nutr Diet*. 2013;113(6):S11-S16.
42. Kidd JL, Radler DR, Brody RA, Parrott JS. Nutrition focused physical assessment (NFPA) teaching practices in Accreditation Council for Education in Nutrition and Dietetics (ACEND)–accredited dietetic internships and coordinated programs (DIs/CPs). *J Acad Nutr Diet*. 2012;112(9):A23.
43. Stankorb S, Rigassio-Radler D, Hafiz K, Touger-Decker R. The professional practices of nutrition focused physical examination among registered dietitians. *J Am Diet Assoc*. 2009;109(9):A9.
44. Ward B, Rogers D, Mueller C, Touger-Decker R, Sauer KL. Distinguishing entry-level RD and DTR practice: results for the 2010 commission on dietetic entry-level dietetics practice audit. *J Am Diet Assoc*. 2011;111(11):1756-1761.
45. Cobb B, Hardin E, Click A, Watcom L. Customizing malnutrition documentation accelerates hospital revenue and RD value. *J Am Diet Assoc*. 2011;111(9):A77.