

The Role of Nutrition for Pressure Injury Prevention and Healing: The 2019 International Clinical Practice Guideline Recommendations

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GENERAL PURPOSE: To review the nutrition-related recommendations presented in the 2019 European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel, and Pan Pacific Pressure Injury Alliance *Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline* with further discussion of nutrition for pressure injury management in the context of the recommendations.

TARGET AUDIENCE: This continuing education activity is intended for physicians, physician assistants, nurse practitioners, and nurses with an interest in skin and wound care.

LEARNING OBJECTIVES/OUTCOMES: After participating in this educational activity, the participant should be better able to:

1. Distinguish nutrition and malnutrition, especially as they relate to the development and healing of pressure injuries.
2. Differentiate the tools and techniques that help clinicians assess nutrition status as well as the causes of pressure injuries in specific populations.
3. Identify interventions for improving nutrition status and promoting pressure injury healing.

ABSTRACT

Macro- and micronutrients are required by each organ system in specific amounts to promote the growth, development, maintenance, and repair of body tissues. Specifically, nutrition plays an important role in the prevention and treatment of pressure injuries. The purpose of this manuscript is to review the nutrition-related recommendations presented in the 2019 European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel, and Pan Pacific Pressure Injury Alliance *Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline*. Nutrition for pressure injury management is discussed in the context of the recommendations.

KEYWORDS: assessment, clinical practice guidelines, evidence, malnutrition, nutrition, pressure injury, screening

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INTRODUCTION

Nutrition plays an important role in the prevention and treatment of pressure injuries (PIs). Macro- and micronutrients are required by each organ system in specific amounts to promote growth, development, maintenance, and repair of body tissues. The 2019 European Pressure Ulcer Advisory Panel (EPUAP), National Pressure Injury Advisory Panel (NPIAP), and Pan Pacific Pressure Injury Alliance (PPPIA) *Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline* (EPUAP/NPIAP/PPPIA CPG) provides guidance on the prevention and management of PIs.¹ This guideline was a collaboration between the EPUAP, NPIAP, and PPPIA with the assistance of 14 associate organizations. The goal of this international collaboration was to provide an updated, comprehensive review of the research literature and develop recommendations reflecting recent evidence. The intent is for health professionals around the world to use the recommendations generated to prevent and treat PI.

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The purpose of this article is to review the nutrition-related recommendations presented in the EPUAP/NPIAP/PPPIA CPG, and to discuss nutrition for PI management in the context of the recommendations. The recommendations were developed using a rigorous methodology outlined in the guideline in print and online (internationalguideline.com). Each recommendation includes a list of implementation considerations. Table 1 presents the nutrition-related recommendations from the EPUAP/NPIAP/PPPIA CPG, including the strengths of evidence and assigned

recommendations. With the recommendations presented in Table 1 in mind, this article will discuss the underpinning research and the context in which the recommendations are implemented in the nutritional management of individuals with or at risk of PIs.

NUTRITION AS A RISK FACTOR FOR PRESSURE INJURIES

A large body of prognostic research has reported on the influence of impaired nutrition on the risk of PI in adults. As reported in the EPUAP/NPIAP/PPPIA CPG, of 50

Table 1. 2019 INTERNATIONAL GUIDELINE NUTRITION RECOMMENDATIONS

The strength of evidence (SoE) ratings used in this table are defined as follows: B1, level 1 studies of moderate or low quality providing direct evidence, level 2 studies of high or moderate quality providing direct evidence, and/or most studies have consistent outcomes and inconsistencies can be explained; B2, level 2 studies of low quality providing direct evidence, level 3 or 4 studies (regardless of quality) providing direct evidence, and/or most studies have consistent outcomes and inconsistencies can be explained; C, level 5 studies (indirect evidence) and/or body of evidence with inconsistencies that cannot be explained, reflecting genuine uncertainty; and Good Practice Statements (GPSs; statements that are not supported by a body of evidence but considered by the Guideline Governance Group to be significant for clinical practice). The strength of recommendation (SoR) ratings are as follows: ↑↑, strong positive recommendation: definitely do it; ↑, weak positive recommendation: probably do it.

No. ^a	Recommendation	SoE, SoR, or GPS ^b
1.10	Consider the impact of impaired nutritional status on the risk of pressure injuries.	SoE = C; SoR = ↑
4.1	Conduct nutritional screening for individuals at risk of a pressure injury.	SoE = B1; SoR = ↑↑
4.2	Conduct a comprehensive nutrition assessment for adults at risk of a pressure injury who are screened to be at risk of malnutrition and for all adults with a pressure injury.	SoE = B2; SoR = ↑↑
4.3	Develop and implement an individualized nutrition care plan for individuals with, or at risk of, a pressure injury who are malnourished or who are at risk of malnutrition.	SoE = B2; SoR = ↑↑
4.4	Optimize energy intake for individuals at risk of pressure injuries who are malnourished or at risk of malnutrition.	SoE = B2; SoR = ↑
4.5	Adjust protein intake for individuals at risk of pressure injuries who are malnourished or at risk of malnutrition.	GPS
4.6	Provide 30 to 35 kcalories/kg body weight/day for adults with a pressure injury who are malnourished or at risk of malnutrition.	SoE = B1; SoR = ↑
4.7	Provide 1.25 to 1.5 g protein/kg body weight/day for adults with a pressure injury who are malnourished or at risk of malnutrition.	SoE = B1; SoR = ↑↑
4.8	Offer high-calorie, high-protein fortified foods and/or nutritional supplements in addition to the usual diet for adults who are at risk of developing a pressure injury and who are also malnourished or at risk of malnutrition, if nutritional requirements cannot be achieved by normal dietary intake.	SoE = C; SoR = ↑
4.9	Offer high-calorie, high-protein nutritional supplements in addition to the usual diet for adults with a pressure injury who are malnourished or at risk of malnutrition, if nutritional requirements cannot be achieved by normal dietary intake.	SoE = B1; SoR = ↑↑
4.10	Provide high-calorie, high-protein, arginine, zinc and antioxidant oral nutritional supplements or enteral formula for adults with a Category/Stage II or greater pressure injury who are malnourished or at risk of malnutrition.	SoE = B1; SoR = ↑
4.11	Discuss the benefits and harms of enteral or parenteral feeding to support overall health in light of preferences and goals of care with individuals at risk of pressure injuries who cannot meet their nutritional requirements through oral intake despite nutritional interventions.	GPS
4.12	Discuss the benefits and harms of enteral or parenteral feeding to support pressure injury treatment in light of preferences and goals of care for individuals with pressure injuries who cannot meet their nutritional requirements through oral intake despite nutritional interventions.	SoE = B1; SoR = ↑
4.13	Provide and encourage adequate water/fluid intake for hydration for an individual injury, when compatible with goals of care and clinical conditions.	GPS
4.14	Conduct age appropriate nutritional screening and assessment for neonates and children at risk of pressure injuries.	GPS
4.15	For neonates and children with or at risk of pressure injuries who have inadequate oral intake, consider fortified foods, age appropriate nutritional supplements, or enteral or parenteral nutritional support.	GPS
22.2	Provide pressure injury education, skills training and psychosocial support to individuals with or at risk of pressure injuries.	SoE = C; SoR = ↑

^aFor ease of reference, the recommendation number published in the Clinical Practice Guideline has been used.

^bAs published in the Clinical Practice Guideline.

Adapted with permission from the European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel, and Pan Pacific Pressure Injury Alliance.



prognostic studies reporting multivariable analyses that included at least one measure of nutrition status, 40% identified a measure of nutrition as a significant predictor of PIs. This suggests there is a moderate statistical association between nutrition status and developing a PI. The EPUAP/NPIAP/PPPIA CPG recommends providers consider the impact of impaired nutrition status on the risk of PI (Table 1).¹ Impaired nutrition has not been included in pediatric PI risk factor studies to date; however, it is reasonable to assume that this guideline recommendation is also relevant to neonates and children.

The research on PI risk factors reports a wide selection of measures that can be used to identify impaired nutrition, including food intake, a medical diagnosis of malnutrition, skin fold thickness, arm circumference, weight, body mass index (BMI), nutrition assessment scales, and so on. Some of these measures are included in nutrition screening tools and have been validated as predictors of impaired nutrition.²⁻⁴ However, there is low consistency regarding the significance of these outcome measures as positive predictors for PI. For example, “food intake” was reported as significant in only 46.7% of studies that included that measure in a multivariate analysis.⁵⁻¹⁹ There are numerous contextual considerations and limitations to this prognostic research. The variability in research quality, choice of other outcomes, and the number of participants all influence the results. Few studies had an adequate number of participants with extremely low or high weights/BMIs in the sample.

Translating research into clinical practice requires clinical judgment informed by knowledge of the literature.¹ When undertaking a PI risk assessment, the use of clinical judgment that considers the individual’s overall presentation and the significance of that individual’s nutrition status is required. For example, if an individual presents with other risk factors considered highly predictive of PI risk (eg, immobility), and the individual’s clinical condition is vulnerable, nutrition should be considered when assessing that individual’s PI risk.^{1,20,21}

Nutrition status is included on most of the commonly used PI risk assessment tools, including those for specific populations such as pediatric or critically ill patients.^{20,22-26} In prognostic studies, nutrition assessment scales were not significantly predictive of PIs. Only one of 16 (6.3%) reported a nutrition assessment scale as a significant factor in a multivariate analysis.¹⁸ In that study, data from 170 participants recruited prospectively in a private hospital were analyzed. From 16 factors included in the predictive model, five were statistically significant, including scores on the Subjective Global Nutrition Assessment ($P < .001$).¹⁸ However, when used as a part of an overall structured PI risk assessment in conjunction with clinical judgment, findings from a PI risk scale can guide nutrition (and other) care planning.

Malnutrition

Malnutrition involves several disorders that include undernutrition, obesity, and abnormal micronutrient levels. Other nutrition-related disorders that impact an individual’s nutrition status include frailty, sarcopenia, and cachexia, which have multifaceted pathogenic origins.²⁷ The European Society for Parenteral and Enteral Nutrition (ESPEN) defines malnutrition as “a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease.”^{27,28}

Several organizations have defined criteria to diagnose malnutrition. Most recently, the Global Leadership Initiative on Malnutrition developed criteria to help identify malnutrition in adults in healthcare settings, consisting of three phenotype characteristics (weight loss, low BMI, decreased muscle mass) and two etiologic characteristics (decreased food intake or assimilation and disease burden/inflammation). The presence of one phenotype and one etiologic characteristic is required.²⁹ Table 2 outlines the malnutrition criteria used by different organizations.

Malnutrition and PIs. Meeting the body’s nutrition requirements is essential to promote health and well-being. Although the point at which inadequate nutrient intake affects skin integrity has not been defined, it is known that decreased acceptance of food and fluids/water and weight loss are associated with PIs. Also, insufficient nutrient intake and low body weight are both associated with impaired wound healing.^{5,30-35}

International research suggests there is a relationship between nutrition and PI prevalence. In the US, a study of 2,425 patients concluded that 76% of participants were malnourished.³⁶ An Australian study conducted in acute and long-term care settings found that, for adults with malnutrition, the odds ratio of developing a PI was 2.6 (95% confidence interval [CI], 1.8-3.5) in acute care settings, and 2.0 (95% CI, 1.5-2.7) in long-term care.³⁷ In Japan, a study by Iizaka et al³² examined the impact of nutrition on the development and severity of PIs in home care. The sample consisted of 290 patients with PIs and 456 patients without. Researchers reported the prevalence of malnutrition was higher in older adults with a PI.³² Similarly, a Belgian study found that the odds ratio of an older adult with a PI being malnourished was 5.02 (95% CI, 1.69-14.92; $P < .01$).³³

Malnutrition is a major health concern in community-dwelling older adults. A meta-analysis analyzing data from 111 studies conducted in 38 countries ($n = 69,702$) reported that malnutrition ranges from 0.8% in Northern Europe to 24.6% in Southeast Asia. In this systematic review, older adults receiving home care had the highest prevalence of malnutrition (14.6%). It was also more prevalent in rural versus urban communities (9.9% and 5.7%, respectively).³⁸

Table 2. DIAGNOSTIC CHARACTERISTICS FOR MALNUTRITION

Characteristic	ASPEN/Academy of Nutrition and Dietetics		
	Dietetics	ESPEN	GLIM
Unintended weight loss	X		X
Low body mass index		X	X
Loss of muscle mass	X		X
Loss of subcutaneous fat	X	X	
Localized or generalized fluid accumulation	X		
Decreased functional status	X		
Reduced food intake or assimilation	X		X
Disease burden/inflammation			X
At risk per validated screening tool		X	
	Two of the six characteristics must be present	Once the person is deemed at risk by a validated screening tool, one of the other two items must be present.	One phenotype and one etiologic characteristic must be present

Abbreviations: ASPEN, American Society for Parenteral and Enteral Nutrition; ESPEN, European Society for Parenteral and Enteral Nutrition; GLIM, Global Leadership Initiative on Malnutrition. Sources: White JV, Guenter P, Jensen G, et al. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). *J Parenter Enteral Nutr* 2012;36(3):275-83. Cederholm T, Jensen GL, Correia MITD, et al.²⁹

Undernutrition. Decreased intake of calories, protein, vitamins, and minerals is commonly seen in individuals with malnutrition, which is often associated with undernutrition. This results in unplanned and undesired weight loss, protein-calorie malnutrition, decreased BMI, reduced muscle mass, and dehydration, all of which are linked to PIs.^{39,40} Unplanned or involuntary weight loss is considered a major risk factor for both malnutrition and PI development.⁴¹

Overnutrition/Obesity. Overnutrition is a form of malnutrition in which the amount of nutrients consumed exceeds the amount of nutrients needed to support growth,

development, and metabolism. Overnutrition can result in individuals becoming overweight and obese. In 2013, the American Medical Association acknowledged obesity as a disease that should be medically treated.⁴²

In the US, the rate of obesity has reached epidemic proportions. The CDC reported its prevalence was 39.8% in 2015 and 2016.⁴³ Obesity has been linked to health conditions such as cardiovascular disease, diabetes, cancer, hypertension, dyslipidemia, respiratory problems, and impaired wound healing.⁴³

Comorbidities such as skin infection, dehiscence, PIs, and venous ulcers are common in obese individuals. These conditions occur because of hypoperfusion and ischemia in subcutaneous adipose tissue. Hypovascularity also contributes to the prevalence of PIs in patients who are obese.⁴⁴ The decreased mobility and difficulty with self-repositioning often associated with individuals who are obese or extremely obese further increase the risk of PI development. Microorganisms that are attracted to the moist environment created by skin folds contribute to infections and tissue injuries.⁴⁴

NUTRITION SCREENING

This is defined as “the process of identifying patients, clients, or groups who may have a nutrition diagnosis and benefit from nutrition assessment and intervention by a registered dietitian nutritionist.”⁴⁵ Recognizing that nutrition screening helps to identify and treat malnutrition in patients with or at risk for a PI, the EPUAP/NPUAP/PPPIA CPG recommends it for all individuals at risk of a PI (Table 1). Any member of the interdisciplinary team who has been educated on screening tools can use them, and screening can be conducted in any practice setting.⁴⁶ A validated screening tool can determine nutrition risk in all types of patients, including those with fluid shifts and for whom weight and height cannot be easily obtained.^{47,48} Validated tools should be quick and easy to use, reliable and valid, economical, of low risk to the individual being screened, and appropriate for the population and care setting.

Nutrition screening and rescreening should be conducted in accordance with the mandates outlined by accrediting bodies and a healthcare facility’s internal policies. In acute care facilities in the, nutrition screening is conducted within 24 hours of admission. Information collected through the screen is used by a registered dietitian nutritionist (RDN) to identify patients whose nutrition concerns warrant further assessment. In long-term postacute care, nutrition screening is completed at regular intervals based on the Minimum Data Set regulations. In all care settings, communication with the RDN is essential to determine appropriate intervention(s) and discuss opportunities to improve patient outcomes.

Many nutrition risk screening parameters are common in assigning risk level. These include height and weight,



unintentional weight changes, changes in intake/appetite, lifestyle habits (physical activity, tobacco use), gastrointestinal disorders, and medical history. Laboratory data are not used in traditional nutrition screens, and serum proteins such as albumin and prealbumin are not endorsed for nutrition screening.⁴⁹ There is no association between increased or decreased protein intake and changes in these markers. As a result, nutrition screening or assessment based on serum protein levels is not recommended.⁴⁶

Nutrition Screening Tools

Common nutrition screening instruments include the Mini Nutritional Assessment (MNA), Malnutrition Universal Screening Tool, Nutrition Risk Screening 2002, and the Short Nutritional Assessment Questionnaire.^{3,47,48,50-55} All of these screening tools have been validated for identifying nutrition risk.

For example, Grattagliano and colleagues⁵⁰ used the MNA to screen 274 patients 75 years or older in four towns in Southern Italy. They concluded that the easy-to-use screen allowed the four general practitioners involved in the study to quantify the risk for major events. Early identification of impaired nutrition status allowed for the timely development and implementation of interventions.⁵⁰ Further, a prospective cohort study of 471 patients admitted to a medical center in Helsinki concluded that decreased nutrition status, as measured by the Malnutrition Universal Screening Tool score (OR, 3.825; 95% CI, 1.730-8.455; $P = .001$), is one of the best predictors for the development of PIs in older adults.⁵⁶ Finally, research data collected from 422 patients (average age, 85.0 ± 7.6 years) at a rural intermediate and acute care hospital in Japan imply that the MNA screen assisted in forecasting the development of PIs and that a score of less than 8 on the MNA is a better predictor for PIs than the Subjective Global Assessment, the Braden Scale, and plasma arginine levels. The results of these studies reinforce the need to conduct nutrition screens and assessments.⁵⁷

NEONATES AND CHILDREN

As indicated in several studies, neonates and pediatric patients are also at risk of developing PIs. Multicenter studies report PI prevalence estimates from 0.47% to 35%, with the highest rates occurring in ICUs.^{58,59} Schliuer and colleagues⁵⁹ estimated a 43% PI incidence in their neonatal ICU. Most pediatric PIs are facility acquired,⁶⁰ and medical devices account for the highest number of PIs in neonates and young children.^{58,61}

Pediatric PIs are also expensive. A study by Goudie et al⁶² reported the average cost for patients aged 1 to 4 years was \$20,000 per PI. This increased to \$85,803 when multiplied by the available prevalence and incidence data.⁶²

Pediatric malnutrition leads to complex hospital stays because of the complications from underlying diseases and conditions such as slow wound healing. In these patients, this contributes to increased hospital costs and length of stay.⁶³ The ASPEN defines pediatric malnutrition (undernutrition) as “an imbalance between nutrient requirement and intake, resulting in cumulative deficits of energy, protein or micronutrients that may negatively affect growth, development and other relevant outcomes.”⁶⁴ Many factors are involved in defining pediatric malnutrition including illness, injury, and adverse environmental or behavioral conditions. The Academy of Nutrition and Dietetics and ASPEN’s consensus statement on the indicators of pediatric malnutrition (undernutrition) for ages 1 month to 18 years recommends that a standardized set of diagnostic indicators be used to identify and document undernutrition in routine pediatric practice. The recommended indicators include z scores for weight for height/length, BMI for age, length/height for age, or mid-upper arm circumference when a single datum is available.⁶⁵ When two or more data points are available, indicators may also include weight gain velocity (<2 years of age), weight loss (2-20 years of age), deceleration in weight for length/height z score, and inadequate food nutrient intake.⁶⁵

Neonates and pediatric patients are at risk of compromised nutrient intake because of an increased nutrition requirement per unit weight to meet their normal growth needs, along with smaller appetites. Children at risk of and with PIs usually have other comorbidities that compromise their ability to consume adequate nutrients to promote and maintain wound healing.⁶⁶ Early nutrition screening and assessment are important to identify malnutrition risk and implement a care plan. The EPUAP/NPIAP/PPPIA CPG recommends providers conduct an age-appropriate nutritional screen and assessment for neonates and children at risk of PIs (Table 1).¹ There are various screening tools used for this population, including the Subjective Global Nutritional Assessment for Children, the Pediatric Nutritional Risk Score, the Screening Tool for the Assessment of Malnutrition in Pediatrics, Pediatric Yorkhill Malnutrition Score, and the Screening Tool for the Risk of Impaired Nutritional Status and Growth.

Growth assessment is the strongest gauge of nutrition status in pediatric patients and neonates. Anthropometric data including weight, height, growth scores, head circumference, and Z scores are used to determine if a neonate or child is developing according to established parameters. Z scores are the preferred nutrition assessment tool because they are more descriptive than growth charts.^{66,67}

As part of the nutrition assessment, the RDN may conduct a nutrition-focused physical examination to determine micronutrient deficiencies and signs of malnutrition. They should

conduct weekly nutrition assessments for critically ill children.^{68–70} The healthcare team, including the RDN and pediatrician, should devise an individualized nutrition plan for the pediatric patients, and it should include the mode of feeding, frequent monitoring of intake and growth status, oral supplements, nutrition support, and feeding strategies for parents and caregivers.^{67,71}

NUTRITION ASSESSMENT

The EPUAP/NPIAP/PPPIA CPG recommends the completion of a comprehensive nutrition assessment for adults at risk of PIs and malnutrition, as well as for all adults with a PI (Table 1).¹ A pre/post quasi-experimental design study conducted in Florida examined the use of an interprofessional nutrition protocol on 100 patients 60 years or older with Stage 2 and/or 3 PIs. This study concluded that conducting a nutritional assessment is linked to increased PI healing rates.⁷² Completing a nutrition assessment is a component of the Nutrition Care Process. Developed by the Academy of Nutrition and Dietetics and adopted by countries around the world, this process includes four basic steps: nutrition assessment, diagnosis, interventions, and plan monitoring and evaluation.

The nutrition assessment should be completed by an RDN in collaboration with the interprofessional nutrition team.⁷² The assessment includes the interpretation of anthropometric, biochemical, clinical, and dietary data.⁷³ Information obtained and analyzed should include food/nutrition-related history, biochemical data, medical tests and procedures, anthropometric measurements, nutrition-focused physical findings, and patient history.⁷³ The food/nutrition-related history domain includes assessment parameters such as food and nutrient intake, medication and complementary/alternative medication use, factors affecting food and nutrition supplies, and physical activity. Anthropometric measurements include height, weight, body frame, weight change, body mass, growth pattern indices, and body compartment estimates. Nutrition-focused physical findings include muscle and subcutaneous fat atrophy, oral health, swallowing function, and appetite. Patient history includes a personal, medical, social, and health history.⁷³

Body composition is an independent risk factor for malnutrition, sarcopenia, and associated comorbidities. Very often, patients who are overweight or obese are described in the medical records as “well nourished.” Taking a closer look at the body composition of these individuals over time can show decreased body mass, uncovering an increased risk for sarcopenic obesity. In addition, sarcopenia is also often present in (immobile) individuals with undernutrition.

Again, although they support the use of laboratory data such as albumin and prealbumin to establish the overall prognosis of the patient, these values are not

sensitive indicators of nutrition status. Serum protein levels can be affected by inflammation, renal function, hydration, and other factors.^{49,74–77}

NUTRITION CONSIDERATIONS FOR PREVENTION AND HEALING

The EPUAP/NPIAP/PPPIA CPG recommendation is to provide 30 to 35 kcal/kg of body weight per day for adults with a PI who are malnourished or at risk of malnutrition. The recommendation for protein is 1.25 to 1.5 g/kg of body weight per day.¹

Providing and consuming adequate kilocalories support collagen and nitrogen synthesis, thus promoting anabolism by sparing protein from being used as an energy source. Fat is the most concentrated source of calories, providing a reserve source of energy in the form of stored triglycerides in adipose tissue. It cushions bony prominences, provides insulation, and transports the fat-soluble vitamins A, D, E, and K, which are stored in the liver.

If the energy from carbohydrates and fat fails to meet the individual's needs, the liver and kidneys synthesize glucose from noncarbohydrate sources, such as protein. The body uses this released energy as fuel for anabolism, which increases the body's metabolic rate and caloric requirements. Wound healing is compromised if the body is forced to produce glucose by degrading protein and depleting lean body mass (LBM). The decline in LBM can lead to muscle wasting, decline in subcutaneous fat, and poor PI healing. Demling's⁷⁸ research noted that any loss of LBM is detrimental, but with a 20% loss, the competition between using protein to rebuild LBM and wound healing is equal, therefore slowing the healing process. This study recommended increasing energy intake 50% above the normal level and increasing protein to 1.5 g/kg of body weight.⁷⁸

Because there is no specific research on optimal caloric requirement to prevent PIs, the EPUAP/NPIAP/PPPIA CPG suggests that energy and protein intake be optimized for the individual. This should be done within the context of the individual's nutrition status (eg, current, usual, and goal weights) and clinical condition.

The EPUAP/NPIAP/PPPIA CPG also provides specific guidance on the energy needs of patients with PIs (Table 1). In a meta-analysis of observational studies, Cereda et al⁷⁹ reported that the use of indirect calorimetry to measure resting energy expenditure using a correction factor of 1.3 for physical activity (for individuals confined to bed) and a 1.1 PI correction factor adds to a total daily energy requirement of about 30 kcal/kg per day.⁷⁹ Ohura et al⁸⁰ reported that, in hospitalized older adults receiving tube feeding (n = 60), 12 weeks of nutrition support calculated using resting energy expenditure × activity factor 1.1 × stress factor 1.3 to 1.5 (mean intake, 37.9 ± 6.5 kcal/kg



per day) was associated with reduced PI size ($P < .001$) and depth ($P < .05$) compared with standard care (mean intake, 29.1 ± 4.9 kcal/kg per day).

The energy and protein needs of pediatric patients are also increased when they experience the metabolic stress of healing wounds. Their caloric and protein requirements should be assessed frequently to avoid over or under feeding. The RDNs and clinicians assessing and estimating nutrition needs for the pediatric population can refer to the *Academy of Nutrition and Dietetics Pediatric Nutrition Care Manual* and the *Pediatric Pocket Guide to Nutrition Assessment* for guidance.

Protein

Protein is vital for the growth and maintenance of cells, fluid balance, and blood clotting; its functions include immune function preservation, wound healing enzyme repair and synthesis, cell multiplication, and collagen and connective tissue synthesis. Additional protein is also required to compensate for the nitrogen losses that occur with PI exudate.

Research supports the theory that increased protein levels are linked to improved PI healing. As early as 1993, Breslow et al⁸¹ demonstrated that individuals receiving higher-protein/higher-calorie diets had a statistically greater reduction in PI surface area compared with baseline than the individuals receiving a standard diet ($P < .02$). A change in PI surface area was correlated with both dietary protein ($r = 0.50$, $P < .01$) and energy intake ($r = -0.41$, $P < .03$).⁸¹ A randomized controlled trial (RCT) by Ohura et al⁸⁰ stated that a high intake of protein can result in reduced PI size and depth compared with a low protein intake. An RCT by Lee et al⁸² reported that providing a standard diet with a concentrated protein supplement equaling 45 g daily resulted in a 60% reduction in Pressure Ulcer Scale for Healing scores after 8 weeks of treatment, whereas standard care and a placebo resulted in a 48% reduction ($P < .05$). Yamamoto et al³⁵ demonstrated improvement in PI healing when adults consumed more than 30 kcal/kg of body weight per day, whereas individuals consuming ≤ 20 kcal/kg of body weight per day experienced deterioration or no improvement in healing. Finally, in a trial by Ohura et al⁸⁰ comparing the efficacy of two different nutrition regimens, high-calorie (37.9 ± 6.5 vs 29.1 ± 4.9 kcal/kg per day) and high-protein intake (intake 1.62 ± 0.30 vs 1.24 ± 0.22 g/kg per day) resulted in improved PI healing (higher reduction in area and depth). A secondary analysis of the same trial data demonstrated that high-calorie, high-protein support in patients with PIs is a cost-effective intervention.⁸³

The recommended dietary allowance for protein for all adults, including older adults, is 0.8 g/kg of body weight. Evidence supports that LBM is maintained

when an older adult consumes higher levels of protein, in the range of 1.0 to 1.2 g/kg per day.^{84–86} Evidence also supports increasing energy and protein intake for adults and children with PIs who are malnourished or at risk of malnutrition.^{84–86}

Fluid/Water

An adult's body is 60% water, which is distributed in the intracellular, interstitial, and intravascular compartments. It serves as the transport medium for moving nutrients to the cells and removing waste products. Water is the solvent for minerals, vitamins, amino acids, glucose, and other small molecules, allowing them to diffuse into and out of cells.

The EPUAP/NPIAP/PPPIA CPG recommends providers encourage adequate fluid intake. Although current research has not determined the optional formula for calculating a daily fluid requirement for individuals with PIs, 1 mL fluid/kcal consumed is commonly used.^{62,54,87} Adequate daily fluids/water should be offered to and encouraged for all individuals with PIs. Those with draining wounds, emesis, diarrhea, elevated temperature, or increased perspiration require additional fluids/water to replace lost fluid.⁸⁸ Clinicians should monitor individuals for any signs or symptoms of dehydration: changes in weight, skin turgor, urine output, or elevated serum sodium. Older adults usually have increased body fat and decreased LBM, thus decreasing the percentage of water their bodies can store. This, combined with a decreased sense of thirst, increases their risk of dehydration.⁸⁸ Fluid requirements are met with liquids, including the water content of food, which accounts for 19% to 27% of the total fluid intake of healthy adults.

Micronutrients

As explained in Table 3, micronutrients play a role in the PI healing process and are key components of a healthy diet. Previously, megadoses of supplements such as ascorbic acid and zinc have been prescribed for patients with PIs. Because of the lack of evidence-based research on the validity of this practice, the 2019 Guideline committee did not study this issue. Many of the oral supplements, enteral formulas, and fortified foods recommended for individuals with PIs contain additional micronutrients and should be considered before recommending additional supplementation.

THE ROLE OF SUPPLEMENTS

Evidence-based guidelines, particularly those focusing on nutrition in older populations, have highlighted that despite many trials the most effective treatment options for malnutrition still need to be identified. Therefore, approaches should be comprehensive, relying first on improving oral intake.^{89,90} Prior to or in addition to offering

oral nutrition supplements, clinicians should consider comprehensive approaches for improving oral intake:

- nutrition counseling
- modifying food, such as with fortified foods
- revising/modifying or liberalizing diet restrictions that result in decreased intake⁹¹
- offering assistance with eating
- honoring cultural/religious food preferences
- providing a pleasant eating environment

As reported above, a positive energy and protein balance to sustain anabolism plays a crucial role in skin viability and wound healing. However, patients with chronic diseases or at risk of/with a PI frequently cannot meet protein and calorie needs. Aside from increasing the energy expenditure of the patient, PIs are responsible for a further worsening the energy balance.⁷⁹ When oral feeding is safe, the use of oral nutritional supplements (ONSs) can be an effective strategy to help fulfill protein and calorie requirements.

The EPUAP/NPIAP/PPPIA CPG recognizes the role of supplements and recommends ONSs with micronutrients for individuals with a PI who are malnourished (or at risk; Table 1). According to a systematic review of RCTs, ONSs are usually well tolerated and result in both a positive energy balance and clinical benefits, especially when higher-energy-density ONSs (1.5-2.4 kcal/mL) are consumed between meals.⁹² Because ONSs include products that supply macro- and micronutrients, providers must weigh their value for the treatment plan. Health professionals are advised to review the nutrition labeling to determine nutrient adequacy.

Studies investigating the role of ONSs in preventing PIs have mixed findings, with uncertainty surrounding their efficacy. All of the investigations included in the guideline review were conducted in older populations in which PIs are clearly of multifactorial origin, and the contribution of ONSs is more difficult to establish because it is only one part of the overall patient's care, which is oriented toward treating all underlying conditions. Further, the heterogeneity in study designs contributed to the risk of bias.^{5,6,93-96} However, a meta-analysis of trials in this area found that the provision of high-calorie (250-500 kcal) high-protein ONSs is associated with a 25% lower incidence of PIs in individuals at risk compared with routine care (OR, 0.75; 95% CI, 0.62-0.89).⁹⁷

On the other hand, evidence on the efficacy of ONSs in increasing the rate of healing is consistent and substantiated by different trials, which also suggest that the duration of intervention should be at least 4 weeks and reasonably up to complete healing. These studies support not only the importance of extra energy and protein but also the positive effect adding arginine and micronutrients (zinc and antioxidants).^{5,81,82,98-101} A recent large double-blind RCT (the Oligo Element Sore

Trial) has elucidated the independent role of these additional nutrients in PI healing.^{100,102} In this study, high-energy, high-protein ONSs (two bottles per day; 500 kcal and 40 g protein) enriched with arginine, zinc, and antioxidants were compared with isocaloric, isonitrogenous control ONSs in malnourished adults with Stages 2 through 4 (70% Stage 3 or 4) PIs. After 8 weeks, a greater reduction in wound surface area was achieved in the intervention group (adjusted mean change, 18.7%; 95% CI, 5.7-31.8). Interestingly, a reduced intensity of care (fewer dressings and less time spent changing them) has been reported with the use of this formula.¹⁰³

Last but not least, using data from available RCTs, Australian researchers have demonstrated that nutrition support is a cost-effective intervention in preventing PIs in the hospital setting. Specifically, ONSs are likely responsible for a reduction in length of hospital stay when compared with usual care (standard diet).¹⁰⁴⁻¹⁰⁶ Analysis of the Oligo Element Sore Trial data also showed that the studied ONS is a cost-effective treatment associated with substantial savings when compared with the control formula.⁹⁹ With this background, the use of ONSs in preventing and treating PIs could be recommended.

NUTRITION SUPPORT

Despite limited evidence supporting artificial nutrition and hydration for PI intervention and treatment, the interprofessional team should discuss the risks and benefits of enteral nutrition (EN; tube feeding) or parenteral nutrition (PN) with individuals who cannot meet their nutrition requirements through oral intake despite previous intervention. The interdisciplinary team should consider if the patient has the desire and/or capacity to tolerate nutrition support. Nutrition goals should not take priority over the patient-centered goals of the individual.

One low-quality level 1 study and three low-quality level 3 studies indicate that the provision of EN and PN has limited impact on preventing PI for those at risk.^{94,95,107,108} The high-acuity level of patients in acute or long-term care increases the incidence of PIs and can lead to the decision to trial EN or PN. The long-term care patients in Arinzon and colleagues¹⁰⁷ study receiving EN were at greater risk of developing PI and had lower BMIs than those who were not. Considering the length of the trials (from 2 to 12 weeks), lack of reported comorbidities, and quality of the trials, it remains unclear whether offering artificial nutrition and hydration for those at risk of PIs would reduce prevalence.

The goal for artificial nutrition support for individuals with PIs is to improve their nutrition status, promote healing, and restore their immune function.^{109,110} When PI healing has stalled and oral intake is inadequate to support healing, EN should be considered if it is consistent with the individual's goals of care. The RDN and interprofessional team should evaluate the patient's

**Table 3. NUTRIENTS AND THEIR THERAPEUTIC PROPERTIES**

Nutrient	Functions	Notes	Sources	Related CPG Recommendation
Calories	Supply energy, prevent weight loss, preserve lean body mass		Carbohydrate, protein, and fat; carbohydrate and fat are preferred	4.6, 4.8, 4.9, 4.10
Carbohydrates	Glucose supports cell growth, fibroblasts, and leukocytes	Delivers energy; energy needs must be met to spare protein from being used for energy	Grains, fruits, and vegetables; complex carbohydrates are preferred	
Protein	Immune support; binding of skin, cartilage, and muscle	Contains nitrogen, which is essential for wound healing. Arginine becomes a conditionally indispensable amino acid during times of physiologic stress	Meats, fish, poultry, eggs, legumes, milk, and dairy products; favor lean meat and reduced- or low-fat dairy products	4.5-4.10
Fat	Carries fat-soluble vitamins, provides insulation under the skin and padding of bony prominences, helps modulate inflammation and the immune response	Most concentrated energy source	Meats, eggs, dairy products, and vegetable oils	
Fluids/water	Solvent for minerals and vitamins, amino acids, and glucose; helps maintain body temperature; transports materials to cells and waste products from cells; maintains skin integrity		Water, juices, beverages; fruits and vegetables contain approximately 95% water. Most supplements are 75% water	4.13
Vitamin A	Protein synthesis, collagen formation, maintenance of epithelium, immune function	May delay healing in older adults on corticosteroids UL is 3,000 µg; DRI females aged >70 y is 700 µg, males aged >70 y is 900 µg	Beef liver, milk, dark green and yellow vegetables (carrots, sweet potatoes, broccoli, spinach, apricots)	
Vitamin C	Collagen formation, enhances activation of leukocytes and macrophages to wounds, improves tensile strength, aids in iron absorption	Water-soluble, noncaloric organic nutrient	Citrus fruits and juices, tomatoes, potatoes, broccoli	
Vitamin E	Fat metabolism, collagen synthesis, cell membrane stabilization	Antioxidant	Vegetable oils, sweet potatoes	
Copper	Red blood cell formation, responsible for collagen cross-linking and erythropoiesis	Inorganic, noncaloric nutrient UL is 10,000 µg. DRI females and males aged ≥70 y is 900 µg.	Nuts, dried fruit, organ meats, dried beans, whole-grain cereal	
Iron	Transports oxygen to the cells as a component of hemoglobin, important in collagen formation, creates energy from cells		Heme iron: meats, poultry, and fish Nonheme iron: vegetables, grains, eggs, meat, fish	
Zinc	Cofactor for collagen formation, metabolizes protein, assists in immune function, liberates vitamin A from the liver, interacts with platelets in blood clotting	Inorganic, noncaloric nutrient Mega doses of zinc may inhibit healing and cause copper deficiency UL is 40 mg DRI females aged ≥70 y is 8 mg, males aged ≥70 y is 11 mg.	Meats, liver, eggs, and seafood	

Abbreviations: CPG, EPUAP/NPIAP/PPPIA Clinical Practice Guideline; DRI, dietary reference intake; UL, tolerable upper intake level. Adapted with permission from Bernstein M, Munoz N. Nutrition for the Older Adult. 3rd ed. Burlington, MA: Jones and Bartlett Learning; 2020.

medical condition to determine whether EN is a long- or short-term solution. Prior to initiating EN, the risks and benefits of nutrition support must be discussed with the patient and/or caregivers. Although artificial nutrition and hydration are medical treatments, an individual's cultural and/or religious values may dictate their decision to accept or decline EN.

If the gastrointestinal tract is functioning, EN is the preferred route. Parenteral nutrition should be considered for patients whose nutrition requirements cannot be met with EN. Prior to the initiation of EN, the RDN should assess the patient's calorie, protein, and hydration needs and tailor the feeding regimen to meet their needs. There are pediatric enteral formulas designed for children from 1 to 13 years of

age. These formulas meet the recommended dietary reference intakes for children aged 1 to 8 years in 1,000 mL/d and 1,500 mL/d for children aged 9 to 14 years.¹¹¹

After artificial nutrition support is initiated, the interprofessional team should frequently evaluate the patient's tolerance to EN and note any adverse reactions such as nausea, diarrhea, or vomiting. Clinicians should also routinely check and confirm that the patient is receiving the correct formula in the prescribed amount. The RDN and interprofessional team should document the benefit from the feedings in relation to the desired outcome of healing and stabilizing nutrition status in the medical record. They should also monitor and evaluate the individual's tolerance and progress toward achieving the desired outcome and recommended changes as needed.

Research reviewing EN for improved outcomes for PI healing is limited. Two high-level studies, one with 60 individuals and another with 28, noted improvement in healing rates when the nutrition support used was a high-protein, disease-specific formula.^{80,102} Arinzon and colleagues¹⁰⁷ study of residents with dementia residing in long-term care reported more complications, such as pneumonia, weight loss, and death, in the intervention group receiving EN than those receiving an oral diet (61% vs 34%, $P < .01$). Another study reported no change in mortality with PN over EN in critically ill individuals.¹¹²

Palliative Care/Hospice

Patients receiving palliative care are at high risk of developing PIs because they have a serious illness, are immobile, or are approaching end of life. The EPUAP/NPIAP/PPPIA CPG highlights the importance of discussing benefits and harms of EN or PN with individuals in palliative care and their families and/or caregivers (Table 1).

The guiding principles of palliative care for PI management focus on relieving pain and providing comfort for the individual. Nutrition interventions should be compatible with patient goals and desired outcomes. For example, serving the individual's favorite food or beverage when requested improves his or her quality of life.

It is the position of the Academy of Nutrition and Dietetics that "individuals have the right to request or refuse nutrition and hydration as medical treatment,"¹¹³ and ESPEN states that a "competent patient has the right to refuse a treatment after adequate information even when this refusal would lead to his or her death."¹¹⁴ Hospice PI treatment goals should be individualized, respecting each person's unique values and personal decisions.¹¹⁵

CARE PLANNING, PATIENT MONITORING, AND EVALUATION

Regardless of the setting, the EPUAP/NPIAP/PPPIA CPG recommends that an individualized nutrition care plan be developed. The interdisciplinary team is responsible for

nutrition care that addresses the desired outcomes for the individual. Allen's⁷² study demonstrated that individualized nutrition assessment and planning for older adults with Category/Stage 2 or 3 PIs ($n = 100$) are associated with improved wound healing compared with standardized nutrition plans (37% vs 23.4%, $P < .05$). The care plan process should encompass the policies and/or regulations of the organization. The RDN builds the nutrition care plan based on the information gathered in the nutrition assessment, including data generated by the physician; nurses; and physical, occupational, and speech language therapists. The patient-centered care plan should

- be individualized
- involve the individual and all disciplines
- reflect the patient's choices/preferences
- offer a variety of interventions to meet the stated goal
- identify specific interventions
- educate the individual/caregiver on the benefits of the suggested intervention
- include a time frame for completion or review
- be documented in the medical record

The interprofessional team should counsel individuals and suggest a variety of other options for patients residing in the community who cannot prepare meals or afford ONSs and vitamin/mineral supplements. Suggestions include eating small, frequent meals and snacks such as high-calorie bars, sandwiches, Greek yogurt, homemade milk shakes, instant breakfasts, and other nutrient-rich items.⁴⁶ Referral to an RDN for individualized counseling would be advantageous for community-dwelling patients with literacy or language difficulties. Some US hospitals host a Food Pharmacy including ONSs for individuals who have limited access to affordable and nutritious foods. Wound care clinics and rehabilitation departments, acute care hospitals, and post-acute care facilities are encouraged to provide hot and cold beverages as part of their hydration protocols and/or to make strategic connections with a Food Pharmacy program.

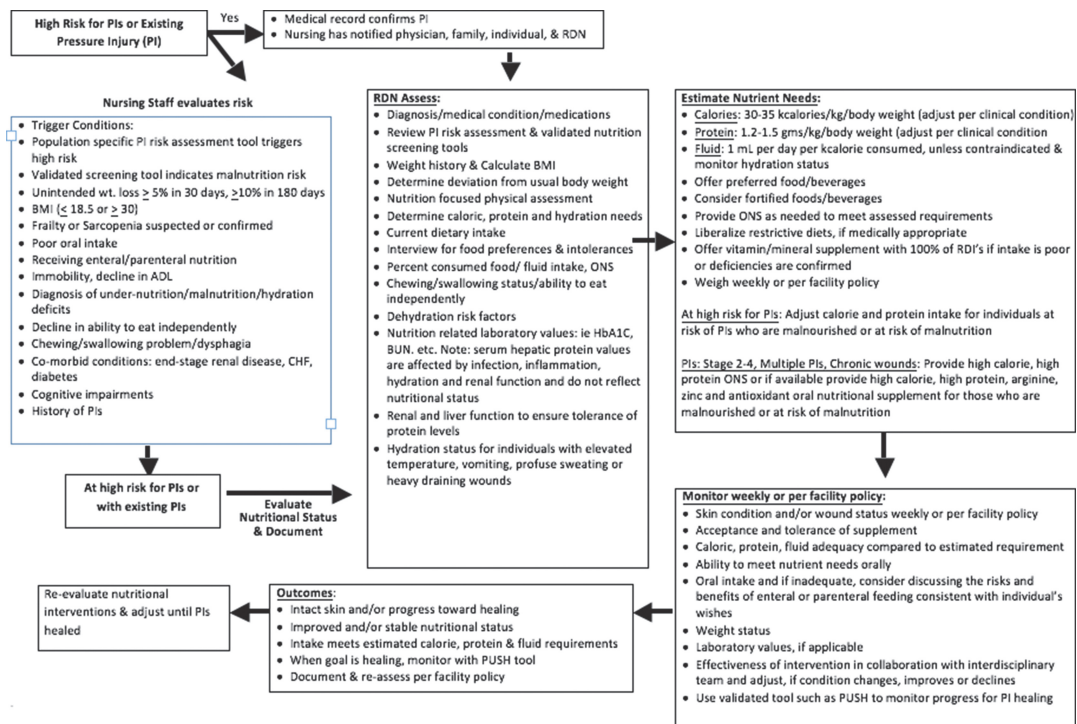
Routine or periodic monitoring of the care plan is the most important component of the nutrition care process. Interventions must be adjusted with any change in conditions and when progress toward the desired outcome is not achieved. The RDN may need to reassess the patient or refer them to another discipline for further evaluation or treatment (Figure 1).

PATIENT EDUCATION AND ENGAGEMENT

Patient education and engagement are an important component of nutrition assessment and treatment for all individuals, including those with or at risk of PIs.¹ Evidence on the effectiveness of education in reducing PI incidence and promoting healing has shown mixed results; however, there was sufficient evidence for the EPUAP/NPIAP/PPPIA CPG to recommend providing



Figure 1. GUIDE FOR THE NUTRITION MANAGEMENT OF PRESSURE INJURIES (PI) FOR ADULTS IN ACUTE OR LONG-TERM CARE



individuals with or at risk of PIs access to education, skills training, and psychosocial support. The evidence indicates that for individuals with ongoing PI risk (eg, those with spinal cord injury), multifaceted lifestyle skills programs or telephone-based education and support programs can produce short-term positive impacts on knowledge, education, and quality of life.^{116–119} Patients themselves have noted the importance of engaging in nutrition education. Haesler et al^{120,121} reported that 71.8% (275/383) of respondents to an international survey identified that knowing more about what to eat and drink to prevent PI and to maintain healthy skin was important or very important in caring for themselves. Further, the survey respondents identified that nutrition education was also important for their family and caregivers.

Given the complexities of nutrition for individuals with and at risk of PIs, education and nutrition-related lifestyle coaching (eg, guidance on weight management, menu planning, food selection and preparation) are an important component to include in patient and family education and engagement programs.^{120,121} Written information on nutrition should be presented in a concise manner to reinforce person-to-person education. Hartigan et al¹²² noted that providing a simple pamphlet with evidence-based PI-related messages, including “Eat plenty of protein (e.g. meat, fish, eggs)” to a sample of community-based older adults at risk of PI (n = 75)

was associated with improvements in knowledge of PI risk factors. A similar concise written resource was used by Chaboyer et al¹²³ as a part of a comprehensive PI prevention bundle delivered in eight Australian hospitals. The simple nutrition message provided to patients was “Eat a healthy diet.” The hazard ratio (0.48; 95% CI, 0.20–1.21) indicated a 52% reduction in hospital-acquired PIs associated with the intervention. In this acutely ill population, the researchers noted that the willingness of individuals to engage in education interventions is limited by their clinical condition.¹²³ This suggests that appropriate timing is an important consideration for nutrition-related education.

RESEARCH PRIORITIES

Nutrition plays a vital role in human growth and development; the maintenance of good health and functionality; prevention and treatment of infectious, acute, and chronic diseases; and PI development and treatment. To effectively and efficiently advance the role of nutrition in improving and sustaining health and tissue viability to prevent or treat PI, efforts must be made to advance nutrition research.

Improved nutrition could be one of the most cost-effective approaches to address many of the societal, environmental, and economic challenges facing nations around the world today.¹²⁴ Adequate nutrition promotes positive outcomes

among patients at risk of or with PIs in all care settings. Key research priorities on nutrition and PI prevention and treatment include the impact of malnutrition, frailty, and sarcopenia on patient recovery. Methods to estimate calories and protein requirements for individuals classified as obese need to be defined. Patient history, including personal, medical, social, and health history, also influences PI development. Research on the use of high-calorie, high-protein ONSs as an intervention to reduce the incidence of PI is needed, along with studies on key nutrients such as amino acids, zinc, and antioxidants as adjunct therapy. The value and benefits of EN and PN, either supplemental or total, should also be clarified. Finally, the cost-effectiveness of nutrition interventions in patients with PIs must always be considered among the outcomes of interest.

CONCLUSIONS

Nutrition is an important consideration when treating patients at risk of or with PIs. Early nutrition screening using a validated tool and assessment is a key element in diagnosing malnutrition, which can impede healing. The interdisciplinary team including the RDN should apply the CPG recommendations to reduce process variation and achieve positive outcomes.

PRACTICE PEARLS

- Use a validated nutrition screening tool to identify the nutrition status of individuals at risk of or with PIs.
- Refer individuals at risk of or with PIs to an RDN or other qualified professional for a nutrition assessment and collaborate with the interprofessional team and patient to determine a patient-centered nutrition plan.
- Encourage consumption of a balanced diet based on individualized requirements. Supplement between meals if needed to achieve assessed requirements.
- Offer nutrition support to individuals who cannot consume adequate intake, assuming this is compatible with individual's goals and wishes. ●

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