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Laboratory Biomarkers and Nursing Assessment in Nutritional Status: A Comprehensive Review

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Abstract

Nutritional status is an important domain in the health domain, having influences on health recovery, prevention of diseases, and quality of life in many populations. Malnutrition, including undernutrition, overnutrition, and micronutrient deficiency, is associated with hospital length of stay, morbidity, and mortality. This systematic review explored the contributions of laboratory biomarkers and nursing assessments in assessing nutritional status. Laboratory biomarkers (e.g., serum albumin, prealbumin, micronutrient levels including vitamin D and zinc) can provide objective, quantifiable indicators of deficiencies of nutrients and metabolic abnormalities. However, the validity of laboratory biomarkers may be less than optimal as they are affected by many non-nutritional parameters such as inflammation and liver failure. Nursing assessments (dietary histories, anthropometric measurements, and physical exam types such as subjective global assessment) can provide a more holistic, high-level understanding of dietary patterns, physical status, and psychosocial aspects, but are constrained by time and nursing instrument validity. However, combining lab and nursing assessments improves the diagnostic power when identifying and diagnosing malnutrition (examples: MUST (Malnutrition Universal Screening Tool), case studies of older adults, surgical patients). Challenges in assessing nutritional status include variability in laboratory biomarkers, restricted time in nursing assessments (physical exam and dietetics), and difficulties associated with differences in populations. Future directions on assessments include metabolomics, wearables, and universal guidelines. This study will serve as a roadmap for improving nutrition assessment with an interprofessional collaborative approach and using innovative technologies and techniques.

Keywords: Nutritional status, nursing assessment, laboratory biomarkers, interdisciplinary care, malnutrition

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1. Introduction

Nutrition is a cornerstone of human health, which has a significant impact on recovery, disease prevention, and quality of life across diverse populations and clinical conditions. Suitable nutrition maintains physiological function, optimizes immune function, and improves tissue repair as it is a fundamental determinant of health outcome in acute and chronic disease (Scrimshaw & SanGiovanni, 1997). Malnutrition, in particular its forms of undernutrition, overnutrition, and micronutrient deficiency, is a significant global health challenge with a variety of consequences for health. Undernutrition related to calorie, protein, or micronutrient intakes is a common condition in hospital patients, where almost half of acute care admissions can be malnourished, leading to prolonged hospital stay, impaired wound healing, increased infection risk (Barker et al., 2011). Overnutrition, in the form of obesity, is an increasing global challenge and is associated with comorbidities of type 2 diabetes, cardiovascular disease, and some cancers, and the prevalence of obesity worldwide has almost tripled since 1975 (World Health Organization, 2020). Regardless of the form of malnutrition, this is associated with morbidity, mortality, and as a cost to the healthcare system, so there is an urgent need for implementable nutritional assessment tools (Cederholm et al., 2017).

Timely determination of nutritional status is crucial in identifying those at risk for malnutrition and appropriately implementing targeted interventions to minimize its consequences. Nutritional status requires a multimodal approach, using both objective (measurable) biomarkers and subjective (patient-reported) assessments to encapsulate the complexities of nutritional status. Laboratory biomarkers such as serum albumin, prealbumin, and micronutrient levels provide reliable information on nutrient deficiencies, metabolic derangement, and overall health so that clinicians can detect discrete nutritional deficiencies (Bharadwaj et al., 2016). Decreased serum albumin will usually indicate protein-energy malnutrition, while vitamin D or B12 deficiency may indicate more generalized nutritional deficiency (Holick, 2007). Biomarkers are insufficient alone, however, since they can reflect non-nutritional processes such as inflammation or liver disease and need contextual interpretation (Fuhrman et al., 2004).

Nurse evaluation fills gaps of laboratory biomarkers with patient-focused, holistic understanding involving dietary patterns, physical performance, and socioeconomic factors that influence nutrition. With dietary histories, anthropometric assessments, and physical observations, the nurse can obtain clinical indicators of malnutrition, assess dietary patterns, and assess barriers to appropriate nutrition, such as food insufficiency or dietary approaches, by use of the Subjective Global Assessment, dietary histories, or modified dietary assessment records (Bauer et al., 2011). As an illustration, the Subjective Global Assessment adds physical exam results with subjective report by the patient, classifying nutrition by use of these findings, providing information not determinable by use of laboratory tests alone (Detsky et al., 1987). Also, patient contact by nurses at the point of care allows nurses to consider psychosocial factors, such as mental or socioeconomic factors, affecting nutritional well-being, with broad influence on nutrition (Kamp et al., 2010). This two-prong approach—with the objectivity of the biomarker supplemented by richness of nursing evaluation context—ensures an extensive review addressing, at once, clinical and social factors that affect nutrition.

The purpose of the review is to critically analyze the relationship between nursing assessments and laboratory biomarkers, determine their effectiveness in varied clinical environments, and recommend how to synthesize them to summarize nutritional care. The review, through an integration of peer-reviewed articles, elucidates the strengths and weaknesses of each method, their complementary use in screening and treating malnutrition, and how they can be integrated to facilitate condensed nutritional care. It includes the combinations of using biomarkers and nursing assessments in various settings/contexts of long-term, community, and acute care as well as the associated variability across diverse populations. Issues such as the reliability of biomarkers and barriers preventing complete nursing assessment are explored, as well as suggestions for future research on emerging biomarkers, technology-enabled devices, and standardized methods or protocols. Overall, the review provides the clinician and the researcher with the guidance to improve nutritional care, prevent malnutrition, and improve patient outcomes in various contexts.

2. Methodology

This review adopted a systematic process of searching and synthesizing literature between 2000-2023 with the aim of offering a comprehensive review of the evidence available. Major databases of PubMed, CINAHL, and Scopus were searched employing a mix of terms such as "nutritional status," "laboratory biomarkers," "nursing assessment," "malnutrition," and "nutritional screening." Inclusion criteria sought studies carried out on adults in clinical settings with emphasis placed on the application of laboratory biomarkers or nursing assessment by nurses. Papers were selected based on their methodology, alignment with the purpose of research, and contribution to nutritional assessment knowledge. Peer-reviewed articles covering randomized controlled trials and cohorts, to systematic reviews and guidelines, were included. The evidence was synthesized thematically to address the utilization of laboratory biomarkers, nursing assessment methods, combined utilization of both clinical settings, and challenges faced. Synthesis entailed clustering findings under overarching themes of biomarker reliability, assessment instrument validity, and interprofessional teamwork to develop an overall picture of available nutritional assessment scenarios.

3. Laboratory Biomarkers in Nutritional Assessment

Biomarkers in a lab are critical tools for assessing nutritional status through objective, measurable estimations of nutrient insufficiency, metabolic impairment, and health status. Biomarkers are particularly beneficial in a clinical environment where data must be exact as a prelude to intervention. Serum proteins, micronutrient levels, inflammatory markers, and new markers constitute the most applied biomarkers, each with unique applications and limitations.

3.1. Serum Proteins

Proteins found in serum, like albumin, prealbumin, and transferrin, are some of the most commonly used indicators of nutritional status because they are associated with protein-energy malnutrition. Serum albumin is a well-established marker with a half-life of approximately 20 days; even so, values of serum albumin below 3.5 g/dL on a routine basis indicate malnutrition, chronic disease, or inflammation (Bharadwaj et al., 2016). Much to the chagrin of many clinicians, serum proteins are not perfect, and albumin is known to be affected by non-nutritional factors like liver disease, hydration status, and acute-phase response to trauma or infection (Don & Kaysen, 2004). Hypoalbuminemia can be a sign of inflammatory processes rather than dietary insufficiency, and hence its utility as an independent nutritional marker is diminished (Fuhrman et al., 2004). Albumin is still a useful marker of longitudinal assessment of nutritional status, however, particularly for those patients with a stable status on a clinical level.

Prealbumin (also called transthyretin) has a shorter half-life of 2-3 days and therefore has a quicker response to acute changes in nutritional status compared to albumin (Beck & Rosenthal, 2002). Prealbumin levels < 15mg/dL show protein depletion, indicative of a patient with acute reduction in dietary intake, or increased metabolic demand (Devoto et al., 2006). Similar to albumin, its values are influenced by inflammation, renal disease, and metabolic stress, making information challenging to interpret (Shenkin, 2006). Transferrin is a serum protein that is most commonly evaluated as an indicator of iron status but is of little use in nutritional assessment because it is affected by malignant iron metabolism, anemia, or hemochromatosis (Wish, 2006). While these serum proteins are essential indicators, it is important to interpret the results carefully and avoid misdiagnosing a nutritional deficiency in your clinical setting.

3.2. Micronutrient Levels

Both developing and developed countries experience vitamin and mineral micronutrient deficiencies, with concentrations in hospitalized and chronically ill patients as well (Shenkin, 2006). Serum concentrations of micronutrients, such as vitamin D, vitamin B12, zinc, and iron, are good indicators of nutritional status. Serum 25-hydroxyvitamin D concentrations <20 ng/mL indicate depletion and are associated with impaired bone metabolism and immune status, and increased risk for chronic disease (Holick, 2007). Vitamin B12 deficiency is rare, and is calculated by serum concentration or methylmalonic acid levels, leading to anemia and possible neurological abnormalities, particularly in the elderly or in states

of malabsorption (Green, 2017). Low serum concentrations of zinc (<70 μg/dL) indicate a severely compromised immune status, with the potential to impair wound healing effects, and it is associated with the surgical or critically ill population (Prasad, 2008). For iron deficiency, the best indicators are serum ferritin and transferrin saturation, which also serve as good markers for recovery in patients with any form of anemia and chronic disease (Camaschella, 2015). While these assessments for micronutrients are often good, the limitations are related to cost and need for specialized equipment, which limits representation in resource-limited settings (Bourdel-Marchasson et al., 2010).

3.3. Inflammatory Markers

There is a significant influence of inflammation on nutrient biomarker modulation, often making it difficult to clinically interpret. Acute-phase proteins – such as interleukin-6 (IL-6) and C-reactive protein (CRP) – are often measured to indicate inflammatory status and have significant effects in depressing serum protein concentration and masking nutrient deficiency (Gabay & Kushner, 1999). Elevated concentrations of CRP, for example, are associated with decreased production of prealbumin, albumin, and even in the absence of malnutrition, consider caution in interpreting these markers (Fuhrman et al., 2004). The NUTRIC (Nutrition Risk in Critically Ill) score, a score developed for acute care settings (ICU), incorporates IL-6 and other inflammatory markers to improve the accuracy of nutritional risk classification (Heyland et al., 2011). The NUTRIC score allows patients to be identified by controlling for the effects of inflammation in those most likely to benefit from aggressive nutrition therapy (Rahman et al., 2016). Inflammatory marker assessment on a routine basis, though, demands sophisticated lab facilities, which may lack universal accessibility (Jensen et al., 2011).

3.4. Emerging Biomarkers

In recent years, there has been a rise in nutritional science supporting new markers like insulin-like growth factor-1 (IGF-1) and fibroblast growth factor-21 (FGF-21) that are deemed to be more external markers. IGF-1 is a growth hormone-dependent nutritionally regulated hormone that is less affected by acute-phase responses; therefore, it should provide a less variable measure of early protein-energy malnutrition (Clemmons, 2004). Likewise, FGF-21 is a metabolic regulator and has also been suggested as a marker of some nutrient deficiencies in critically ill patients further, higher levels are suggested as markers of disturbance of energy and nutrient support (Zhang et al. 2019). New markers are particularly beneficial under circumstances when traditional markers are compromised by inflammation or other comorbidities. New markers are, however, limited by a need for further validation and standardized reference points (Combs & McClung, 2017). Ongoing research into metabolomics and proteomics will soon yield further markers with potential to enhance the accuracy of nutritional assessments (D'Alessandro & Zolla, 2012).

4. Nursing Assessment of Nutritional Status

Nurse evaluation offers a patient-centered, holistic view of nutritional status as another form of complementary information, as opposed to data obtained from laboratory-biomarker results. Physical assessment, anthropometry, psychosocial assessment and dietary histories provide a fuller program of assessment to quality a person's nutritional state.

4.1. Dietary History

The complete dietary history is the foundation of nursing assessment; it enables assessment of the consumption of nutrients overall and the eating style of patients and potential deficiencies. Tools like 24-hour dietary recalls, food frequency, dietary history tools, and diaries have been used often to obtain these histories (Thompson & Subar, 2017). However, these tools can be susceptible to recall bias, under-reporting by cognitively impaired adult subjects, or by those experiencing limited health literacy (Archer et al. 2013). Standardized measures, such as the Mini Nutritional Assessment (MNA), streamline data collection and promote reliability by asking about dietary intake, weight loss, and mobility (Vellas et al., 2006). Nurses take on a chief role in conducting these interviews, using communication skills to build rapport and provide accurate information. Dietary histories can reveal not only whether an individual had inadequate nutrient

intake, but more importantly, other barriers to healthy eating, such as food insecurity or barriers based on culture (Kamp et al., 2010).

4.2. Anthropometric Measurements

Anthropometric assessments, including body mass index (BMI), mid-arm circumference (MAC), and skinfold thickness, can offer objective information on body composition and nutritional status. BMI is a widely employed measure, calculated as weight in kilograms divided by height in meters squared. However, it is not as sensitive as some anthropometric measures to distinguish fat from lean tissue, particularly in the elderly, and in the case of the affected patient in an edematous state (Prentice & Jebb, 2001). MAC and skinfold thickness can add information on muscle and subcutaneous fat, respectively; however, MAC and skinfold thickness measurements can only provide additional information if the measurements are taken by users who have the requisite training, if change over time is to be reproducible and accurate (Frisancho, 1990). MAC measures are particularly valuable in identifying muscle wasting in the thwastely or critically ill, where BMI is not helpful (Naber, 2009). Anthropometric measures are useful but can suffer from measurement error or inter-observer variability and therefore require standardized methods (Kyle et al., 2005).

4.3. Physical Examination

Through physical examination, nurses can identify clinical manifestations of malnutrition such as muscle wasting, edema; hair loss, or abnormal skin conditions; The Subjective Global Assessment (SGA) is a reliable tool that incorporates patient history and physical examinations to classify the patient's nutritional status, which are: well-nourished; moderately malnourished; or severely malnourished (Detsky et al., 1987). The SGA assesses multiple variables including weight status, dietary intake, gastrointestinal complaints, and physical examination findings, thus a valid, but subjective measure (Detsky et al., 1994). Though efficient but not comprehensive, SGA's reliance on clinical experience can lead to variability, particularly for novice practitioners (Steenson et al., 2013). Nurses' ability to record subtle physical findings like temporal wasting of muscle or loss of subcutaneous fat increases precision to these assessments (Jeejeebhoy, 2000).

4.4. Psychosocial and Socioeconomic Factors

Nutritional status will be determined by multiple psychosocial and socioeconomic factors, like mental illness, food insecurity, and eating patterns informed by culture. Nurses will assess these factors during patient interviews and through screening tools such as the Malnutrition Screening Tool (MST), which considers patients' loss of weight and decreased appetite over a short time (Ferguson et al., 1999). Mental illness disorders, such as depression or anxiety, will suppress appetite and food intake and make individuals vulnerable to malnourishment (Söderhamn et al., 2012). Food insecurity, or the constrained or uncertain availability of nutritionally adequate and safe food, is a determinant of nutritional status, especially among lower-income populations (Loopstra et al., 2015). The nurse's ability to recognize these barriers through empathetic communication is necessary to create individualised interventions that address clinical determinants as well as social determinants of health.

5. Integration of Nursing Assessments with Laboratory Biomarkers

Integrating nursing assessments with laboratory biomarkers is a key component of a total nutritional assessment. Joining objective, quantitative information with subjective, patient-specific information based upon clinical examination, laboratory biomarkers provide precise measurements of nutrient deficiency and metabolic dysregulation yielding a snapshot of the physiological status required to identify disease, including protein-energy malnutrition or micronutrient deficiency (Bharadwaj et al, 2016). Nursing assessment encompasses a broader scope of nutritional status determinants, involving food intake, physical status and psychosocial determinants of nutritional status that include food insecurity and culturally influenced food choices (Bauer et al., 2011). The use of the combined method allows the clinician to observe a more complete picture of nutritional status in the patient, enabling the clinician to develop a targeted intervention that considers both the clinical and social issues of malnutrition. Accessing information from

these two complementary methods enables health professionals to formulate a more defined diagnosis and to develop a plan of care tailored to the individual that optimizes patient outcomes in a range of clinical pathways.

5.1. Complementary strength

Both biomarkers from the laboratory and nursing assessment of various aspects related to nutritional status, when used in combination, can have synergistic gains. Biomarkers, such as serum albumin, prealbumin, and micronutrient levels, can provide objective evidence of individualized deficiency in a patient, allowing clinicians to identify issues like protein depletion or vitamin deficiency with precision (Bharadwaj et al., 2016). Decreasing serum albumin levels (<3.5 μg/dL) may suggest protein-energy malnutrition, allowing the nurse to follow up with a thorough diet history, looking for inadequate protein and possible reasons such as malabsorption (Bauer et al., 2011). However, nursing assessment could have provided physical evidence of malnutrition, including muscle wasting, edema, or alopecia, which then could be included with potential biomarkers to order specific tests (Jeejeebhoy, 2000). Nursing assessment may, however, provide physical evidence of malnutrition such as muscle wasting, edema, or alopecia that could guide the specific biomarkers for ordering targeted testing (Jeejeebhoy, 2000). For example, if the nursing assessment had physical exam findings of muscle wasting, then the nurse may order targeted testing to measure insulin-like growth factor-1 (IGF-1), a biomarker sensitive to protein deficiency (Clemmons, 2004). This two-pronged approach enhances diagnostic accuracy as the objective data can be interpreted within the context of patients' clinical characteristics or lifestyle attributes.

Standardized tools like the Malnutrition Universal Screening Tool (MUST) demonstrate a good example of how biomarkers can be incorporated in nursing assessment. The MUST, taking into account anthropometrics (e.g., body mass index and weight loss), clinical history (e.g., the effects of acute illness), and the results of biomarkers (if available), ranks the risk of malnutrition as low, medium, or high (Elia, 2003). The tool helps to screen at-risk patients so that appropriate individualized interventions, like dietary counseling or supplementation, can be implemented depending on the overall assessment. The Mini Nutritional Assessment (MNA) follows a similar framework and combines information from dietary intake, anthropometrics, and clinical observations to assess the older adult for nutrition, using biomarkers like prealbumin or vitamin D status as additional information (Vellas et al., 2006). Utilizing any or all of these approaches enables clinicians to address both physiological and environmental contributors to malnutrition to arrive at interventions that are both evidence-informed and person-centred.

5.2. Multidisciplinary Approach

Completing an effective nutrition assessment is a multidisciplinary endeavor and requires collaboration amongst nurses, dietitians, physicians, and other health care professionals to pool laboratory values and clinical data in a comprehensive approach. In this model, nurses are the hub of the wheel, synthesizing objective biomarker data and applying it as part of patient-focused care (Tappenden et al., 2013). To illustrate this, we can examine the Nutrition Risk in Critically Ill (NUTRIC) score leveraged in ICUs, which synthesizes laboratory parameters such as interleukin-6 (IL-6) values and clinical parameters such as age, comorbidities, and length of stay when screening for patients at high nutritional risk who would benefit from aggressive nutrition intervention (Heyland et al., 2011). Nurses coordinate this process by collecting pertinent clinical data and situating biomarker data around pertinent patient history and then synchronizing care plans with dietetics and physician teams. This multidimensional approach ensures nutrition interventions are developed from objective and subjective data, or "big data," identifying the best directions for interventions and, hopefully, improving patient outcomes.

In specialized environments, i.e., oncology, the combination of biomarkers with nursing assessment is even more important for the treatment of multi-factorial treatment for cachexia with both nutritional deficits and inflammation. Combining increased C-reactive protein (CRP), an inflammatory marker, with results from the Subjective Global Assessment (SGA) has been shown to enhance the recognition of cachexia in cancer patients, resulting in treatment targeted directly at the inflammatory process with anti-inflammatory agents or nutrition (Argilés et al., 2010). Nurses facilitate integration through the conduct of

SGAs, interpretation of biomarker tests in consultation with clinicians, and the relay of results to dietitians, aiming at the development of individualized nutrition regimens. This integration not only optimizes diagnostic accuracy but also provides holistic treatment of the patient, with regard for the interactions between nutritional condition, disease course, and psychosocial influences (Kamp et al., 2010). Figure 1 represents the integrated model of nutritional assessment.

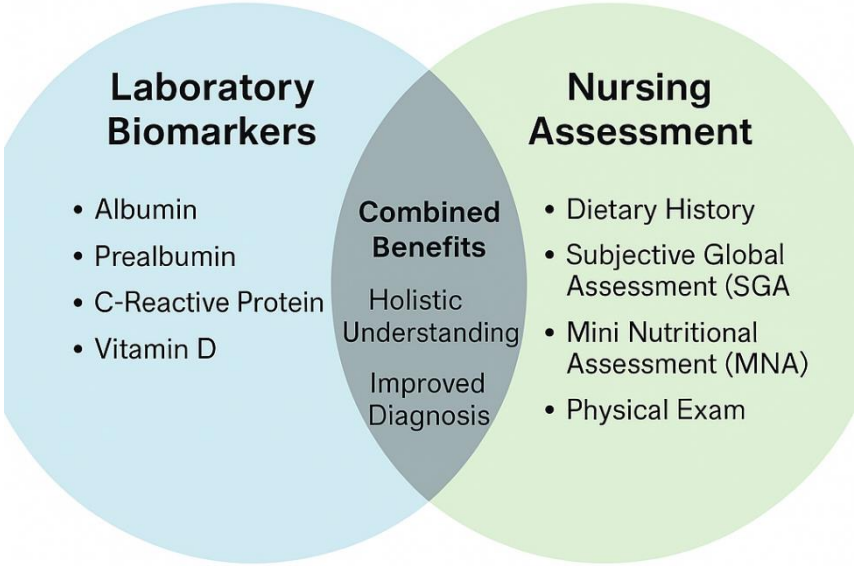

Figure 1 Integraded model of Nutritional Assessment

5.3. Case Studies

Case studies provide strong evidence of clinical benefit from combining biomarkers with nursing assessment in the field. In elderly patients at long-term care facilities, low levels of prealbumin (<15 mg/dL) were confirmed by MNA findings of poor dietary intake and unintentional weight loss, with high risk for malnutrition identified (Guigoz et al., 2002). Angulo et al. (2011) point out that the integration of such subjective and objective assessment facilitated a prompt for specific interventions, such as oral supplementation and dietary counseling, aimed at improving dietary intake and preventing readmission. Similarly, with a population of surgery patients, the integration of serum concentration of zinc with physical assessment of healing of the sternum detected those with zinc deficiency improved or cured by supplementation, with attendant earlier discharge and reduced post-operative complications (Prasad, 2008). These case studies point out the merit of a two-track approach, with biomarkers providing specific diagnostic information and nursing assessment providing contextual information for guiding effective intervention. For example, with a population of intensive-care children, the integration of serum ferritin concentration with physical measurements and dietary consumption histories identified iron-deficient anemia in severely ill children, prompting individually tailored supplementation regimens that improved hematological outcome (Joosten & Hulst, 2011). These case studies indicate how assessments can be

integrated for the healing of the physiological and environmental causes of malnutrition for optimum and effective nutrition care. Figure 2 represents the clinical workflow of nutritional assessment.

6. Challenges in Nutritional Assessment

Despite the significant contributions of nursing assessment and laboratory biomarkers to nutritional assessment, both approaches are plagued with significant challenges that can invalidate their effectiveness

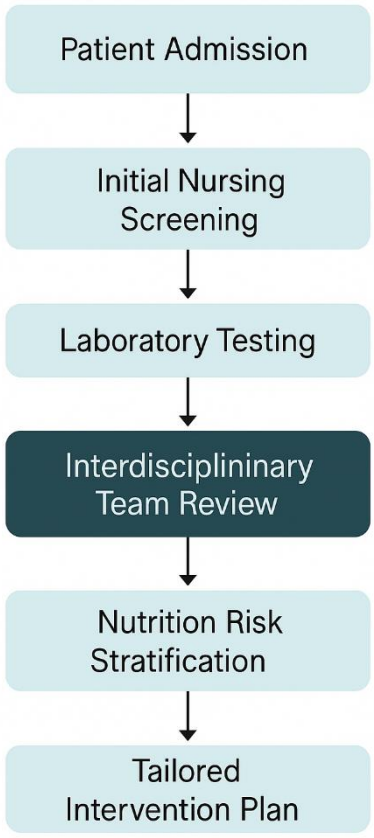

Figure 2. A multidisciplinary workflow of nutritional assessment and intervention

in the clinical environment. These challenges range from the extent of the reliability of biomarkers, the process of conducting thorough nursing assessments, and inconsistencies in the use of assessment tools within populations. Addressing these challenges is key to improving the quality and use of nutritional assessments, particularly in resource-challenged and highly stressful clinical settings.

6.1. Limitations of Biomarkers

The use of laboratory biomarkers is often confounded by non-nutritional reasons that undermine their utility as predictors of nutritional status. Serum albumin and prealbumin, popular for the diagnosis of protein-caloric malnutrition, can remain within the reference range early into the malnutrition period due to compensatory responses, generating false negatives when the diagnosis and treatment are already delayed (Fuhrman et al., 2004). In addition to non-nutritional issues, inflammatory disease, including sepsis, autoimmune disease, and cancer, further complicates the interpretation of biomarkers due to the undeniable acute-phase response, which decreases protein production, hiding true nutrient insufficiency (Gabay & Kushner, 1999). Increased CRP levels may diminish albumin and prealbumin values, even in well-nourished individuals, warranting the need for a contextualizing additional marker such as IL-6 (Heyland et al., 2011). In addition, new biomarker testing, such as IGF-1 or fibroblast growth factor-21 (FGF-21) assays, requires advanced laboratory technologies and substantial cost to implement, which leaves limited

provision in low-resource facilities (Bourdel-Marchasson et al., 2010). As a result, this requires us to diagnose with caution and design ever more targeted biomarkers to aid in understanding client health.

6.2. Barriers to Nursing Assessments

Nurse assessments are beneficial because they cover an all-encompassing picture. However, they take longer and require extra training to be reliable and accurate. Yet, in overcrowded clinical situations, such as busy acute care hospitals, or lack of staff allocation in long term care settings, time allowed for assessments is often limited. Consequently, the result is an incomplete or shallow assessment that cannot be reliable and may overlook significant malnutrition signs (Persenius et al., 2008). One example is providing an entire dietary history using instruments such as the 24-hour dietary recall - or the MNA, which is not possible without a dedicated time segment and patient buy-in, as this may present an obstacle in a fast-paced atmosphere or with cognitively impaired patients (Archer et al, 2013). Cultural and linguistic diversity also introduces barriers in obtaining a dietary history, especially in ethnically diverse communities with differing eating practices and health literacy (Söderhamn et al., 2012). In addition, the subjective nature of instruments like the SGA and the fact that it relies, in part, on clinical judgment to evaluate physical findings and patient history, leaves room for interobserver variability, especially when using assessment by inexperienced clinicians (Steenson et al., 2013). Taking together, these limitations emphasize the need for systematized training and efficient assessment instruments to enhance the feasibility and reliability of a nurse assessment.

6.3. Variability Among Populations

Nutrition assessment tools must be population-specific to account for physiological, cultural, and socio-economic differences in nutritional status. Population-specific malnutrition cut-offs for anthropometric measures, like body mass index (BMI), vary among older populations compared to younger populations because age-related changes, such as sarcopenia, alter the composition of muscle mass and interpretation of BMI (Winter et al., 2014). Age, biological sex, and ethnicity impact reference ranges for biomarkers, e.g., vitamins (vitamin D) and trace elements (zinc), and population-specific standards are warranted to consider diagnostic accuracy (Kyle et al., 2005). Similarly, pediatric patients and critically ill patients are especially challenging populations because standard nutritional assessment tools (e.g., BMI, serum albumin) are not indicators of unique nutrient needs (e.g., increased energy need due to growth or critical condition) (Joosten & Hulst, 2011). Dietary habits and socio-economic status, such as household food insecurity, further complicate nutrition assessments because a patient may be able to consume adequate nutrients but not be able to access nutrient-dense food items (Loopstra et al., 2015). Therefore, given such variations, it is very important to develop and validate population-specific nutrition assessment tools and reference ranges for fair and accurate nutrition assessments for patients in various populations.

7. Future Directions

The future of nutritional assessment depends on addressing current limitations through technological advancement, standardized methodologies, and interdisciplinary collaboration. New technologies, including metabolomics and proteomics, could reduce gaps in identifying new specific and sensitive biomarkers (Combs & McClung, 2017). Wearable devices and mobile health applications can augment nursing assessment by providing real-time data streams of dietary intake, physical activity, and metabolic measures (Pereira et al., 2015). For example, dietary tracking applications via smartphone technology have added value to dietary histories and offset recall bias (Thompson & Subar, 2017).

Standardization of assessment methodologies is critical to achieving consistency in clinical practice settings. Standardized diagnostic criteria for malnutrition have been endorsed by the Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition (ASPEN), combining biomarkers with clinical assessment to help benchmark assessment accuracy against a standardized definition (White et al., 2012). Additionally, education-based programs for nurses have the potential to increase accuracy and confidence in assessments, particularly in resource-poor environments where laboratory capabilities are limited (Tappenden et al., 2013). Electronic health records (EHR) integrated with

decision-support tools can be leveraged to analyze real-time biomarkers and assessment data to provide timely clinical intervention (Corkins et al., 2014).

Socioeconomic determinants of malnutrition, such as food insecurity, require policy-level interventions to create equitable access to nutrition resources. Community-based and public health strategies that target systemic barriers to healthy eating can help referring clinicians supplement their clinical assessments (Loopstra et al., 2015). Finally, continued research into personalized nutrition that has been informed by genetic and metabolomic profiles holds great potential for directing individualized interventions and maximizing the clinic's nutritional assessments (Ordovas et al., 2018).

8. Conclusion

Laboratory biomarkers and nursing assessments have divergent yet complementary capabilities and, considered together, can offer an all-encompassing evaluation of nutritional status. Biomarkers can provide precise, objective data on any nutrient deficiencies or metabolic imbalances, while nursing assessments offer a more holistic overview of nutrition that considers drivers of health, including dietary habits, physical condition, and psychosocial concerns. Although both laboratory biomarkers and nursing assessments have unique strengths, ongoing development to troubleshoot and improve areas that can limit utility will need to continue, including variability of biomarkers, timing of assessments, and differences in populations. Future advancements in relation to biomarker discovery, biomarker technology, and standardized protocols for assessing nutrition will enable greater accuracy and accessibility for nutritional assessment and are ultimately expected to improve patient outcomes overall. By building and supporting collaboration across disciplines to address the socioeconomic challenges of food systems, health systems may incorporate and implement sustainable, effective, and equitable nutrition care.

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حالة المؤشرات الحيوية المخبرية والتقييم التمريضي في الحالة التغذوية: مراجعة شاملة

الملخص

تُعد الحالة التغذوية من الجوانب المهمة في مجال الصحة، حيث تؤثر على التعافي الصحي، والوقاية من الأمراض، وجودة الحياة لدى العديد من الفئات السكانية. وترتبط سوء التغذية، بما في ذلك نقص التغذية، وفرط التغذية، ونقص المغذيات الدقيقة، بمدة الإقامة في المستشفى، والمراضة، والوفيات. استعرضت هذه المراجعة المنهجية مساهمات المؤشرات الحيوية المخبرية والتقييمات التمريضية في تقييم الحالة التغذوية. يمكن للمؤشرات الحيوية المخبرية (مثل الألبومين، والبري ألبومين، ومستويات المغذيات الدقيقة مثل فيتامين د والزنك) أن توفر مؤشرات موضوعية وقابلة للقياس حول نقص العناصر الغذائية والاضطرابات الأيضية. ومع ذلك، قد تكون صلاحية هذه المؤشرات أقل من المثالية، لأنها تتأثر بعوامل غير تغذوية مثل الالتهاب وفشل الكبد. من ناحية أخرى، توفر التقييمات التمريضية (كالسير الذاتية الغذائية، والقياسات الجسمانية، والفحوصات البدنية مثل التقييم الذاتي الشامل) فهماً أكثر شمولاً للأنماط الغذائية والحالة البدنية والجوانب النفسية والاجتماعية، ولكنها محدودة بعوامل مثل الوقت وصلاحية أدوات التمريض. إلا أن الجمع بين التحاليل المخبرية والتقييمات التمريضية يعزز القدرة التشخيصية عند التعرف على سوء التغذية وتشخيصه) مثل: أداة التقييم الشامل لسوء التغذية(MUST) ، ودراسات الحالات لكبار السن، والمرضى الجراحيين .(وتشمل التحديات في تقييم الحالة التغذوية التباين في المؤشرات الحيوية، وضيق الوقت المتاح للتقييمات التمريضية، وصعوبات التقييم الناجمة عن الاختلافات بين الفئات السكانية. تشمل التوجهات المستقبلية في التقييم استخدام الميتابولومكس، والأجهزة القابلة للارتداء، وتوحيد الإرشادات. ستُعدّ هذه الدراسة بمثابة خارطة طريق لتحسين تقييم التغذية من خلال نهج تعاوني متعدد التخصصات، والاستفادة من التقنيات والابتكارات الحديثة.

الكلمات المفتاحية :الحالة التغذوية، التقييم التمريضي، المؤشرات الحيوية المخبرية، الرعاية متعددة التخصصات، سوء التغذية.