HANDBOOK OF

Nutrition in the Aged

Third Edition
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HANDBOOK OF
Nutrition in the Aged
Third Edition

Edited by
Ronald R. Watson
Series Preface for Modern Nutrition

The CRC Series in Modern Nutrition is dedicated to providing the widest possible coverage of topics in nutrition. Nutrition is an interdisciplinary, interprofessional field par excellence. It is noted by its broad range and diversity. We trust the titles and authorship in this series will reflect that range and diversity.

Published for a scholarly audience, the volumes in the CRC Series in Modern Nutrition are designed to explain, review, and explore present knowledge and recent trends, developments, and advances in nutrition. As such, they will also appeal to the educated layman. The format for the series will vary with the needs of the author and the topic, including, but not limited to, edited volumes, monographs, handbooks, and texts.

Contributors from any bona fide area of nutrition, including the controversial, are welcome.

We welcome the contribution *Handbook of Nutrition in the Aged, Third Edition*, edited by my ever-productive colleague Ronald R. Watson. Scientific interest in aging, especially nutritional aspects, continues unabated. I am sure this volume will make a scholarly contribution to the field, as have the prior two very worthy editions.

Ira Wolinsky, Ph.D.

*University of Houston*

*Series Editor*
Preface

As we age, lower levels of physical activity and food consumption accentuate changes associated with aging. Lower levels of income and finances substantially reduce nutritional state and ability to maintain health via adequate nutrition. Therefore, the main focus of this book is understanding the role of nutrition, as well as supplementation and undernutrition, in health in the elderly. Intuitively and scientifically, adequate diet and thus nutrition, education, and nutritional supplementation should improve the amount and quality of life in seniors.

Undernutrition and very low food intake, leading sometimes to malnutrition and starvation, are significant problems of seniors, especially when institutionalized. Therefore, the needs of the elderly, which differ from those of young adults and growing children, are defined for key nutrients. In addition, support mechanisms and ways to provide improved dietary intake in the institutionalized are described and evaluated. Assessment of nutritional status in the elderly presents special problems.

The association of diet and hypertension in seniors is important to increasing longevity, as are other nutritional problems including undernutrition. The aging adult offers a number of nutritional challenges, such as determining which nutrients or combination will promote health and how they affect cell structure and function. Nutritional support for surgery patients or those with anorexia are special needs of seniors, not just healthy young adults. Cells in older people have altered nutritional needs and biochemical activities, including protein turnover. Key systems that protect the individual, such as immune defenses, decline with age even under adequate nutrition. Therefore, knowledge of the changing composition of the body, its needs for micro- and macronutrients, and its nutritional state facilitates care and survival of older people. The overall focus of this book is on the role of altered nutritional intake and needs in health promotion in older people.
About the Editor

**Ronald R. Watson, Ph.D.**, has edited 50 books, including three books on aging. He worked for 20 years on research relating to nutrition and its role in moderating aging and immunosenescence.

Dr. Watson attended the University of Idaho but graduated from Brigham Young University in Provo, Utah with a degree in chemistry in 1966. He completed his Ph.D. degree in 1971 in biochemistry at Michigan State University. His postdoctoral schooling was completed at the Harvard School of Public Health in nutrition and microbiology, including a 2-year postdoctoral research experience in immunology. He was an assistant professor of immunology and did research at the University of Mississippi Medical Center in Jackson from 1973 to 1974. He was an assistant professor of microbiology and immunology at the Indiana University Medical School from 1974 to 1978 and an associate professor at Purdue University in the Department of Food and Nutrition from 1978 to 1982. In 1982, he joined the faculty at the University of Arizona in the Department of Family and Community Medicine. He is also a research professor in the University of Arizona’s newly formed College of Public Health. He has published 450 research papers and review chapters. Dr. Watson initiated and directed the Specialized Alcohol Research Center at the University of Arizona College of Medicine for 6 years.

Dr. Watson is a member of several national and international nutrition, immunology, and cancer research societies. He has directed a program studying ways to slow aging, funded by Wallace Genetics Foundation, for 22 years. He is also currently studying the role of nutrition and antioxidants to moderate heart disease in a model of aging.
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Section I

Nutritional Supplementation and Health
Nutrition and Electrolytes in the Elderly

Marthe J. Moseley

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Nutrition plays a pivotal role in health promotion, disease prevention, and chronic disease management. The normal physiologic changes of aging place the elder at risk for potential complications regarding altered nutritional state and electrolyte imbalance. The most important principle in limiting the possibility of complications at any time throughout the age span is prevention.

I. INTRODUCTION

The population of older persons has risen dramatically and will continue to grow rapidly throughout the world. In 1990, more than 31 million Americans were over the age of 65; by 2040 this number will exceed 75 million (1). One of the major reasons for increased life expectancy and longevity includes increased emphasis on health promotion and disease prevention (2). Although longevity has increased, whether the added years of life are filled with health and vigor or chronic disease and limited functional status or disability is unknown (1).

There is a trend toward increased life expectancy in the aged, yet chronic conditions are prevalent and influence older people's ability to maintain their functional state (3). Good health is the key factor in maintaining an independent and productive life in the elderly. The expected outcome of good health reaches beyond longevity to the goal of an acceptable quality of life, without debilitating disabilities. For those with chronic illness, optimizing functional status is cornerstone in preventing a downward functional decline (4).

II. BACKGROUND

Dietary and nutritional factors underlie many elements that contribute to health disparities in elders (5). In the past, national health care expenditures have totaled more than $666 billion, for which
30% are associated with inappropriate diet (6). Those at risk for diminished quality of life and functional status due to the effects of an altered nutrition intake include individuals who have chronic disease conditions (6). Presence of nutrition risk factors may extend into chronic disability (7). Some data indicate that many of the continued health problems associated with the elderly are preventable through dietary intervention (8).

Inappropriate dietary intake is associated with 5 of the 10 leading causes of death in the U.S.: coronary artery disease, certain cancers, stroke, diabetes mellitus (noninsulin-dependent), and atherosclerosis (9,10). Many of the health problems associated with the elderly are preventable or controllable through dietary changes (9–11).

III. IMPORTANCE OF ADEQUATE NUTRITION

Adequate nutritional status has been recognized as an important factor in the prevention and treatment of chronic disease (12). The elderly are particularly prone to inadequate nutritional status because of age-related physiologic (13,14) and social changes, development of chronic diseases (15), use of medications (16–18), and decreased mobility (19,20). These factors may lead to subclinical malnutrition, which is not easy to recognize or separate from changes resulting from the aging process itself. If undetected, subclinical malnutrition among older people may result in more rapid deterioration of health and early death.

Factors affecting nutritional status are multidimensional and interrelated. For older adults, age-related changes in body function (gastrointestinal changes) (21,22), lifestyle, medication use (23,24), and the prevalence of chronic disease challenge maintenance of good nutrition. Psychosocial factors including income (25), social interactions, and access to transportation all can affect the client’s nutritional state (26,27). Measures to promote good nutrition must specifically address the interrelated and multifactoral factors that affect nutritional status.

Nutrition plays a pivotal role in health promotion (28), disease prevention, chronic and disease management (29,30). Older Americans experience a variety of nutritional problems related to changes associated with aging. These changes are related to social, environmental, economic and physical alterations (17,31–33). Major physiologic changes that occur comprise a decrease in total body protein, a reduction in total body water, a loss in bone density, and an increase in the proportion of total body fat with a redistribution of fat stores (29). Cumulatively, these changes place a substantial number of elderly at high risk for poor nutrition status (28,34,35).

More specifically, many elderly patients requiring hospitalization show signs of malnutrition on admission or develop malnutrition during hospitalization (36–39). Malnutrition from any cause impacts on the recovery and rehabilitation after surgery and is not limited to protein-calorie deficiency but also low intakes of iron, vitamins, and minerals (29,38). Management of perioperative care in geriatric patients is typically more complex than in younger patients, due to changes associated with advancing age (40). One in four elderly suffer from malnutrition, which is costly in the surgical patient because it leads to impaired immune system, poor wound healing, infections, complications, multi-system organ failure, prolonged hospitalizations, catastrophic costs, and death (29,40–44). Factors that are critical for obtaining the best outcomes from surgical treatment of elderly patients include avoidance of disturbances in nutritional and electrolyte status (40).

Immune response, typically a protective pattern, is impaired in old age, resulting in an augmented risk of infection (29,40,45). Nutrition is a significant determinant of immunocompetence. Functional adaptations include decreased lymphocyte proliferation, reduced production of interleukin-2, impaired mixed lymphocyte reaction, and decreased natural killer cell activity (45–48).
IV. DETECTION OF NUTRITIONAL RISK

The DETERMINE your nutritional health checklist (Figure 1.1) completed during an assessment phase may detect high nutritional risk (36,49). The elderly can complete this form during an annual checkup in a primary care clinic, upon admission to the hospital or during the pre-admission work-up (50). The checklist depicts a series of warning signs of poor nutritional status for elder Americans. A foundation for further assessment and intervention is also provided. Elders with higher checklist scores are more likely to have the poorest levels of nutrient intake and increased threat of adverse health risks (35). The checklist, developed by the Nutrition Screening Initiative, can be used by a wide range of social service and health care professionals (18). Specifically, the Level II Screen helps to distinguish those individuals with nutritional problems that can have a profound impact upon nutritional health for the hospitalized elder. A thorough history and physical examination, including use of the Level II Screen alerts the health care provider of abnormal values, including anthropometric measurements and laboratory data; drug use, including use of over-the-counter medications; and clinical features including eating habits, living environment, functional status and mental/cognitive status issues affecting nutritional status in the elder (18,51).

THE DETERMINE YOUR NUTRITIONAL HEALTH CHECKLIST.

The warning signs of poor nutritional health are often overlooked. Use this checklist to find out if you or someone you know is at risk.

Read the statements below. Circle the number in the yes column for those that apply to you or someone you know. For each yes answer, score the number in the box. Total your nutritional score.

YES

I have an illness or condition that made me change the kind and/or amount of food I eat. 2
I eat fewer than 2 meals per day. 3
I eat few fruits or vegetables, or milk products. 2
I have 3 or more drinks of beer, liquor, or wine almost every day. 2
I have tooth or mouth problems that make it hard for me to eat. 2
I don't always have enough money to buy the food I need. 4
I eat alone most of the time. 1
I take 3 or more different prescribed or over-the-counter drugs a day. 1
Without wanting to, I have lost or gained 10 pounds in the last 6 months. 2
I am not always physically able to shop, cook, and/or feed myself. 2

Total


In those elders who are identified as having a poor nutritional status, screening identifies the need for additional support (28). An outcome of poor nutritional status may lead to functional impairment and disability, which, in turn, may reduce quality of life and increase morbidity and mortality (36,40,53,54).

V. OPTIMAL INTERVENTION

Interventions are taken to improve an elderly individual’s nutritional status once a nutrition problem has been identified. Nutritional intervention planning begins with estimating the patient’s nutrient balance, for example, nutrient intake vs. nutrient loss. Calorie and protein intake calculated through
a diet history is essential in estimating the nutrient intake (49,55). Many times, nutrient loss is predicted as a total of all output excreted from the elder.

Harris and Benedict equation (HB) estimates basal energy expenditure (BEE) through parameters such as gender, age, height, and weight (56). A correction factor is added to the BEE to determine calorie needs conditional on the degree of metabolic stress the elder exhibits. The relationship between resting metabolic rate (RMR) and the HB was explored in a study that suggested that the World Health Organization (WHO) equations appear more precise than the HB equations (57). The FAO/WHO/UNU Expert Group recommendations determined weight to be the most useful and practical index for predicting BEE within a given gender and age range (Table 1.1) (58). The BEE is multiplied by factors that account for energy costs to determine total energy requirement (Table 1.2).

### TABLE 1.1
Estimate of BEE (kcal) by Age and Gender

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>18–30</td>
<td>15.3 W + 679</td>
<td>14.7 W + 496</td>
</tr>
<tr>
<td>30–60</td>
<td>11.6 W + 879</td>
<td>8.7 W + 829</td>
</tr>
<tr>
<td>60+</td>
<td>13.5 W + 487</td>
<td>10.5 W + 596</td>
</tr>
</tbody>
</table>

**Note:** W = body weight in kilograms


### TABLE 1.2
Energy Costs of Physical Activity Expressed as Multiples of BEE

<table>
<thead>
<tr>
<th>Level of Activity</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light work</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Moderate work</td>
<td>2.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Heavy work</td>
<td>3.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Residual time (no activity, but awake)</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Sleeping</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>


Protein is the main nutrient used as a reference point for determination of the nutritional requirements in the elderly surgical patient (38). It is well known that amino acids are the building blocks of proteins and are essential in the metabolic response to stress (38). Nitrogen balance is used as an index of protein nutritional status (48). Nitrogen is released when amino acids are catabolized and excreted in the urine as urea. Nitrogen balance determination is indicated when an elder is anabolic (positive nitrogen balance) or catabolic (negative nitrogen balance), and is an
Nutrition and Electrolytes in the Elderly

indication of depletion of the lean body mass. Nitrogen balance is essential and the human body must maintain an adequate supply.

Prospects for achieving positive or even neutral nitrogen balance are unlikely when there is greater stress on an elder (31). The amount of replacement nitrogen to consider to be administered to an elder with a calculated loss is determined by measuring nitrogen lost in urine, feces, and through the skin. Protein requirements can be estimated without actual measurements of nitrogen lost through these body substances. The minimum requirement for the elderly for protein amount to 1 g/kg/day (59). When necessary, protein intake must be increased to fulfill the demand of disease or illness. The requirement for this increase is 1.5 to 2.0 g/kg/day (31,60).

VI. ROUTE SELECTION

If nutritional support is indicated in an elderly person, the most appropriate route must be determined. A nutrition support consultation may be indicated for older individuals who, because of anatomical, physiological or mental health problems, cannot meet their nutritional needs by eating a nutritionally balanced diet. Nutrition support consultation may provide for interventions that include altering usual food intake by modification of nutrient content or optimizing nutrient density or food consistency or form. The goal of nutritional support is to maintain adequate nutritional state, to determine and institute dietary modifications needed for prevention of energy and nutrient deficiencies, and for management of the elder with the most efficient method possible (35).

The enteral route is the preferred route and the optimal route for nutrition administration. The estimation of the nutrient balance accomplished when completing the calorie count might reveal at least 50% ingestion of nutritional needs; supplementation may be sufficient to increase intake to an optimal nutrient level. If, however, less than 50% of nutritional needs are ingested, tube feedings may become a necessity (38,61). Tube feedings can be instigated if gastric output is not more than 600 ml per day on gravity drainage (38). In the hospital or acute care setting the gastric residuals are obtained every 4 hours to determine that the residual does not exceed 50% of the volume infused. At the start of gastric feedings, rates are initially slow to determine tolerance. Increases by 20 to 25 ml/h are completed every day until the patient’s nutrient requirements are met (38). Other options for feeding access include nasoenteric tubes or jejunostomies in the compromised elder. It is well known and documented that bowel rest causes intestinal mucosa atrophy with increased permeability to bacteria and endotoxins, thus the phenomenon of bacterial translocation and endotoxemia (31). As a result of this, one may need to consider, for example, that if all nutritional needs cannot be met intestinally, whenever possible, the intestine should be stimulated with some amount of enteral nutrition as a preventive measure (38). A balanced diet administered continuously over 24 hours in the elderly should include an optimally balanced polymeric formula of the three major nutrients — protein, carbohydrates, and lipids (38).

VII. WATER AND ELECTROLYTE BALANCE

Total body water accounts for 60% of body weight in young men and somewhat less in young women. Declining with age, water content reaches 50% and 45% of body weight in men and women over 60 years old, respectively (62). This reduction in body water is associated with the decrease in lean body mass, as water composes 72% of muscle tissue (13).

Age, body size, fluid intake, diet composition, solute load presented for renal excretion, metabolic and respiratory rates, body temperature, and presence and extent of abnormal fluid losses — for example, diarrhea, wound drainage, and fever — in part determine fluid and electrolyte balance (13). The body gains water via the gastrointestinal tract (GI) with additional water produced as a result of oxidation. Oral intake encompasses approximately two-thirds of the intake and usually
is in the form of pure water or some other beverage, and the remainder is via ingested food (13). Water is mainly lost through the skin, lungs, GI tract, and kidneys. These fluid losses are coupled with varying losses of electrolytes, which must also be replaced.

The kidneys primarily regulate homeostasis, the maintenance of body fluids. There is a progressive decrease in kidney function, in particular the glomerular filtration rate (GFR), as a result of aging (63). The reduction in GFR is equivalent to the decline in muscle mass explanatory of the normal creatinine associated with aging (63).

Cardiac output (CO) in part determines renal blood flow and GFR. Thus, any alteration in CO, such as hypothermia, that results in a decrease in CO will result in a reduced renal blood flow and GFR (63). Acute renal failure (ARF) is one indicator for increased mortality in the elder patient. The characteristics of ARF are a rise in the blood urea nitrogen (BUN) and creatinine, with or without oliguria. In the elder patient, an immediate evaluation of the cause of increased BUN or creatinine to correct or remove reversible factors is required.

### VIII. PREVENTIVE INTERVENTION

Prevention is the most practical approach to fluid and electrolyte balance in the elderly. Although the recommended amount of water ingested is not different for adults across the lifespan, the elder is prone to an inadequate water intake, with dehydration manifesting as the most common disturbance (60).

The elderly in general are less able to restore and maintain fluid, as the handling of water is less effective and the physiological response of aldosterone and vasopressin is altered (61). There is some justification for increased requirements for water in older patients as a result of increased loss through thinned skin and impairment of the concentrating ability of the kidneys (61).

An elder individual should be encouraged to consume 2 l of fluid per day or 1 ml of fluid per kilocalorie ingested to approximate at least 1500 ml/day. Adequate water intake is 30 ml/k of actual body weight and is essential for normal renal and bowel function (29).

The kidney plays a critical role in control of fluid balance regulating electrolyte homeostasis as well. The physiological capability of an elder to deal with extremes in sodium load has not been well studied. A wide variety of disease states commonly found in the elderly are linked to the incidence of altered sodium levels (64). Components of the excretion of sodium are affected by GFR. As the GFR decreases in the elderly, the ability of the kidneys to handle wide ranges in sodium load is diminished. This may be related to a decrease in the sensitivity to sodium or an altered response of the angiotensin–aldosterone system (63,64).

As in sodium regulation, the kidney is responsible for maintaining the potassium balance and metabolic acid levels in the body. Gastrointestinal losses of potassium and acids are at times common in the elderly especially those undergoing a surgical event. Serum concentrations of potassium and hydrogen ion may not reflect the severity of the deficit due to a simultaneous dehydration. Potassium depletion predisposes the elder to dysrhythmias. The risk of an alteration in rhythm status is compounded and particularly dangerous if the patient is also on digitalis medications (13). Hyperkalemia in itself is a serious dilemma for elderly persons on potassium-sparing diuretics.

Whether acute or chronic, many illnesses are accompanied by exaggerated additions in metabolic acid production. The aging kidney may not excrete the hydrogen ion load as effectively, thus increasing the severity of metabolic acidosis (63). The usually predictable compensatory response by the lungs to hyperventilate may be inadequate with the addition of pulmonary disease.

Severe imbalances of electrolyte concentrations are often accompanied by serious clinical manifestations (64). Particularly in the older patient, clinical improvement may lag behind correction of the electrolyte abnormality (63). Therefore, electrolyte imbalances should be recognized and corrected as soon as possible.
IX. CONCLUSION

Physiologic changes associated with the normal process of aging place the elder at risk for complications, particularly during illness. Prevention is the most important principle in limiting the possibility of complications. The goals for the elderly person include maintaining nitrogen balance, sustaining intravascular volume, and preserving electrolyte status. Scrupulous attention must be placed on screening and assessment to prevent untoward events from occurring. Awareness with the circumstances of the elderly plus routine and regular screening offers the best guarantee for timely identification of nutritional risk and electrolyte imbalance, which leads to prompt, appropriate intervention. Nutritional and electrolyte status maintenance in the elderly improves health status and quality of life.

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<td>Health Status and Physical Functioning</td>
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