

Clinical and economic outcomes of nutrition interventions across the continuum of care

Marian de van der Schueren,¹ Marinos Elia,² Leah Gramlich,³ Michael P. Johnson,⁴ Su Lin Lim,⁵ Tomas Philipson,⁶ Azra Jaferi,⁷ and Carla M. Prado⁸

¹Dutch Malnutrition Steering Group and VU University Medical Center, Amsterdam, the Netherlands. ²National Institute for Health Research Biomedical Research Centre (Nutrition), and University Hospital Southampton NHS, University of Southampton, Southampton, England, United Kingdom. ³Department of Medicine, University of Alberta, Edmonton, Alberta, Canada. ⁴BAYADA Home Health Care, Moorestown, New Jersey. ⁵Dietetics Department, National University Hospital, Singapore. ⁶Harris School of Public Policy, University of Chicago, Chicago, Illinois. ⁷The New York Academy of Sciences, New York, New York. ⁸Department of Agricultural, Food, and Nutritional Sciences, University of Alberta, Edmonton, Alberta, Canada

Address for correspondence: annals@nyas.org

Optimal nutrition across the continuum of care plays a key role in the short- and long-term clinical and economic outcomes of patients. Worldwide, an estimated one-quarter to one-half of patients admitted to hospitals each year are malnourished. Malnutrition can increase healthcare costs by delaying patient recovery and rehabilitation and increasing the risk of medical complications. Nutrition interventions have the potential to provide cost-effective preventive care and treatment measures. However, limited data exist on the economics and impact evaluations of these interventions. In this report, nutrition and health system researchers, clinicians, economists, and policymakers discuss emerging global research on nutrition health economics, the role of nutrition interventions across the continuum of care, and how nutrition can affect healthcare costs in the context of hospital malnutrition.

Keywords: malnutrition; hospitalization; health economics; health care; patient outcomes

Introduction

Malnutrition has traditionally been associated with overt famine and starvation, evident in conditions such as kwashiorkor and marasmus. However, these conditions are not nearly as common as the malnutrition that is seen in many hospitalized patients and that may not be detected by simple visual observation. This recognition led to recent efforts to rethink malnutrition as it relates to what is being seen in hospitals in the 21st century, prompting a shift from the traditional starvation-related definition of malnutrition to disease-related malnutrition.¹ The occurrence of malnutrition in hospitals worldwide ranges from 20% to 50% and is associated with adverse clinical outcomes.^{2,3} Furthermore, poor nutritional status is known to worsen during hospital stay.⁴ The prevention and treatment of hospital malnutrition offers an opportunity to optimize the overall quality of patient care, improve clinical outcomes, and reduce healthcare costs. However,

malnutrition continues to remain unrecognized and untreated in many hospitalized patients.⁵

To address the global problem of malnutrition, leading international researchers, clinicians, economists, and policymakers convened at the conference “Clinical and economic outcomes of nutrition interventions across the continuum of care,” held March 13, 2014, presented jointly by the Abbott Nutrition Health Institute and the Sackler Institute for Nutrition Science at the New York Academy of Sciences. This report provides an overview of the topics presented at the conference, including research on nutrition health economics, the role of nutrition interventions across the continuum of care, and how nutrition can affect healthcare costs in the context of hospital malnutrition.

The new malnutrition: challenges of changing the paradigm globally

Kelly Tappenden (University of Illinois) set the stage for the conference with a keynote address on the

current context of healthcare reform, the burden of malnutrition, the benefits of nutrition intervention, and initiatives to enhance nutrition care. She emphasized three straightforward take-home messages from her presentation: (1) malnutrition is common worldwide; (2) malnourished patients have poorer health-related outcomes than their non-malnourished counterparts; and (3) nutrition intervention can make a difference.

Among the factors that are driving current healthcare reform in the United States are the aging population and healthcare costs. The number of individuals older than 55 years of age is steadily increasing, and the older the patient, the higher the costs of health care. For patients over 75 years of age, healthcare costs are three times more than for the average aged adult.⁶ In 2010, \$2.6 trillion—nearly 18% of U.S. GDP—was spent on health care and the largest portion of these healthcare expenditures (34%) went toward hospital care. Part of healthcare reform involves increasing the quality of care and avoiding preventable and costly occurrences in the hospital, including surgical site infections (\$39 million/year), falls (\$6.6 billion/year), pressure ulcers (\$11.1 billion/year), and readmissions (\$12 billion/year).^{7,8} When these hospital events occur, the length of stay can increase, readmissions are more likely, and patient satisfaction can decrease. All of these issues—an aging population, more consumption of health care, and evolving healthcare policies where pressures exist to increase quality and decrease costs—offer a timely opportunity to elevate the role of nutrition in improving patient outcomes and decreasing the cost of care.

Tappenden discussed the recent shift from the traditional starvation-related definition of malnutrition to disease-related malnutrition,¹ including two new categories of malnutrition most relevant to the topics discussed at the conference and that differ from the traditional definition in that inflammation is a central component of the condition. First, in chronic disease-related malnutrition, inflammation is chronic and mild to moderate, such as that seen in patients with organ failure, pancreatic cancer, rheumatoid arthritis, or sarcopenic obesity. Second, acute disease- or injury-related malnutrition involves acute severe inflammation seen, for example, with major infections, burns, trauma, or closed-head injury. The new disease-related definitions of malnutrition set the stage for the development of

a consensus statement by the American Society for Parenteral and Enteral Nutrition (ASPEN) and the Academy of Nutrition and Dietetics on the characteristics for the identification and documentation of adult malnutrition,⁹ primarily undernutrition. The group developed six criteria, of which two or more were needed to diagnose malnutrition, including insufficient energy intake, weight loss, decreased functional status, fluid accumulation, decreased subcutaneous fat, and decreased muscle mass.

Tappenden explained that, although sick or injured individuals, especially the elderly, are at risk for malnutrition,¹⁰ hospitalization itself often worsens nutritional status.¹¹ According to studies using various nutrition assessment methods to diagnose malnutrition in a broad U.S. population from 1976 to 2013, one-third to one-half of patients entering the hospital are malnourished;² of those that were well-nourished upon hospital admission, 38% became malnourished over the course of their stay.⁴ Malnutrition is common not only in U.S. hospitals but also in hospitals worldwide. For example, 50% of European nursing home and hospital patients over 80 years of age were at risk for malnutrition;¹² 43% in Cuban hospitals were moderately malnourished and 11% were severely malnourished;¹³ 51% of older Australians in rehabilitation hospitals were at risk for malnutrition;¹⁴ and 42.5% in a Chinese hospital were found to be malnourished.¹⁵

The high prevalence of malnutrition in hospitals in the United States and worldwide is particularly problematic given that malnourished patients have poorer health-related outcomes than their well-nourished counterparts. Tappenden presented a study by Fry *et al.* examining over 880,000 surgical patient cases from 1368 hospitals in an effort to describe the risks of severe events and hospital-acquired infections in those with preexisting malnutrition/weight loss.¹⁶ It was found that the risk for developing a surgical site infection among these patients was 2.5 times greater compared to patients without preexisting malnutrition. Furthermore, the risk was 5.3 times greater for mediastinitis, 5.1 times greater for urinary tract infections, and 3.8 times greater for pressure ulcers, suggesting that malnutrition can dramatically increase the risk of severe events.

Nutritional status also influences a range of other health-related outcomes in hospitalized patients regardless of disease severity. For example, a study that

controlled for disease severity as well as other non-nutritional factors (age, gender, disease type, and quality-of-life indicators) found that, among 3122 participants from 56 hospitals, malnourished patients had a significantly increased length of hospital stay (15 days versus 10 days), increased readmission rates (36% versus 30%), and a twofold greater risk of 90-day in-hospital mortality compared to controls.¹⁷ Therefore, despite having the same severity of disease as their non-malnourished counterparts, malnourished patients had poorer outcomes.

Nutrition interventions in malnourished patients can improve patient care quality and reduce overall healthcare costs. These interventions have been shown to result in a 28% reduction in avoidable readmissions,¹⁸ a 2-day reduction in average length of hospital stay,¹⁹ a 25% reduction in pressure ulcer incidence,²⁰ and a 14% reduction in overall complications (e.g., infections, anemia).²¹ In an example of the effects of a nutrition intervention on falls in malnourished older adults newly admitted to an acute care hospital, those given an energy- and protein-enriched diet, oral nutrition supplementation (ONS), calcium/vitamin D supplements, and telephone counseling for 3 months after hospital discharge were found by a randomized controlled trial (RCT) to suffer fewer falls compared with controls receiving the usual care.²² Nutrition intervention also results in clinical, nutritional, and functional benefits in a broader elderly population with a range of diseases, including gastrointestinal disease, cancer, chronic obstructive pulmonary disease, and pressure ulcers. Specifically, a systematic review of 36 RCTs among elderly subjects reported that high-protein ONS significantly reduced complications by 19%, length of hospital stay by 10%, hospital readmissions by 30%, and increased handgrip strength, body weight, muscle mass, and protein and energy intake with little reduction in normal food intake.²³

Various education and awareness initiatives have responded to the evidence on the value of nutrition interventions. Tappenden discussed, for example, the Alliance to Advance Patient Nutrition, which represents over 100,000 dietitians, nurses, physicians, and other clinicians, and aims to provide hospitals with resources to advocate for effective nutrition practices, ultimately transforming patient outcomes through nutrition. The Alliance identified a number of barriers that exist within hospitals to enhance patient nutrition. For example, (1)

one-third of patients admitted to hospitals are malnourished; (2) the problem of malnutrition is often considered to be the responsibility of dietitians, but dietetics departments are often inadequately staffed; (3) nutrition care is often delayed due to the patient's medical status, lack of diet order, or the time it takes to receive a nutrition consult; (4) nurses are present 24 h/day, observe intake and tolerance, and interact with patients and their families, yet are not consistently included in nutrition care; (5) a physician sign-off is required to implement a nutrition care plan; and (6) many patients experience difficulty consuming meals without assistance. With these barriers in mind, the Alliance published a consensus paper that urged an interdisciplinary approach to address adult hospital malnutrition²⁴ and described the Alliances Nutrition Care Model that identified the need for principles to transform the hospital environment and to guide clinical action. The paper argues that, to transform the hospital environment, hospitals need to create an institutional culture where nutrition is viewed as a priority for improving care quality and cost; redefine clinicians' roles to include nutrition; and communicate nutrition care plans and leverage electronic health records to standardize nutrition documentation. The consensus paper also outlined three principles to guide clinician action, including recognizing and diagnosing all patients at risk of malnutrition; implementing interventions within 24 h of at-risk screening; and finally, incorporating nutrition care and education in the hospital discharge plan.

Tappenden concluded the keynote address by suggesting that one way to attract the attention of colleagues that are not nutrition advocates, particularly policy makers and hospital administrators, and to encourage them to prioritize nutrition is to emphasize not just the quality-of-care issues, but also the financial impact, stressing that nutrition can improve both patient outcomes and financial costs.

Malnutrition data and insights from around the world

Prevalence and impact of malnutrition in Canadian hospitals

Leah Gramlich (University of Alberta) opened the first session with a presentation on recent research on malnutrition in Canadian hospitals, conducted by the Canadian Malnutrition Task Force (CMTF). The CMTF was formed under the Canadian

Nutrition Society in 2010 by a group of Canadian researchers and practitioners, with the goal of creating knowledge and closing the gaps between research and practice in the prevention, detection, and treatment of malnutrition among Canadians through the continuum of care. In order to facilitate this vision, CMTF developed and implemented a prospective cohort study in adult patients admitted to Canadian hospitals (including academic, community, small, and large centers) in eight provinces, which included over 1000 patients in 18 hospitals. This work was done in collaboration with CMTF members Johane Allard, Paule Bernier, Donald Duerksen, Khurshed Jeejeebhoy, Manon Laporte, H el ene Payette, and Heather Keller. The purpose of the study was to address the pan-Canadian prevalence of malnutrition, to assess nutrition care in Canadian hospitals, and to evaluate how malnutrition and nutrition care affected patient outcomes, such as the length of hospital stay, readmission, mortality, and changes in nutritional status.

Gramlich presented preliminary results on the first 160 patients from this study, which has been published in abstract form.²⁵ Patient participants were on average 63.2 ± 15.8 years of age, and 56% were female. Their most frequent diagnosis was related to a gastrointestinal disorder (34%) and cancer (8.1%), with a Charlson comorbidity index score of 2 (0–14). Fifty-five percent, 35.6%, and 9.4% of patients had a Subjective Global Assessment (SGA) score of A, B, or C, respectively, indicating an overall presence of malnutrition in almost one-half of the patients. Further analysis identified 53% of the sample as elderly and more likely to be malnourished than patients younger than 65 years of age.²⁶ Accessing food while admitted to the hospital was a common issue for patients, with 20% unable to access meals, 16% needing help to cut their food, 30% having difficulty opening packages, 9% experiencing difficulty feeding themselves, and 15% having chewing or swallowing difficulties.²⁶ One month after hospital discharge, 30% and 26% of elderly patients reported poor appetite and significant weight loss, respectively.²⁶ Furthermore, readmission rates and mortality were higher in patients with malnutrition (SGA B and C) compared to well-nourished patients (SGA A), and hospital stay was associated with deterioration in nutritional status, indicated by reductions in weight and mid-arm and calf circumference.²⁵

The CMTF also aimed to identify and understand the perspectives of patients, nutrition care personnel, physicians, and nurses in order to support an ongoing national strategy related to knowledge translation. Preliminary data on patient surveys ($n = 240$; 94% response rate) showed that patient perception of food quality was high, but many reasons were given for not eating food. The study identified meal disturbances and help with meals as issues that need to be addressed to improve nutrition care.²⁷ A qualitative study with 91 participants (dietitians, dietetic interns, diet technicians, and menu clerks) in eight focus groups at participating study hospitals provided evidence and guidance towards improving nutrition culture in Canadian hospitals;²⁸ this evidence has been woven into the CMTF knowledge translation priorities. Physician surveys were also undertaken at the study hospitals to determine physician attitudes and perceptions regarding the detection and management of malnutrition in Canadian hospitals.²⁹ While physicians believe that a nutrition assessment should be performed at admission, during hospitalization, and at discharge, the majority felt that this was not being done on a regular basis.²⁹ Similarly, there was a gap between what was perceived to be the ideal management of hospital-related malnutrition and current practices.²⁹ According to the study's conclusions, what is needed is a multidisciplinary team to address hospital malnutrition and educational strategies that target members of the team to promote better detection and management throughout the hospital stay.

Through the work of the CMTF, national-level data on malnutrition prevalence and predictors of in-hospital malnutrition have been identified—specifically, how to more readily respond to and improve malnutrition. The CMTF now has an increased understanding of how to achieve nutrition care goals that integrate patient needs and of overcoming barriers to food and nutrition intake. This has resulted in the identification of the following knowledge translation priorities in order to achieve the goals of the CMTF:

- standardized screening is mandatory in acute care hospitals;
- administrators and healthcare teams are educated on the need to integrate nutrition care into medical practice;

- mealtimes are patient focused; protected care is consistent with the nutrition care plan;
- food and nutrition services are optimized to provide high-quality appropriate (e.g., culturally, texturally appealing) food with adequate nutrients for recovery;
- multidisciplinary teams are involved in nutrition care, and roles are delineated; registered dietitians determine nutrition care plan, including route; and
- nutrition therapies, including ONS and enteral and parenteral nutrition, are used effectively.³⁰

Gramlich concluded that the work of the CMTF may facilitate the mobilization of provincial malnutrition strategies by building on CMTF data and processes. Ultimately, the goal is to influence health policy such that malnutrition screening and care becomes mandatory across the continuum of care. For example, CMTF malnutrition strategies align with evolving initiatives at a provincial level in Alberta Health Services (AHS). The AHS approach is characterized by the assertion that “nutrition care is everyone’s responsibility.” In order to achieve these provincial goals, nationally developed nutrition care processes supported by the CMTF can create an appetite for policy and practice change that may support more widespread implementation across Canada.

Hospital malnutrition: practical steps to improve clinical outcomes—the Singapore experience

In her presentation, Su Lin Lim (National University Hospital) used the malnutrition experience of hospitals in Singapore to illustrate practical steps to improve clinical outcomes. Although previous studies have shown a prospective association between malnutrition and clinical outcomes, the confounding effect of disease and its complexity has seldom been taken into consideration using diagnosis-related groups (DRGs). It is widely agreed that disease and malnutrition are closely linked and that disease may cause secondary malnutrition, and vice versa. However, it is often argued that the length of hospital stay, mortality, and hospitalization costs are primarily determined by the patient’s medical condition rather than malnutrition.

In order to determine the prevalence and outcomes of hospital malnutrition, Lim and her colleagues conducted a 3-year prospective study on 818 newly admitted patients in a Singapore tertiary hospital.³¹ The results were adjusted for gender, age, and ethnicity, and matched for DRG. They found that the prevalence of malnutrition was 29%. Furthermore, malnourished patients stayed in the hospital one and a half times longer than well-nourished patients (6.9 ± 7.3 days versus 4.6 ± 5.6 days, $P < 0.001$) and were twice as likely to be readmitted within 15 days of being discharged (adjusted relative risk = 1.9, 95% CI 1.1–3.2, $P = 0.025$). Within a DRG, the mean difference between the actual cost of hospitalization and the average cost for malnourished patients was three times higher than that for well-nourished patients ($P = 0.014$). Malnourished patients had a four times and three times higher risk of death at 1 year and 3 years post-discharge, respectively (adjusted hazard ratio = 4.4, 95% CI 3.3–6.0, $P < 0.001$).³¹

In order for hospital malnutrition to be properly addressed, Lim stated that there must be a comprehensive start-to-end system that provides continuity of care from hospital admission to post-discharge (Fig. 1). She recommended that this include screening hospitalized patients to identify those who are malnourished or at risk of malnutrition, referral of appropriate patients for nutrition assessment, inpatient nutrition intervention, and post-discharge follow-up and monitoring. The first critical step in managing malnutrition is the systematic screening and identification of malnourished patients, using a screening tool that is simple, quick, reliable, valid, and cost-effective. Lim discussed the development and validation of such a screening tool, referred to as the 3-Minute Nutrition Screening (3-MinNS), specific for the Singapore population with its multiethnic population. The 3-MinNS was found to be both sensitive (86–89%) and specific (83–88%) in identifying patients at risk of malnutrition^{32,33} and showed good inter-rater reliability among nurses (agreement = 78.3%, $k = 0.58$, $P < 0.001$).³³

Even with the use of a valid and reliable nutrition screening tool, inaccurate screening results may be obtained if the tool has missing data or the screening is completed erroneously. In fact, studies have reported screening incompleteness and error rates of 28–97% in commonly used nutrition screening tools.^{34,35} This may result in the under-recognition

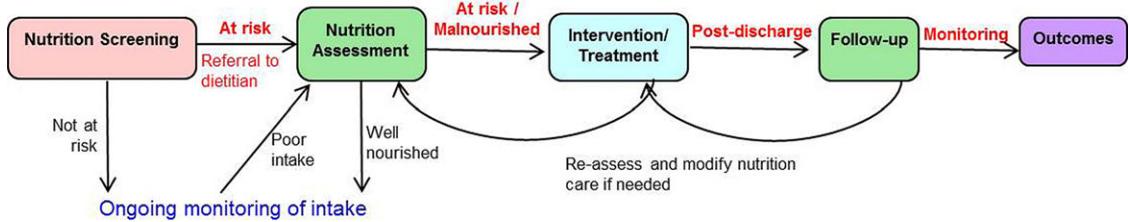


Figure 1. A start-to-end system providing continuity of care from hospital admission to post-discharge in order to address hospital malnutrition.

and subsequent under-treatment of malnourished or at-risk patients, especially when patients are not referred to a nutrition-trained professional. In order to determine nurses' compliance to nutrition screening, Lim and her colleagues carried out a 6-year audit and quality-improvement study on 4467 patients³⁶ and found that the error rates were 33% and 31% in 2008 and 2009, respectively, with 5% and 8% of the forms being blank or missing. Of all patients scored to be at risk of malnutrition, 10% were not referred to a dietitian. A series of quality-improvement activities were subsequently implemented, which included (1) establishing a nutrition screening protocol in the hospital system, (2) incorporating nutrition screening training as part of the compulsory nurses' orientation program, (3) empowering nurses to participate in the online dietetics referral of at-risk cases, (4) establishing a closed-loop feedback system, and (5) removing a component of the nutrition screening that caused the most error, without compromising sensitivity and specificity. After implementation of these quality-improvement activities, error rates were reduced to 25% (2010), 15% (2011), 7% (2012), and 5% (2013), and the percentage of blank or missing forms was reduced to and sustained at 1% over the past 3 years. Non-referrals decreased to 7% (2010), 4% (2011), and 3% (2012 and 2013), and the mean turnaround time from screening to referral was reduced significantly from 4.3 ± 1.8 days to 0.3 ± 0.4 days ($P < 0.001$).³⁶ This study showed the extent that a nutrition screening tool can be completed accurately by nurses so that newly admitted patients at nutritional risk can be provided with the appropriate intervention as soon as possible.

Lim recommended that any patient identified at the time of screening to be malnourished or at risk of malnutrition should be referred to receive a full nutritional assessment and intervention, followed by

comprehensive management, including monitoring and/or intervention. However, these patients often become lost to follow-up after hospital discharge, and there is limited evidence on effective methods of post-discharge follow-up to treat malnutrition. An audit on dietetic follow-up of 261 malnourished patients discharged from the hospital in 2008 found that only 15% of patients returned for follow-up with a dietitian within 4 months post-discharge. After implementation in 2010 of a novel model of care, referred to as Ambulatory Nutrition Support (ANS), a 100% follow-up rate was achieved.³⁷ ANS provides 4 months of post-discharge care consisting of telephone calls, outpatient appointments, and home visits for patients who failed to attend the scheduled outpatient appointments. Seventy-four percent of malnourished patients enrolled under the ANS program showed improved nutrition status, as determined by an SGA. Mean body weight improved from 44.0 ± 8.5 kg to 46.3 ± 9.6 kg ($P < 0.001$). In addition, the European Quality of Life Five Domains Visual Analogue Scale improved from 61.2 ± 19.8 to 71.6 ± 17.4 and handgrip strength improved from 15.1 ± 7.1 kg force to 17.5 ± 8.5 kg force ($P < 0.001$).

Lim concluded that, on the basis of evidence from studies on hospital malnutrition in Singapore, it is possible to successfully deliver a comprehensive model for managing hospital malnutrition, from screening on admission and referral for assessment, to intervention and post-discharge follow-up.

Malnutrition screening and strategies in the Netherlands

Marian de van der Schueren (Dutch Malnutrition Steering Group and VU University Medical Center) continued the global theme from the previous presentations and showed work from the Dutch Malnutrition Steering Group on strategies and keys to

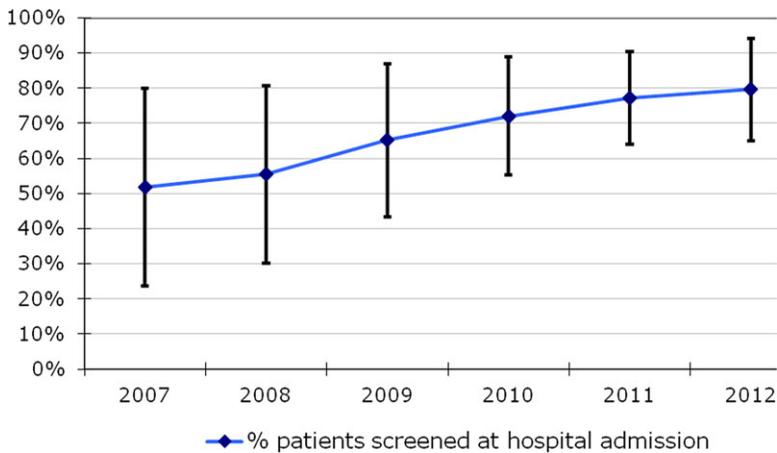


Figure 2. Percentage of patients screened for malnutrition at hospital admission in the Netherlands (2007–2012),⁴³ following implementation of a large national project by the Dutch Malnutrition Steering Group.

success in fighting malnutrition in the Netherlands. The Dutch Malnutrition Steering Group was established in 2005 with the goal of facilitating prevention, recognition, and optimal treatment of malnutrition in the Netherlands, as well as encouraging scientific research on the problem of malnutrition. In order to reach these goals, the Dutch Malnutrition Steering Group adhered to a stepwise approach involving the following 10 steps: (1) raise a multidisciplinary steering group with authority, representing all disciplines involved in the screening and treatment of malnutrition; (2) create awareness of the problem of malnutrition by collecting prevalence data (the Dutch Annual Measurement of Care Problems); (3) develop quick and easy malnutrition screening tools, connected to a treatment plan; (4) screen and treat malnutrition as mandatory quality indicators; (5) develop validated evidence-based tools and conduct cost-effectiveness research; (6) involve the Ministry of Health as a key stakeholder in order to strengthen the message; (7) carry out implementation projects in all healthcare settings, including hospitals (with children and outpatients), residential care homes, primary care, and home care; (8) make toolkits, ready-to-use presentations, and best practices freely accessible to everyone; (9) encourage multidisciplinary project teams at all institutions; and (10) develop training programs and workshops. This stepwise approach was first implemented in hospitals, then in residential care and the community.

De van der Schueren stressed that, with regard to malnutrition programs, implementation is a prerequisite for success. A large national implementation project entitled “Early recognition and optimal treatment of malnutrition in hospitals” was carried out between 2006 and 2009 and involved almost all hospitals in the Netherlands. Hospitals could participate either actively by attending meetings that guided them through the first year(s) of implementation or passively by following and independently implementing the strategies developed and published by the Dutch Malnutrition Steering Group. Following the implementation project in hospitals, similar projects were carried out in the nursing home setting and in primary care.

De van der Schueren discussed four main achievements of the Dutch Malnutrition Steering Group since 2005, of which the first were quality indicators. Malnutrition is now included in the main list of quality indicators in Dutch health care. All hospitals have to report their performance on 17 predefined quality indicators, such as the number of blood transfusions and perioperative infections. Screening for malnutrition became a quality indicator in 2007, meaning that screening became mandatory for all patients admitted to hospitals. Out of more than 1 million hospital admissions per year, 80% of patients were screened for malnutrition in 2012 (Fig. 2).³⁸

As of 2013, screening for malnutrition has become mandatory for children (with a screening tool

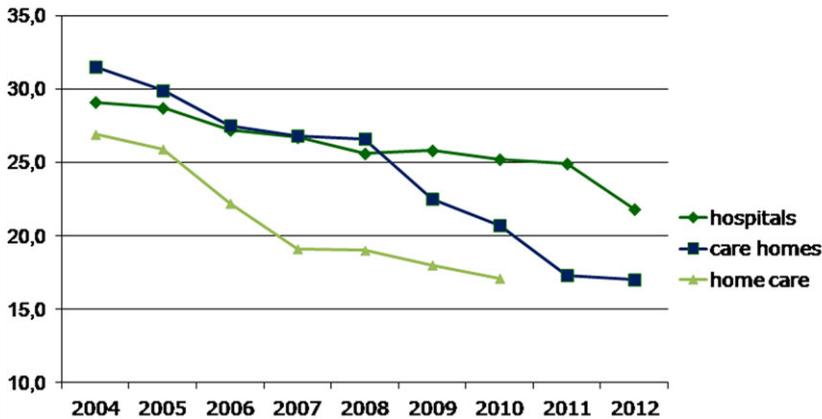


Figure 3. Steady decrease in malnutrition prevalence rates in all healthcare settings in the Netherlands,³⁹ following screening and treatment strategies implemented by the Dutch Malnutrition Steering Group.

specific for children) and for outpatients in high-risk departments (e.g., perioperative, geriatrics). Even more important than screening is monitoring the treatment of malnourished patients, and since 2008, treatment of malnutrition has also become a quality indicator. Optimal treatment is measured by the percentage of patients with an adequate protein intake (at least 1.2 g/kg body weight) on the fourth day of hospital admission. Although the goal is to have 60% of malnourished patients reach this lower limit of 1.2 g protein/kg/day, this goal has not yet been met in the majority of Dutch hospitals. Following the screening and treatment strategy, malnutrition prevalence rates have decreased steadily over time in all healthcare settings (Fig. 3).³⁹

The second achievement of the Dutch Malnutrition Steering Group was the development of a website and a multitude of tools (Short Nutritional Assessment Questionnaire (SNAQ) screening tools for different healthcare settings,⁴⁰ pocket booklets, methods for the easy recording of intake, information leaflets for hospitals and patients, and PowerPoint presentations) to facilitate implementation of malnutrition screening and treatment in different healthcare settings. In 2010 the Dutch Malnutrition Steering Group was awarded the European Society for Clinical Nutrition and Metabolism (ESPEN) Medical Nutrition International (MNI) grant for their efforts to fight malnutrition in the Netherlands. This award was used to translate and develop an international website (www.fightmalnutrition.eu), describing the strat-

egy of the Dutch Malnutrition Steering Group and providing free tools for download in different languages.⁴¹

The third achievement discussed by de van der Schueren relates to the reimbursement of supplements. If a validated screening tool has been used and a patient has been identified as at risk of malnutrition, ONS or tube feeding will be reimbursed by insurance companies.

Lastly, the Dutch Malnutrition Steering Group conducted validation studies of the screening tools, cost-effectiveness studies on the effects of nutritional interventions, collected prevalence data, and studied enablers and barriers to screening.^{38,40,42,43} All data collected were published, either in Dutch or English, to guarantee continued awareness of the problem of malnutrition.

Although the Dutch have a unique position worldwide with national mandatory screening and treatment of malnutrition, the work is not yet done. De van der Schueren described several new goals for the future: (1) For inpatients, treatment of malnutrition needs to be improved with a multidisciplinary approach and strict treatment plans. (2) In addition to inpatient malnutrition, the focus is shifting to outpatients; the chain could be better strengthened, thus providing continuity of nutritional care across healthcare settings. (3) Community-dwelling older adults have an increased risk of malnutrition, especially those receiving home care. Although for community dwelling patients that receive home care the reported prevalence rates of malnutrition

are high (approximately 30%), the recognition of malnutrition in this group is low.¹² In addition to creating more awareness among healthcare professionals, informing and involving the patients themselves as well as their caregivers might provide a strategy to successfully fight malnutrition among frail home-living older adults. (4) Basic education in clinical nutrition for physicians and nurses needs to be improved. (5) Funding of the Dutch Malnutrition Steering Group comes from grants; the work is highly appreciated by all parties involved, including the Ministry of Health. Being able to establish a malnutrition knowledge center, with the certainty of at least some amount of stable and basic funding, would allow the Dutch Malnutrition Steering Group to continue its work and be able to create a long-term strategy. (6) Finally, after almost 10 years of addressing the problem of malnutrition and with the aim of becoming an established knowledge center, the Dutch Malnutrition Steering Group is evaluating and restructuring itself, attracting people with more influence in the political arena, and appointing key researchers for subsections concerning children, chronically ill patients, and the elderly.

In summary, the Dutch Malnutrition Steering Group has now been actively involved in fighting malnutrition in the Netherlands for 9 years. Malnutrition prevalence rates are steadily decreasing across healthcare settings. De van der Schueren concluded that future goals will, among others, aim to improve preadmission and post-discharge recognition and treatment of malnutrition, treatment of all patients identified as malnourished, and education. The recognition of malnutrition as an important healthcare problem needs to be stressed continuously and an established knowledge center may help attract ongoing attention from healthcare professionals, governments, and patients themselves.

Consequences of malnutrition on oncology treatment

Carla Prado (University of Alberta) closed the first session with a presentation on malnutrition in cancer, the influence of malnutrition on cancer prognosis, and reversing malnutrition in cancer, potentially with anabolic therapy. Cancer is associated with severe malnutrition caused by a variety of neural, nutritional, pro-inflammatory, and autocrine/endocrine factors that ultimately cul-

minate in an imbalance between anabolism and catabolism,⁴⁴ favoring the latter. Malnutrition during the cancer disease trajectory has traditionally been identified as abnormally low body weight, commonly defined as a body mass index (BMI) lower than 18.5 kg/m², and often studied as part of the cancer-associated cachexia syndrome. Cancer-associated cachexia was originally described as a dynamic process of involuntary weight loss and as a syndrome associated with anorexia, chemosensory distortion, early satiety, and hypermetabolism. However, recent evidence suggests that the majority of patients with cancer, especially those diagnosed with advanced disease, have, in fact, normal or even high body weights.^{44–49} As extensively highlighted in previous publications, body weight and its derivative BMI do not depict the different proportions of lean versus adipose tissue, which may have different prognostic relevance.^{50,51}

Lean tissue depletion, particularly skeletal muscle depletion, has been the hallmark of cancer-associated cachexia.^{44,52} The prevalence and significance of skeletal muscle depletion as a marker of malnutrition has been more recently highlighted due to the development of new technology to assess human body composition.⁵¹ Among the available techniques, Prado highlighted the use of computerized tomography (CT) scans, whose images can be retrieved from patients' medical records for the additional purpose of body composition research, providing accurate and reliable information on the quantity and quality of skeletal muscle (Fig. 4).^{50,53} The use of CT images for the study of body composition in cancer has provided a different perspective on the identification of skeletal muscle depletion. Although muscle loss would be expected to occur alongside changes in body weight, severe muscle depletion (termed *sarcopenia*) has been found to be prevalent regardless of body weight.^{49,54} In other words, muscle depletion can occur at any given BMI (low, normal, or high).

The understanding of the variability in body composition of contemporary cancer patients has been leading to a change in paradigms in cancer cachexia research. Cancer cachexia has recently been recognized by an international consensus group as a syndrome characterized by muscle depletion that can occur regardless of body weight (i.e., with or without loss of fat mass).⁵² This new face of malnutrition (particularly manifested by muscle loss)

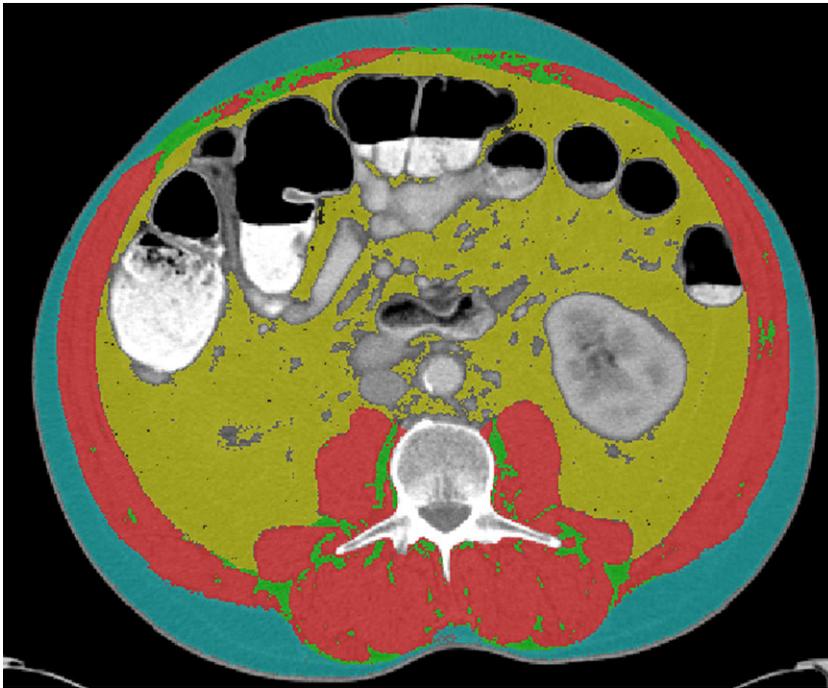


Figure 4. Computerized tomography image analyzed for body composition.⁵⁰ The third lumbar vertebrae were analyzed using SliceOmatic software (Tomovision, Montreal, Quebec, Canada). The colors represent skeletal muscle (red), intramuscular adipose tissue (green), visceral adipose tissue (yellow), and subcutaneous adipose tissue (blue).

has emerged as an important and independent predictor of poorer outcomes for patients undergoing oncology treatment, affecting chemotherapy toxicity,^{50,55} outcomes of surgery,^{48,56} tumor progression, as well as survival.^{45,49,54}

Prado presented data showing, in patients with severe muscle depletion, a higher incidence of dose-limiting toxicity, which is an unfavorable response to cytotoxic agents, leading to treatment termination, discontinuation, hospitalization, and death.⁵⁰ Recent data have also highlighted the association of muscle depletion with the outcomes of major surgery; these patients present with higher rates of postsurgical complications and have a consequently prolonged length of hospital stay.^{48,56}

The independent association between muscle depletion and shorter time to tumor progression or shorter survival has also recently been shown and may be indicative of a potential relationship between muscle catabolism promoting tumor progression or impaired immunologic responses.^{45,49,54} Of note, the majority of patients in the abovementioned studies were classified as being in the overweight

or obese BMI category, highlighting the fact that muscle depletion, and hence malnutrition, may be a hidden condition, requiring more sophisticated nutritional assessment tools for its diagnosis and accurate prognosis.⁵⁷

Last, Prado discussed how the substantial influence of malnutrition on oncology treatment suggests the value of nutritional assessment, as well as the need to develop appropriate interventions to countermeasure losses of muscle mass. Recent evidence suggests a window of opportunity for anabolism earlier within the disease trajectory and may be an opportune time for conducting RCTs of emerging new interventions that stop or reverse muscle loss.⁵⁸ In Prado *et al.*, cancer patients within 3 months of death were characterized by intense muscle loss and low likelihood of muscle gain.⁵⁸ Therefore, contrary to the common inclusion criteria of RCTs, the study highlighted that the patients most likely to respond to an anabolic therapy are those with stable disease with greater than 3 months of life expectancy, who may not necessarily be losing weight at that time.⁵⁸

Nutrition interventions, costs, and economic benefits

Impact of oral nutritional supplementation on hospital outcomes

Opening the session on costs and economic benefits of nutrition interventions, Tomas Philipson (University of Chicago) discussed the effect of ONS use on hospital outcomes. Malnutrition in hospitalized patients is common and hazardous, affecting as many as 62% of acute care patients⁵⁹ and being especially prevalent in oncology and gastroenterology patients,⁶⁰ and in the elderly.²² Previous work suggests that malnourished patients have longer hospital stays, higher complication and readmission rates, greater and more severe morbidities, and an increased mortality risk.⁶¹ The use of ONS on the other hand, may reduce the likelihood of these adverse outcomes.⁶² Despite the risks to health and the existence of a potential solution, malnutrition in hospitalized patients is underappreciated and under-treated.

While studies on malnutrition and ONS use are informative and suggestive, several issues, such as narrowly selected patient populations and modest cohort sizes, limit their interpretation. An observational study design confers several advantages over randomized controlled trials in this context. It considers real-world prescription rates, adherence, and pricing; large sets of actual patient data; and outcomes spanning long periods. The notable limitation is that observational design lacks randomization—treated patients can be systematically different from untreated patients. Fortunately, these biases can be minimized using techniques from the field of health economics and outcomes research.

To reduce potential confounds arising from differences in observed patient characteristics, Philipson and his colleagues used propensity-score matching to pair ONS episodes to similar non-ONS episodes. Specifically, they used logistic regression of ONS use on the basis of demographic and health covariates (e.g., age, ethnicity, admission history, comorbidities), pairing each ONS-episode patient with her/his nearest non-ONS-episode neighbor. They also used instrumental variables (IV) analysis to reduce the effect of selection bias and identify the causal effect of ONS on outcomes that may result from nonrandom case selection.^{63,64} In other words,

they measured a hospital's propensity to prescribe ONS rather than the patient characteristics that may have prompted its use. In this way, they created a "natural experiment" from retrospective data. For comparative purposes, they also used ordinary least squares (OLS) analysis, an approach that retains certain selection biases.

The focus of Philipson's study was the effect of ONS use on 30-day readmission rates, length of hospital stay, and episode costs for hospitalized adult patients, using the Premier Research database (Premier, Inc., Charlotte, North Carolina), a database that contains diagnostic and billing information on 44 million adult inpatient episodes at 460 sites during the years 2000 to 2010.⁶⁵ Length of stay was defined as the number of days of direct patient care from hospital admission to discharge. Episode cost was defined as actual inpatient costs reported in 2010 inflation-adjusted dollars. Admission to any Premier hospital within the same month or month following discharge for any diagnosis was classified as a 30-day readmission. ONS use was defined as a Premier database entry of "complete nutritional supplement, oral," and episodes involving tube feeding were excluded. The return on investment equaled: (savings generated through ONS use – amount spent on ONS)/amount spent on ONS, where the amount spent on ONS was the average cost of ONS use per episode, and the savings generated through ONS use were the average reduction of actual cost in the episode that ONS was used.

Within the 11-year database, ONS was used in 724,027 of 43,968,567 adult inpatient episodes (1.6%); Philipson considered 1,160,088 observations for length of stay and episode cost (Table 1).⁶⁵ Using IV analysis, the predicted length of stay without ONS was 10.88 days versus 8.59 days with ONS, a reduction of 2.29 days (21%). The use of ONS reduced the average episode cost from \$21,950 to \$17,216, a reduction of \$4,734 or 21.6%. Of 862,960 relevant episodes, the probability of readmission was 0.320 in the ONS-treated group versus 0.343 in matched patients not receiving ONS, a reduction of 6.7% or 1.7 readmissions per 100 admissions. At an average readmission cost of \$18,418, this amounts to a savings of \$314.13 per episode. Since the average per-episode ONS cost was \$88.26 (fully burdened, including all relevant capital and labor expenses), this yields an expected net savings of \$225.87. In

Table 1. Effect of ONS use on LOS, cost, and 30-day readmission using instrumental variables analysis

	Without ONS	With ONS	Difference (percentage)
Length of stay	10.88 days	8.59 days	−2.29 days (−21.0%) ^a
Episode cost	\$21,950	\$17,216	−\$4,734 (−21.6%) ^a
Probability of readmission	0.343	0.320	−0.023 (−6.7%) ^a

^aSignificant at 1% level.

NOTE: LOS and episode cost based on 1,160,088 observations; 30-day probability of readmission based on 862,960 observations. Abbreviations: ONS, oral nutritional supplement; LOS, length of stay.

other words, for every dollar spent on ONS, the net savings was at least \$2.56.

In summary, Philipson illustrated how health economics and outcomes research techniques afforded rigorous study of a large, real-world patient data set. IV analysis minimized randomization bias and created a natural experiment from retrospective data. It was concluded that ONS use reduces length of stay, total cost, and 30-day readmission, and provides an over 2.5:1 return on investment.⁶⁵

The new interventions protocol in England from a systems approach

Marinos Elia continued the discussion on the economic outcomes of nutrition interventions in his presentation on a new nutrition intervention protocol developed in England from a systems approach. Since the treatment of malnutrition over the course of a patient's journey often spans more than one care setting, the costs and cost savings in a single setting provide an incomplete picture of the overall economic consequences of the treatment. This issue is confounded further when there are separate funding streams for different care settings, especially if one of the streams absorbs the costs and another reaps the benefits (cost savings). For example, the use of ONS can incur a substantial cost in the community setting, especially if they are prescribed for several months, but randomized controlled trials suggest that they can produce cost savings in the hospital setting by reducing admissions.⁶⁶ Another complexity is that subjects may receive more than one type of treatment simultaneously (e.g., ONS, dietary counseling, and enteral tube feeding (ETF)) or sequentially. A budget impact analysis can help provide insights into some of these complexities, if it is made on the basis of a costing model involving several types of nutritional support in numerous care settings.

In 2012 and 2013, the National Institute for Health and Care Excellence (NICE) in England updated the evidence base, underpinning its guidelines on nutritional support in adults and drafted a quality standard to indicate aspirational but achievable standards of nutritional care in hospital, community, and care home settings involving ONS, ETF, and parenteral nutrition (PN).⁶⁷ Accompanying the quality standard was a costing document,⁶⁸ which examined the budget impact of changing the current pathway of nutritional care to one incorporating the NICE clinical guidelines/quality standard. Although implementation of the proposed pathway required substantial additional investment to enable additional screening, assessment, and treatment (with ONS, ETF, and PN) to be carried out in hospital, community, and care home settings, it produced an overall net cost savings (budget impact) of £UK 71,800 (\$US 113,800; 2012 prices) per 100,000 of the general population.⁶⁸ With this net cost savings, nutritional support in adults was ranked third among all calculated net cost savings resulting from implementation of NICE clinical guidelines for a wide range of treatments for different conditions. A summary of the main components of the cost impact analysis for nutritional support in adults is shown in Figure 5.

Having observed some potential limitations and inconsistencies in the above economic model, Elia and his colleagues conducted an independent review of the budget impact analysis of nutrition support interventions. The preliminary results from this review indicate that the overall net cost savings are greater than that reported by NICE, with the hospital dominating both the cost savings and the overall budget impact, predominantly due to ONS use (work in progress). The model suggested that even more favorable results can be achieved by reducing the time required for nutritional screening, the

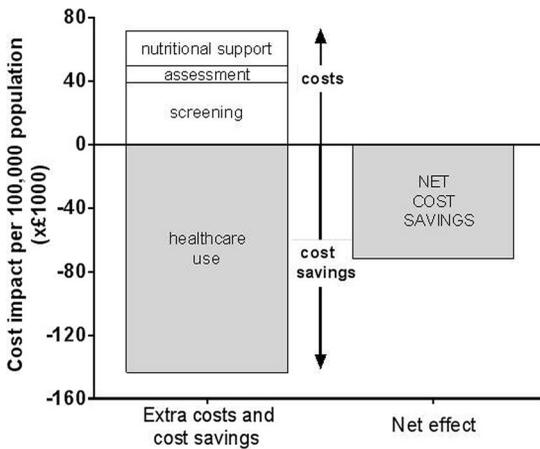


Figure 5. Cost impact analysis associated with changing the current pathway of nutritional care to one incorporating the National Institute for Health and Care Excellence (NICE) nutritional support guidelines/quality standard.⁶⁸ The results are expressed per 100,000 of the general population of England.

plausibility of which has been suggested by recent studies of hospital outpatients.⁶⁹ It also indicated that a more favorable budget impact is likely to be achieved in hospitals with high admission rates and a high admission prevalence of malnutrition, especially if there are policies to close large gaps that may exist between current and desired standards of care. Through a series of sensitivity analyses, the economic model was found to be largely robust. However, these analyses drew attention to the need to generally increase the evidence base on the effects of nutritional support on resource use in all care settings, especially in the hospital setting, which dominated the cost impact analysis, and to specifically increase the evidence base on the effects of dietary therapy without ONS.

Important changes in nutritional care have taken place in England over the last 5–10 years. For example, the Malnutrition Universal Screening Tool (MUST), which uses the same criteria to identify malnutrition in different care settings, is now used in more than 80% of hospital and care homes in the United Kingdom.⁷⁰ The increasing use of this tool, which links identification of malnutrition with management plans, has helped facilitate continuity of care between care settings, as well as meaningful surveys, audits,^{70,71} and health plans. Furthermore, the NICE clinical guidelines and quality standard on nutritional support in adults have been promoted

and become widely available for multidisciplinary implementation.⁷² They have emphasized the need to link the results of screening to a care plan according to local resources and policies, and they have helped increase awareness about the detrimental effects of malnutrition. Education and training, as well as inspection and regulation, have also contributed to the changes in nutritional care over time. In the last 8 years, the estimated screening rate for malnutrition in patients admitted to hospitals in England has improved from approximately 30% to 65%,⁷³ but there is still room for considerable further improvement.

Elia stated that, in order to continue to make progress, it is necessary to take into account patient and caregiver perspectives on nutritional care, especially those that differ from healthcare professional perspectives.⁷⁴ It is also necessary to appreciate that malnutrition, with its various clinical and social care dimensions, cannot be effectively tackled by the Department of Health or government alone. Elia concluded his presentation by emphasizing the need for an integrated system of care, involving both governmental and nongovernmental organizations, including professional and patient organizations, as well as voluntary social care organizations and industry. Such an integrated system of care is more likely to be implemented and embedded in routine care if it is consistent, coordinated, and strategic.

Nutrition prevention interventions to address malnutrition in community-living elderly populations

In her presentation, H el ene Payette (University of Sherbrooke) provided an overview of research on interventions aimed at addressing malnutrition and preventing deterioration of nutritional status in older community-living adults. She began by describing the prevalence of malnutrition in diverse community-living elderly populations from Japan, South Africa, Canada, and various European countries. Regardless of the country or screening tool used, the prevalence of community-living elderly people at risk for malnutrition is similar, ranging from approximately 32–34%.^{12,75,76} A higher risk of malnutrition has been linked to older age, disability, medical illnesses, previous admission to a hospital, low education level, cognitive impairment, smoking, loss of a spouse, and low baseline body weight.⁷⁷

Insufficient dietary intake in community-living elderly individuals has deleterious consequences on physical and cognitive functioning and clinical outcomes. Conversely, a number of factors associated with the aging process influence dietary needs and prevent consumption of a nutritious diet.⁷⁸ For example, an individual's health status, consisting of chronic/acute illnesses, medication, aging-associated sensory changes, and oral health, interacts with nutritional status, and vice versa. Other factors that bidirectionally interact with nutrition include physical/functional status (e.g., physical limitations, balance/mobility, strength/endurance, and physical activity); environmental factors (e.g., economics, access to food, cultural traditions, lifestyle); and cognitive factors (e.g., depression, food habits, changes in mental status). Payette presents malnutrition in aging as a spiral, where reduced food intake will rapidly result in, for example, fatigue, decreased resistance to infections, depression, and loss of muscle strength, ultimately leading to a loss of autonomy and morbidity. She suggested that community-based interventions should use a multifaceted approach focusing on prevention of malnutrition and maintenance of nutritional well-being that targets both the causes and effects of malnutrition.

Some existing nutrition intervention programs established for older adults in the community are often very effective in improving energy and nutrient intake, as shown by data on the Meals on Wheels (MOW) program.⁷⁹ Programs that simply provide nutrition education to community-dwelling older adults have also been shown to be effective. For example, a systematic review of experimental studies that provided nutrition education in the form of mailed pamphlets and regular phone calls found significant improvements in dietary intake, behavior, and knowledge among participants recruited from the Older American Act Nutrition Program, Congregate Meals, or community centers, as compared to controls that received the usual care, peer support, or participated in an exercise program.⁸⁰ In addition, studies that offered a more personalized intervention in the form of individualized dietary counseling/advice reported increased healthy food intake, health-related habits, physical and psychological functioning, and reduced depression.⁸⁰ The same systematic review also assessed interventions using nutrition supplements and found that

the use of multinutrient supplements by healthy older adults were found to improve cognition and serum folate, while the use of liquid supplements by frail older adults at nutritional risk did not result in any significant improvements in functional outcomes.⁸⁰ The authors of this review concluded that the best results on nutrition-related outcomes are derived from comprehensive nutrition counseling that is personalized and involves goal setting. The best results on specific outcomes, such as cognition and serum nutrients, were thought to be found with the use of micronutrient supplements, specifically in healthy older adults.

Payette next presented data from two RCTs examining malnutrition among frail community-living elderly subjects.⁸¹ In the first study, elderly subjects (aged 80 ± 7 years) at high risk for undernutrition (weight loss/low body weight) were provided 16 weeks of nutrient-dense protein liquid supplements (Ensure[®], Ross Laboratories) along with counseling to increase food intake. Total energy intake, protein intake, and body weight were significantly increased in subjects that received the supplement but no effects were found on nutrient intake, muscle strength, or performance tests. According to Payette, this nutrition intervention may have been insufficient and delivered too late. She therefore conducted an RCT using the same nutrition intervention but this time over a longer duration of time (24 weeks) and in elderly subjects (aged 79 ± 6 years) that were only at a moderate risk of malnutrition. Again, the intervention succeeded in improving total energy intake, protein intake, and weight gain, but had no effect on muscle strength or performance tests. She concluded that, in order to improve functional status, it may be best to intervene simultaneously not only with nutrition but also with physical activity.

Such a multifactorial intervention was examined in a community-based RCT that combined a nutrition intervention with physical training in frail free-living elderly subjects aged 82.4 ± 4 years.⁸² Specifically, these subjects underwent five nutrition group sessions and individual counseling, plus group physical training twice a week for 3 months. No significant differences were found in energy intake, resting metabolic rate, or body composition. According to the authors of this study, one reason for the lack of significant effects may have been due to the heterogeneity of community-living

subjects. Future studies need to (1) develop methods for nutritional interventions targeting this particular population and those individuals that are more likely to respond to the intervention; (2) choose outcome measures that will be significant but not too far from the intervention; (3) consider ethical issues (e.g., placing frail elderly subjects at nutritional risk into a group receiving physical training alone without nutritional intervention); and (4) use interventions that are more personalized. In addition to the heterogeneity of subjects and the selection of outcomes, Payette also pointed out other methodological issues, including those related to the selection of study subjects, compliance, and the duration and intensity of the intervention. As an example of the importance of the intensity of the intervention, Payette presented data showing that when 50 kcal/kg of weight per day is provided to 20-year-old subjects, they are able to accrue 160 g of new cellular mass, while 70- to 80-year-old subjects undergoing the same intervention only accrue approximately 20 g of cellular mass,⁸³ suggesting that the intervention for elderly subjects was not sufficiently intensive and too short in duration.

Payette also discussed self-management education approaches aimed at increasing caloric intake in community-living elderly subjects. The Behavioral Nutrition Intervention for Community Elders (B-NICE) study,⁸⁴ a 3-month home-based RCT, evaluated the effectiveness of such an intervention in elderly subjects (aged 81.4 ± 8.2 years) that were homebound, had insufficient energy intake, and exhibited weight loss of $\geq 2.5\%$. To increase caloric intake, participants chose three of the following specific measurable short-term goals: add one snack per day; drink one glass of fruit juice daily; add one egg white to scrambled eggs at breakfast; make soup with milk; replace evening glass of water with milk; participate in an MOW program. Neither caloric intake nor body weight was significantly increased in the intervention group compared to the controls. Of note is the number of subjects that dropped out over the course of the study—200 eligible participants began in the study, but only 34 remained by the end. When a similar type of lifestyle intervention in the community was carried out with a larger sample size ($n = 176$ in intervention group and $n = 199$ in control group) and a longer duration (6 months) in elderly subjects, significant improvements were found in nutrition-related behaviors, including fre-

quent fruit intake, fat avoidance, and fat intake; and also increased physical activity, including walking, strength exercise, vigorous activity, and reduced sitting time.⁸⁵ Therefore, with more intensive, longer-duration interventions, significant improvements in nutrition and physical activity in community-living elderly individuals were observed.

Payette concluded her presentation by suggesting that future research in community-living older adults should focus on (1) prevention/promotion and intervention before subjects are at high risk for malnutrition; (2) well-designed behavioral lifestyle interventions; and (3) large trials with sufficient intensity and duration to test the effectiveness of nutrition interventions in improving nutritional status and reducing loss of muscle and function.

Nutrition in post-acute care settings: screening and intervention to reduce unnecessary hospital admissions

In the final presentation, Michael P. Johnson (Bayada Home Health Care) discussed the outcome of nutrition and screening intervention for homebound patients at risk for malnutrition. The growing aging population, both locally and globally, will significantly affect health care in the near future; with advanced age, acute and chronic health conditions are common. As a result, older Americans will experience more and longer hospital stays, and will require additional healthcare services, such as home health care, to support independence. A primary focus in the United States is to reduce hospital readmissions, which can negatively affect patient outcomes and healthcare costs. For healthcare providers, this means improving the quality of care and seeking new and better ways to help keep people safe at home in order to reduce the financial burden on patients, families, and the healthcare system as a whole.

As discussed by the previous speakers, one component of quality health care, often overlooked, is comprehensive nutrition screening, assessment, and intervention. It is clear that malnutrition significantly contributes to adverse outcomes, such as slower wound healing and increased incidence of falls, which, in turn, can lead to longer hospital stays (more days) and a greater frequency of re-admissions to the hospital.⁸⁶ Many patients, upon admission to the hospital, are malnourished and find that the resulting hospitalization only

contributes to further nutritional deterioration during their stay;⁴ these patients must be identified and classified as being at high nutritional risk during the hospital stay and, just as importantly, upon release from the hospital when being discharged to their home with home health services.

Malnutrition and age-related muscle loss, or sarcopenia, have serious health and economic consequences.⁸⁷ Muscle loss is highly prevalent in individuals older than 65 years of age and leads to negative outcomes, such as functional decline, hospitalizations, and poor quality of life. Furthermore, illness often exacerbates muscle loss, leaving many patients unable to consume sufficient calories and protein needed for recovery. ONS, as part of overall medical care, can help improve quality patient care by helping to lower the incidence of hospitalizations, wounds/infections, and falls.

The prevalence of malnutrition, and consequent sarcopenia, presents a unique and challenging situation for home health clinicians when caring for homebound patients.⁸⁸ It highlights the need for a clear focus on a process for nutritional screening and intervention planning, as part of the start of care assessment. Increased attention on malnutrition should help enhance a safer and more effective transition of care for these patients from the hospital back to their own homes. Johnson discussed how BAYADA Home Health Care recognized this gap and has been working to better understand and address the impact of a nutrition screening and intervention programs with new patients.

As an initial pilot project, BAYADA implemented a 6-month nutrition screen-and-intervene program for all new patients in seven offices throughout the United States (work in progress). The program consisted of four main steps: (1) educate and train staff clinicians; (2) find patients at nutritional risk using the validated nutritional assessment instrument already included as part of the Outcome and Assessment Information Set (OASIS); (3) administer the appropriate ONS to patients as part of their nutrition intervention; and (4) follow patients to measure their progress. The project's objectives were to improve healthcare outcomes—primarily decreased hospital readmission—by improving the nutritional status of at-risk home health patients; to educate clinicians on the value of early nutrition intervention and provide educational tools to patients to help

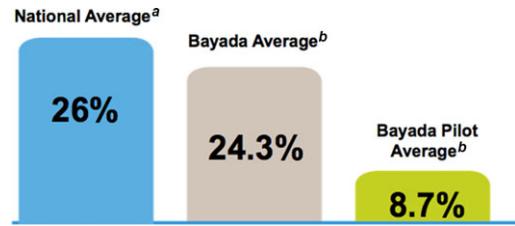


Figure 6. All-cause hospitalization rate. Implementing a clinician-directed early nutrition screen-and-intervene program resulted in a trend towards a lower all-cause hospitalization rate in patients at risk for malnutrition. Data shown are from a 6-month pilot study.

^aFrom <http://medicare.gov/homehealthcompare/search.aspx> (data as of 10/2011).

^bFor seven participating locations (in Arizona, Massachusetts, and New Jersey).

them evaluate their diet and nutritional needs; and to eliminate common barriers to the use of ONS, such as cost, taste, and patients' perceived need.

Of 1,259 total new patients that were classified according to the OASIS, the program identified 26.4% ($n = 332$) as being at a moderate-to-high risk of malnutrition (at risk). Among the at-risk patients, 76.8% received nutrition education; 58.7% received free ONS samples; 24.6% continued to take ONS after receiving the samples; and 8.7% were hospitalized during their course of home health care. It was found that implementing a clinician-directed early nutrition screen-and-intervene program resulted in (1) increased awareness of the importance of nutritional screening; (2) improvement in the nutritional knowledge of patients, caregivers, and clinicians; and (3) a trend towards a lower all-cause hospitalization rate in patients at-risk for malnutrition (Fig. 6).

In summary, the evidence shows that malnutrition and muscle loss are common in patients who need care at home. Johnson concluded that a targeted nutrition screen-and-intervene program can help improve outcomes in these patients. As a result, BAYADA has since implemented this program across its 75 home health offices nationally and expects this effort to help keep more people safe at home.

The clinical challenges of nutrition

To answer remaining questions about nutrition interventions across the continuum of care, the majority of speakers, including Elia, Gramlich, Johnson,

Lim, and Prado, came together for a panel discussion, with Tappenden as the moderator. Throughout the conference, much discussion was devoted to nutrition interventions in acute care, outpatient, and home care settings. However, as one audience member pointed out, nutrition-related initiatives are lacking in the transition of care from one setting (e.g., hospital) to another (e.g., home). Gramlich responded that efforts at her institution to advance nutrition strategies in this realm involve ensuring that data capture is consistent and electronic and allows for making inferences across a wide range of health settings. In addition, Lim described a project in Singapore that focuses on nutrition care in the hospital-to-home transition, where dietitians call and visit patients in their homes to ensure that they are continuing to follow the recommendations made to them in the hospital and to take the nutrition supplements, if any, that were prescribed to them. Johnson emphasized the difficulty of obtaining information about care from a previous setting and discussed efforts by BAYADA, in collaboration with partners in hospitals and skilled nursing facilities, to try to identify the specific nutritional supplements patients were taking in the hospital/nursing facility setting and transfer those to the home setting—a procedure that Lim noted is already taking place at her institution in Singapore. Elia added that, although coordinated care is clearly important, the challenges in providing this care arise from healthcare professionals and organizations working and having interests in one setting without feeling obligated to be responsible for what occurs in another setting, as well as added complexities from different funding streams for different care settings.

Another audience member pointed out the need to clarify common messages to the general public about overnutrition and obesity, so that reduced food intake in an effort to avoid obesity does not inadvertently result in inadequate protein intake and consequent sarcopenia. Gramlich cited European examples where, under the leadership of ESPEN, messages about malnutrition have been spread throughout communities over the past 15 years; the European Union then mandated nutrition risk screening. By contrast, in North America, the political will to accomplish this is still lacking; however, Gramlich urged that it is the responsibility of nutrition leaders and advocates to deliver a consistent message and flag risk factors for malnu-

trition by, for example, asking patients two simple questions: Have you lost weight recently? Are you eating less than normal? Elia added that functional components (e.g., ability to walk up a flight of stairs) are an equally, if not more important, part of assessing risk for malnutrition than weight loss. Indeed, in clinical nutrition, the main focus is on identifying those conditions that are responsive functionally to the interventions. Johnson also raised the point that the language of these messages to the public needs to be simple and digestible; for example, rather than “eat well and exercise,” which implies the necessary use of a gym or exercise equipment, the message should simply be “eat well and move more.”

The next question posed by an audience member was in regard to terminology, such as *well-nourished* and *malnourished*, that physicians commonly use on patients’ hospital admission forms, despite a lack of standardization in the use or specific meaning of these terms. When questioned on the meaning of, for example, *well-nourished*, physicians give a wide range of responses, which the panel agreed is indicative of the knowledge gap in nutrition among healthcare professionals. Tappenden commented that the issue is not that physicians are poorly informed about the most current thinking on how to diagnose malnutrition, they instead lack an understanding of the complexities of nutritional inadequacy to begin with. This is most likely due to, as touched on by Gramlich, the inadequacy of nutrition education for students in nursing and medical schools as well as for practicing healthcare professionals in North America.⁸⁹ Elia commented that, in the United Kingdom, although each medical school is relatively autonomous in determining their nutrition-related curricula and are not obliged to adhere to any national education standards, committees through the Academy of Medical Royal Colleges have been established to assess curricula across clinical schools, including at the undergraduate and postgraduate levels. Elia emphasized that nutrition education is lacking not only for medical doctors, but also for nurses, community healthcare workers, and informal caregivers. Furthermore, Johnson commented that there is little evidence that continuing education requirements for licensure improves clinical practice. Even when physicians are receiving education, there needs to be a system in place to help physicians remember the information and regularly apply it in practice. Education, therefore,

has to be married with process and system design. Elia elaborated on this point by emphasizing the need for an “enabling environment” that demands that healthcare professionals put what they have learned into practice and the need to link learning to an appreciation of its importance and implementation in practice.

In another comment by an audience member, it was suggested that, given that inflammation may be a component of malnutrition, the nutrients that influence inflammation may be an important point of focus in malnutrition research. The question of whether a patient has lost weight is an important one, but in the obese patient, the answer to this question may not provide healthcare professionals with the most relevant information. Determining food intake instead of weight loss may help clarify whether nutrients that affect inflammation might be relevant. Gramlich responded that understanding how to integrate inflammation-modifying nutrients, such as omega-3 fatty acids, antioxidants, and vitamin D, into a therapeutic plan is challenging, as a large evidence base is not yet available. Research on nutrition and inflammation would need to continue to unfold to help further characterize malnutrition. Prado added that omega-3 fatty acids, at least in cancer therapy, are currently the most prominent and promising in nutritional anti-inflammatory therapy, as evidence shows that they not only reduce inflammation but also increase skeletal muscle mass in cancer patients.

Also brought up was the need for anabolic therapy in cancer patients experiencing muscle wasting, as discussed by Prado in her presentation as an important strategy to improve cancer prognosis. To clarify, Gramlich pointed out that anabolic therapy can refer to nutrition rather than medication. Considering the variety of factors leading to abnormal metabolism and eventually to cancer cachexia, Prado explained that nutrition continues to be recognized as an important component of cachexia therapy. Nonetheless, conventional nutritional support cannot fully reverse cachexia, and multimodal therapies are the most promising intervention strategy to countermeasure this syndrome. These therapies would involve the use of nutritional support combined with exercise intervention, anti-inflammatory therapy, and optimal disease treatment. Prado mentioned a promising study under way combining ONS, celecoxib, and physical exer-

cise for patients with advanced lung or pancreatic cancer with cancer cachexia.⁹⁰

In summary, the panel discussion highlighted the importance of coordinating care to maintain nutritional support for patients as they transition from the hospital to home setting. The speakers also touched on the need to improve nutrition education for healthcare professionals and to implement systems to ensure that clinicians routinely carry out nutritional screening and intervention. Last, inflammation was discussed as important in disease-related malnutrition, but further research is needed to determine whether inflammation affects malnutrition treatment, as well as whether multimodal therapies that include nutritional support will improve clinical outcomes in cancer cachexia patients.

Conclusion

Malnutrition among a large percentage of patients entering hospitals negatively affects health-related outcomes and presents a major public health issue in many different regions worldwide, including the United States, Canada, Singapore, the Netherlands, and the United Kingdom. Accumulating evidence demonstrates that nutrition across the continuum of care—assessment, prognosis, and intervention—can independently improve clinical outcomes and reduce healthcare-related expenditures. The work presented in this report exemplifies the importance of institutionalizing initiatives on nutrition interventions so that nutrition is viewed as a priority for improving care quality and cost and of mobilizing multiple stakeholders (e.g., healthcare providers, government and nongovernment organizations) in order to influence health policy. Future malnutrition strategies should focus on improving recognition and diagnosis of all hospital patients that are at risk of malnutrition, promptly implementing nutritional interventions for those patients identified as malnourished, providing continuity of nutritional care for outpatients following hospital discharge, and continuing advocacy and education initiatives so that malnutrition screening and care become mandatory across the continuum of care.

Acknowledgments

The conference “Clinical and Economic Outcomes of Nutrition Interventions Across the Continuum of Care,” presented by the Sackler Institute for Nutrition Science at the New York Academy of Sciences,

was sponsored by an unrestricted educational grant from Abbott Nutrition Health Institute.

The work presented by Marian de van der Schueren was carried out in collaboration with Dutch Malnutrition Steering Group members Hinke Kruizenga, R.D., Ph.D.; Eva Leistra, MS.c.; Jacqueline Langius, R.D.; and Ellen van der Heijden, R.D. Research presented by Tomas Philipson was conducted in collaboration with Julia Thornton Snider, Ph.D.; Darius Lakdawalla, Ph.D.; Benoit Stryckman, M.A.; and Dana Goldman, Ph.D.

Conflicts of interest

The authors declare no conflicts of interest.

References

- Jensen, G.L., J. Mirtallo, C. Compher, *et al.* 2010. Adult starvation and disease-related malnutrition: a proposal for etiology-based diagnosis in the clinical practice setting from the International Consensus Guideline Committee. *JPEN J. Parenter. Enteral Nutr.* **34**: 156–159.
- Norman, K., C. Pichard, H. Lochs & M. Pirlich. 2008. Prognostic impact of disease-related malnutrition. *Clin. Nutr.* **27**: 5–15.
- Lim, H.J., H.S. Cheng, J. Liang, *et al.* 2013. Functional recovery of older people with hip fracture: does malnutrition make a difference? *J. Adv. Nurs.* **69**: 1691–1703.
- Shean, P.M., S.J. Peterson, D.P. Gurka & C.A. Braunschweig. 2010. Nutrition assessment: the reproducibility of subjective global assessment in patients requiring mechanical ventilation. *Eur. J. Clin. Nutr.* **64**: 1358–1364.
- Singh, H., K. Watt, R. Veitch, *et al.* 2006. Malnutrition is prevalent in hospitalized medical patients: are housestaff identifying the malnourished patient? *Nutrition* **22**: 350–354.
- U.S. Census Bureau. 2009. <http://www.census.gov/topics/health.html>.
- Department of Health and Human Services. 2008. Book 2. *Federal Register*. **73**: 48433–49084.
- Hackberth, G.M. *et al.* 2007. *Report to the congress: medicare payment policy*. Washington, D.C.: Medicare Payment Advisory Commission.
- White, J.V., P. Guenter, G. Jensen, *et al.* 2012. Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). *J. Acad. Nutr. Diet.* **112**: 730–738.
- Imoberdorf, R., R. Meier, P. Krebs, *et al.* 2010. Prevalence of undernutrition on admission to Swiss hospitals. *Clin. Nutr.* **29**: 38–41.
- Krumholz, H.M. 2013. Post-hospital syndrome—an acquired, transient condition of generalized risk. *N. Engl. J. Med.* **368**: 100–102.
- Kaiser, M.J., J.M. Bauer, C. Rasmussen, *et al.* 2010. Frequency of malnutrition in older adults: a multinational perspective using the mini nutritional assessment. *J. Am. Geriatr. Soc.* **58**: 1734–1748.
- Barreto Penie, J. 2005. State of malnutrition in Cuban hospitals. *Nutrition* **21**: 487–497.
- Charlton, K.E., C. Nichols, S. Bowden, *et al.* 2010. Older rehabilitation patients are at high risk of malnutrition: evidence from a large Australian database. *Nutr. Health Aging* **14**: 622–628.
- Zhang, L., X. Wang, Y. Huang, *et al.* 2013. Nutrition Day 2010 audit in Jinling hospital of China. *Asia Pac. J. Clin. Nutr.* **22**: 206–213.
- Fry, D.E., M. Pine, B.L. Jones & R.J. Meimban. 2010. Patient characteristics and the occurrence of never events. *Arch. Surg.* **145**: 148–151.
- Agarwal, E., M. Ferguson, M. Banks, *et al.* 2013. Malnutrition and poor food intake are associated with prolonged hospital stay, frequent readmissions, and greater in-hospital mortality: results from the Nutrition Care Day Survey 2010. *Clin. Nutr.* **32**: 737–745.
- Gariballa, S., S. Forster, S. Walters & H. Powers, *et al.* 2006. A randomized, double-blind, placebo-controlled trial of nutritional supplementation during acute illness. *Am. J. Med.* **119**: 693–699.
- Somanchi, M., X. Tao & G.E. Mullin. 2011. The facilitated early enteral and dietary management effectiveness trial in hospitalized patients with malnutrition. *JPEN J. Parenter. Enteral Nutr.* **35**: 209–216.
- Stratton, R.J., A.C. Ek, M. Engfer, *et al.* 2005. Enteral nutritional support in prevention and treatment of pressure ulcers: a systematic review and meta-analysis. *Ageing Res. Rev.* **4**: 422–450.
- Milne, A.C., J. Potter, A. Vivanti & A. Avenell. 2009. Protein and energy supplementation in elderly people at risk from malnutrition. *Cochrane Database Syst. Rev.* **16**: CD003288.
- Neelemaat, F., P. Lips, J.E. Bosmans, *et al.* 2012. Short-term oral nutritional intervention with protein and vitamin D decreases falls in malnourished older adults. *J. Am. Geriatr. Soc.* **60**: 691–699.
- Cawood, A.L., M. Elia & E.J. Stratton. 2012. Systematic review and meta-analysis of the effects of high protein oral nutritional supplements. *Ageing Res. Rev.* **11**: 278–296.
- Tappenden, K.A., B. Quatrara, M.L. Parkhurst, *et al.* 2013. Critical role of nutrition in improving quality of care: an interdisciplinary call to action to address adult hospital malnutrition. *JPEN J. Parenter. Enteral Nutr.* **37**: 482–497.
- Allard, J.P., K.N. Jeejeebhoy, L. Gramlich, *et al.* 2011. Malnutrition in Canadian hospitals: preliminary results from the Canadian Malnutrition Task Force (CMTF). *Clinical Nutrition Supplements* **6**: 208–209.
- Keller, H., J. Allard, M. Laporte, *et al.* 2011. Older adults in Canadian hospitals: nutritional status [abstract]. 40th Annual Scientific and Education Meeting, Canadian Association of Gerontology (CAG) and 4th Pan American Congress, International Association of Gerontology and Geriatrics (IAGG). http://www.cagac.ca/files/ASEM-RSEA2011_Abstacts_FINAL.pdf.
- Keller, H., J. Allard, P. Bernier, *et al.* (2011). What do patients say about nutrition care in Canadian hospitals? *Clinical Nutrition Supplements* **6**: 212.

28. Keller, H.H., E. Vensaver, B. Davidson, *et al.* 2014. Providing quality nutrition care in acute care hospitals: perspectives of nutrition care personnel. *J. Hum. Nutr. Diet.* **27**: 192–202.
29. Duerksen, D.R., H.H. Keller, E. Vesnaver, *et al.* 2014. Physicians' perceptions regarding the detection and management of malnutrition in Canadian hospitals: results of a Canadian Malnutrition Task Force survey. *JPEN J. Parenter. Enteral. Nutr.* Jun 2. pii: 0148607114534731. [Epub ahead of print].
30. Canadian Malnutrition Task Force. www.nutritioncarecanada.ca.
31. Lim, S.L., K.C. Ong, Y.H. Chan, *et al.* 2012. Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality. *Clin. Nutr.* **31**: 345–350.
32. Lim, S.L., C.Y. Tong, E. Ang, *et al.* 2009. Development and validation of 3-Minute Nutrition Screening (3-MinNS) tool for acute hospital patients in Singapore. *Asia Pac. J. Clin. Nutr.* **18**: 395–403.
33. Lim, S.L., E. Ang, Y.L. Foo, *et al.* 2013. Validity and reliability of nutrition screening administered by nurses. *Nutr. Clin. Pract.* **28**: 730–736.
34. Geiker, N.R., S.M. Horup Larsen, S. Stender & A. Astrup. 2012. Poor performance of mandatory nutritional screening of in-hospital patients. *Clin. Nutr.* **31**: 862–867.
35. Raja, R., S. Gibson, A. Turner, *et al.* 2008. Nurses' views and practices regarding use of validated nutrition screening tools. *Aust. J. Adv. Nurs.* **26**: 26–33.
36. Lim, S.L., S.C. Ng, J. Lye, *et al.* 2014. Improving the performance of nutrition screening through a series of quality improvement initiatives. *Jt. Comm. J. Qual. Improv.* **40**: 178–186.
37. Lim, S.L., X.H. Lin, Y.H. Chan, *et al.* 2013. A pre-post evaluation of an ambulatory nutrition support service for malnourished patients post hospital discharge: a pilot study. *Ann. Acad. Med. Singapore* **42**: 507–513.
38. Leistra, E., M.A. van Bokhorst-de van derSchueren, M. Visser, *et al.* 2014. Systematic screening for undernutrition in hospitals: Predictive factors for success. *Clin. Nutr.* **33**: 495–501.
39. The Dutch National Prevalence Survey of Care Problems (LPZ). 2014. Annual measurement of care problems 2004–2012. September 4, 2014. <http://nld.lpz-um.eu/>
40. Kruizenga, H.M., J.C. Seidell, H.C. de Vet, *et al.* 2005. Development and validation of a hospital screening tool for malnutrition: the short nutritional assessment questionnaire (SNAQ). *Clin. Nutr.* **24**: 75–82.
41. Dutch Malnutrition Steering Group. 2014. Fight malnutrition. Accessed May 20, 2014. <http://www.fightmalnutrition.eu/>
42. Kruizenga, H.M., M.W. Van Tulder, J.C. Seidell, *et al.* 2005. Effectiveness and cost-effectiveness of early screening and treatment of malnourished patients. *Am. J. Clin. Nutr.* **82**: 1082–1089.
43. Leistra, E., J.A. Langius, A.M. Evers, *et al.* 2013. Validity of nutritional screening with MUST and SNAQ in hospital outpatients. *Eur. J. Clin. Nutr.* **67**: 738–742.
44. Baracos, V.E. 2006. Cancer-associated cachexia and underlying biological mechanisms. *Annu. Rev. Nutr.* **26**: 435–461.
45. Prado, C.M.M. *et al.* 2010. Overweight and obese patients with solid tumors may have sarcopenia, poor prognosis and early features of cachexia. *Int. J. Body Comp. Res.* **8**: 7–15.
46. Prado, C.M. *et al.* 2009. Sarcopenia as a determinant of chemotherapy toxicity and time to tumor progression in metastatic breast cancer patients receiving capecitabine treatment. *Clin. Cancer Res.* **15**: 2920–2926.
47. Prado, C.M. *et al.* 2014. The association between body composition and toxicities from the combination of Doxil and trabectedin in patients with advanced relapsed ovarian cancer. *Appl. Physiol Nutr. Metab.* **39**: 693–698.
48. Lieffers, J.R. *et al.* 2012. Sarcopenia is associated with postoperative infection and delayed recovery from colorectal cancer resection surgery. *Br. J. Cancer* **107**: 931–936.
49. Martin, L. *et al.* 2013. Cancer cachexia in the age of obesity: skeletal muscle depletion is a powerful prognostic factor, independent of body mass index. *J. Clin. Oncol.* **31**: 1539–1547.
50. Prado, C.M. 2013. Body composition in chemotherapy: the promising role of CT scans. *Curr. Opin. Clin. Nutr. Metab. Care* **16**: 525–533.
51. Prado, C.M. *et al.* 2013. Assessment of nutritional status in cancer – the relationship between body composition and pharmacokinetics. *Anticancer Agents Med. Chem.* **13**: 1197–1203.
52. Fearon, K. *et al.* 2011. Definition and classification of cancer cachexia: an international consensus. *Lancet Oncol.* **12**: 489–495.
53. Prado, C.M., L.A. Birdsell & V.E. Baracos. 2009. The emerging role of computerized tomography in assessing cancer cachexia. *Curr. Opin. Support Palliat. Care* **3**: 269–275.
54. Prado, C.M. *et al.* 2008. Prevalence and clinical implications of sarcopenic obesity in patients with solid tumours of the respiratory and gastrointestinal tracts: a population-based study. *Lancet Oncol.* **9**: 629–635.
55. Prado, C.M. *et al.* 2011. Two faces of drug therapy in cancer: drug-related lean tissue loss and its adverse consequences to survival and toxicity. *Curr. Opin. Clin. Nutr. Metab. Care* **14**: 250–254.
56. Peng, P.D. *et al.* 2011. Sarcopenia negatively impacts short-term outcomes in patients undergoing hepatic resection for colorectal liver metastasis. *HPB (Oxford)* **13**: 439–446.
57. Prado, C.M. *et al.* 2014. A population-based approach to define body-composition phenotypes. *Am. J. Clin. Nutr.* DOI: 10.3945/ajcn.113.078576.
58. Prado, C.M. *et al.* 2013. Central tenet of cancer cachexia therapy: do patients with advanced cancer have exploitable anabolic potential? *Am. J. Clin. Nutr.* **98**: 1012–1019.
59. Naber, T.H., T. Schermer, A. de Bree, *et al.* 1997. Prevalence of malnutrition in nonsurgical hospitalized patients and its association with disease complications. *Am. J. Clin. Nutr.* **66**: 1232–1239.
60. Pirlich, M., T. Schütz, K. Norman, *et al.* 2006. The German hospital malnutrition study. *Clin. Nutr.* **25**: 563–572.
61. Correia, M.I. & D.L. Waitzberg. 2003. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. *Clin. Nutr.* **22**: 235–239.

62. Lawson, R.M., M.K. Doshi, J.R. Barton & I. Cobden. 2003. The effect of unselected post operative nutritional supplementation on nutritional status and clinical outcome of orthopaedic patients. *Clin. Nutr.* **22**: 39–46.
63. McClellan, M., B.J. McNeil & J.P. Newhouse. 1994. Does more intensive treatment of acute myocardial infarction in the elderly reduce mortality? Analysis using instrumental variables. *JAMA* **272**: 859–866.
64. Newhouse, J.P. & M. McClellan. 1998. Econometrics in outcomes research: the use of instrumental variables. *Annu. Rev. Public Health* **19**: 17–34.
65. Philipson, T.J., J.T. Snider, D.N. Lakdawalla, *et al.* 2013. Impact of oral nutritional supplementation on hospital outcomes. *Am. J. Manag. Care* **19**: 121–128.
66. Stratton, R.J., X. Hebuterne & M. Elia. 2013. A systematic review and meta-analysis of the impact of oral nutritional supplements on hospital readmissions. *Ageing Res. Rev.* **12**: 884–897.
67. National Institute for Health and Care Excellence (NICE). 2012. QS24 Quality standard for nutrition support in adults. November 2012. <http://publications.nice.org.uk/quality-standard-for-nutrition-support-in-adults-qs24>.
68. National Institute for Health and Care Excellence (NICE). 2012. QS24 Nutrition support in adults: NICE support for commissioners and others using the quality standard on nutrition support in adults. <http://publications.nice.org.uk/quality-standard-for-nutrition-support-in-adults-qs24/development-sources>.
69. McGurk, P., J.M. Jackson & M. Elia. 2013. Rapid and reliable self-screening for nutritional risk in hospital outpatients using an electronic system. *Nutrition* **29**: 693–696.
70. Russell, C.A. & M. Elia. 2014. Nutrition screening surveys in hospitals in the UK, 2007–2011: a report based on the amalgamated data from the four Nutrition Screening Week surveys undertaken by BAPEN in 2007, 2008, 2010 and 2011. The British Association for Parenteral and Enteral Nutrition (BAPEN). February 2014. <http://www.bapen.org.uk/pdfs/nsw/bapen-nsw-uk.pdf>
71. Russell, C.A. & M. Elia. 2014. Nutrition screening surveys in hospitals in England, 2007–2011: a report based on the amalgamated data from the four Nutrition Screening Week surveys undertaken by BAPEN in 2007, 2008, 2010 and 2011. The British Association for Parenteral and Enteral Nutrition (BAPEN). February 2014. <http://www.bapen.org.uk/pdfs/nsw/bapen-nsw-eng.pdf>
72. Elia, M. 2013. Multidisciplinary input is essential in the care of malnourished people. *Guidelines in Practice* **16**: 42–50.
73. National Institute for Health and Care Excellence (NICE). 2006. Nutrition support in adults: oral nutrition support, enteral tube feeding and parenteral nutrition. NICE Clinical Guideline No. 32. February 2006. <http://www.nice.org.uk/nicemedia/live/10978/29987/29987.pdf>
74. Elia, M. & C. Wheatley. 2014. Nutritional care and the patient voice. Are we being listened to? The British Association for Parenteral and Enteral Nutrition (BAPEN). February 2014. <http://www.bapen.org.uk/pdfs/nutritional-care-and-the-patient-voice.pdf>
75. Kyle, U.G., M.P. Kossovsky, V.L. Karsegard & C. Pichard. 2006. Comparison of tools for nutritional assessment and screening at hospital admission: a population study. *Clin. Nutr.* **25**: 409–417.
76. Ramage-Morin, P.L. & D. Garriguet. 2013. Nutritional risk among older Canadians. *Statistics Canada, Health Reports* **24**: 3–13.
77. Alibhai, S.M., C. Greenwood & H. Payette. 2005. An approach to the management of unintentional weight loss in elderly people. *CMAJ* **172**: 773–780.
78. Bershtein, M.A. & A.S. Luggen. 2010. *Nutrition for the Older Adult*. 1–422. Sudbury: Jones and Bartlett Learning.
79. Roy, M.A. & H. Payette. 2006. Meals-on-wheels improves energy and nutrient intake in a frail free-living elderly population. *J. Nutr. Health Aging* **10**: 554–560.
80. Bandayrel, K. & S. Wong. 2011. Systematic literature review of randomized control trials assessing the effectiveness of nutrition interventions in community-dwelling older adults. *J. Nutr. Educ. Behav.* **43**: 251–262.
81. Payette, H., V. Boutier, C. Coulombe & K. Gray-Donald. 2002. Benefits of nutritional supplementation in free-living, frail, undernourished elderly people: a prospective randomized community trial. *J. Am. Diet. Assoc.* **102**: 1088–1095.
82. Lammes, E., E. Rydwick & G. Akner. 2012. Effects of nutritional intervention and physical training on energy intake, resting metabolic rate and body composition in frail elderly: a randomised, controlled pilot study. *J. Nutr. Health Aging* **16**: 162–167.
83. Shizgal, H.M., M.F. Martin & Z. Gimmon. 1992. The effect of age on the caloric requirement of malnourished individuals. *Am. J. Clin. Nutr.* **55**: 783–789.
84. Locher, J.L., K.S. Vickers & D.R. Buys. 2013. A randomized controlled trial of a theoretically-based behavioral nutrition intervention for community elders: lessons learned from the Behavioral Nutrition Intervention for Community Elders Study. *J. Acad. Nutr. Diet.* **113**: 1675–1682.
85. Burke, L., A.H. Lee, J. Jancey, *et al.* 2013. Physical activity and nutrition behavioural outcomes of a home-based intervention program for seniors: a randomized controlled trial. *Int. J. Behav. Nutr. Phys. Act.* **10**: 14.
86. Yang, Y., C.J. Brown, K.L. Burgio, *et al.* 2011. Under-nutrition at baseline and health services utilization and mortality over a one-year period in older adults receiving Medicare home health services. *J. Am. Med. Dir. Assoc.* **12**: 287–294.
87. Iannuzzi-Sucich, M., K. Prestwood, & A. Kenny. 2002. Prevalence of sarcopenia and predictors of skeletal muscle mass in healthy, older men and women. *J. Gerontol. A. Biol. Sci. Med. Sci.* **57**: M772–M777.
88. Timely Data Resources, Inc. 2009. Disease incidence: a prevalence database. US Census Bureau. December 2009.
89. DiMaria-Ghalili, R.A., M. Edwards, G. Friedman, *et al.* 2013. Capacity building in nutrition science: revisiting the curricula for medical professionals. *Ann. N.Y. Acad. Sci.* **1306**: 21–40.
90. ClinicalTrials.gov. 2014. A feasibility study of multimodal exercise/nutrition/anti-inflammatory treatment for cachexia—the pre-MENAC study. May 2014. <http://clinicaltrials.gov/show/NCT01419145>