

Residency and specialties training in nutrition: a call for action^{1–4}

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ABSTRACT

Despite evidence that nutrition interventions reduce morbidity and mortality, malnutrition, including obesity, remains highly prevalent in hospitals and plays a major role in nearly every major chronic disease that afflicts patients. Physicians recognize that they lack the education and training in medical nutrition needed to counsel their patients and to ensure continuity of nutrition care in collaboration with other health care professionals. Nutrition education and training in specialty and subspecialty areas are inadequate, physician nutrition specialists are not recognized by the American Board of Medical Specialties, and nutrition care coverage by third payers remains woefully limited. This article focuses on residency and fellowship education and training in the United States and provides recommendations for improving medical nutrition education and practice. *Am J Clin Nutr* 2014;99(suppl):1174S–83S.

INTRODUCTION

Medical education and training in nutrition continue to be inadequate despite strong evidence that hospital malnutrition is highly prevalent and affects patient outcomes and costs of care. Undernutrition in hospitals can be as high as 60% in adults (1, 2) and 40% in children (3) and higher when obesity is considered. Nutrition studies in intensive care units (ICUs)⁵ show improved survival, health outcomes, and shortened length of stay (4–7), however, a recent international study of 179 ICUs show a low average nutritional practice performance with 7 of the bottom 10 ICUs located in the United States (8). Geriatric patients, who account for nearly half of all hospitalized patients, are less likely to die 1 y after discharge if they have had a nutrition assessment (9, 10). In 1997, a survey of 19 US hospitals concluded that >\$1000 per patient would have been saved with higher-quality nutrition care (11). These findings underscore the need for improved nutrition training of residents and specialty care physicians.

Nutrition needs not only should be addressed in hospitals but also in ambulatory care clinics. Chronic diseases (eg, cardiovascular diseases, diabetes, and cancer) account for 7 of the top 10 leading causes of death and 70% of all medical expenses in the United States (12). Primary prevention of chronic diseases can be accomplished by addressing a handful of modifiable behaviors, including dietary intake and physical activity (13). The US Preventive Services Task Force (USPSTF) recommends that clinicians screen all adult patients and children ≥ 6 y old for obesity and offer intensive counseling and behavioral interventions to control weight (B recommendations) (14). Unfortunately, limited reimbursement for dietary counseling constitutes a major barrier to adequate delivery of these preventive services (15).

Health care reform must address delivery and outcomes and will ultimately require reform in the education of health care professionals. A renewed effort for establishing nutrition education in the training of physicians is critical to the success of needed health system changes. Unfortunately, inadequate physician nutrition specialist (PNS) role models are a significant obstacle to improving physicians' delivery of nutrition care (16–20). The purpose of this article is to review information relevant to medical nutrition education from the hospital to the community settings and to provide examples of programs and models from a variety of fields that are used to improve nutrition education in postgraduate medical training. To help organize the broad range of information available in the medical literature, we have framed our discussion around 6 critical questions to consider when developing a residency or a fellowship nutrition program.

QUESTION 1: WHAT SHOULD BE THE FOCUS OF RESIDENCY AND FELLOWSHIP TRAINING IN NUTRITION?

Literature addressing the nutrition knowledge or skills of resident and fellow physicians is mostly limited to self-report surveys. Results from board examination have not been published,

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⁵ Abbreviations used: ACGME, Accreditation Council for Graduate Medical Education; ICU, intensive care unit; NAA, Nutrition Academic Award; Ob-Gyn, obstetrics and gynecology; PNS, physician nutrition specialist; QI, quality improvement; T2D, type 2 diabetes; USPSTF, US Preventive Services Task Force; 5As, Assess, Advise, Agree, Assist, Arrange.

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contain relatively few nutrition questions (21), and results are made available only to medical school deans and residency training program directors. Mean nutrition knowledge scores from program evaluations is in the range of 50–77% for both medical residents (22–24) and gastroenterology fellows (25, 26) and appear to reflect only modest short-term retention of information. Studies also show misconceptions regarding the benefit of proper nutrition care. The limited available data suggest that residency and subspecialty trainees are ill prepared to address the nutritional needs of their patients.

Medical resident and fellowship training must address nutrition knowledge, attitudes, and practice skills. New approaches are needed to improve the nutrition skills of residents, fellows, and attending physicians (27). Specific areas of clinical focus should fulfill the practice needs of each specialty (28). For example, trainees in surgery, gastroenterology, and intensive care should focus on hospitalized patients and nutrition support (eg, parenteral and enteral nutrition). Residents and fellows in specialties emphasizing ambulatory practice, such as internal medicine, family practice, pediatrics, obstetrics and gynecology (Ob-Gyn), and endocrinology should focus on counseling skills (eg, for lifestyle changes) and topics such as medical nutrition therapy. Thus, training requirements differ not only with area of specialization but also with the setting in which these skills will be used. In addition, nutrition care requires an interdisciplinary team approach in which patients are appropriately referred to allied health professionals and available community resources. Likewise, an understanding of how nutrition concepts and skills are applied across various clinical settings is integral to effective care.

QUESTION 2: ARE THERE EXAMPLES OF EFFECTIVE METHODS TO IMPROVE CLINICAL NUTRITION SKILLS?

The limited time available to primary care physicians during an office visit and the moderate success of brief physician-driven nutrition counseling trials (29) have resulted in recommendations advocating the use of the 5As (Assess, Advise, Agree, Assist, Arrange) framework to guide practice (Table 1). The barriers to effective counseling relevant for nutrition include the following: 1) uncertainty regarding the effectiveness of nutrition counseling; 2) inadequate skills in providing nutrition counseling; 3) lack of financial incentives; 4) lack of a systematic, organized approach within the practice; 5) needed tools; and 6) collaboration with other health care professionals (29, 30).

TABLE 1
The 5As framework to guide practice¹

5As	Tasks
Assess	Assess risk, current behavior, and readiness to change
Advise	Advise change in specific behaviors
Agree	Agree to and collaboratively set goals
Assist	Assist in addressing barriers and securing support
Arrange	Arrange for follow-up

¹ Source: reference 29. 5As, Assess, Advise, Agree, Assist, Arrange.

Uncertainty regarding the effectiveness of nutrition counseling

The USPSTF has conducted systematic reviews of the literature that document the effectiveness of intensive counseling to prevent and treat obesity (14). Several large clinical trials aimed at improving preventive services utilization with added nutrition counseling support this approach (27–32). For example, a study in primary care internists in Massachusetts showed that the 5As method combined with practice management strategies improved patient outcomes (31), whereas another study showed that counseling by a dietitian provided added benefit (33).

The Obesity Counseling Workshop for pediatric and internal medicine residents (34) is an example of an approach that addresses the barriers implemented in a medical residency program. Based on the 5As and incorporating key principles of motivational interviewing, participants reported likely improvement of their obesity counseling skills. These studies indicate that both residents and practicing physicians are receptive to training in counseling frameworks that support behavior change among their patients.

Inadequate skills in providing nutrition counseling

Both Healthy People 2010 and the USPSTF include recommendations to increase the physician’s role in the provision of nutrition care to patients. One objective is to improve counseling and lifestyle changes during office visits for patients with a diagnosis of cardiovascular disease, type 2 diabetes (T2D), or hypertension from 40% to 75% (35). Registered dietitians, pediatricians, and primary care nurse practitioners all expressed concern about pediatric obesity and its complications and felt that interventions were important, but they identified barriers including the following: limited parental involvement, patient motivation, and support services, as well as low proficiency in physician counseling–related skills needed to manage pediatric patients effectively (36, 37). A systematic review of cardiovascular disease prevention and treatment reported that the proportion of physicians counseling about nutrition and physical activity was low and that few physicians engaged in intensive counseling approaches (38).

Limited financial incentives and reimbursement

The American Diabetes Association estimates that the number of Americans living with T2D will double in the next 25 y to ~44 million, which will have a major impact on the US health care system. The 2007 health care costs of managing T2D totaled \$116 billion, with approximately half of that amount spent on hospital care for largely preventable T2D-related complications. Carpenter et al (39) conducted a study of diabetes self-management coverage information by Medicaid and private insurance providers in 10 states. They showed that despite the evidence of cost-effectiveness of T2D education, only 50% of Medicaid and 55% of sampled private insurance plans offered coverage for diabetes self-management education. They noted that Medicaid’s coverage varied by state from 0 to 20 h of education per year, which was often further restricted by health status. In addition, private plans often limited participation to community programs or included spending caps.

The Center for Medicare and Medicaid Services recently started covering intensive behavioral therapy for obesity by physicians. However, this coverage does not include pediatric patients or improved access to other health care professionals or community resources. The coverage is especially limited because it does not include individuals who are overweight or have prediabetes, and few primary care physicians are adequately trained in lifestyle intervention. Despite the clear benefit of group-based lifestyle intervention, most payers do not cover these services for preventing T2D (40).

Lack of a systematic, organized approach to nutrition care within medical practice

A systematic approach to quality improvement (QI) in practices includes addressing nutrition issues. The use of a systematic approach to practice evaluation in the ICU setting shows that better nutrition care practices are associated with improved outcomes. The Vermont Oxford Network developed and implemented evidence-based nutrition support practices for neonates and achieved improved nutrient intake and growth, while reducing length of stay and costs (4). Similarly, Mehta et al (5) showed that pediatric ICU patients with higher energy intake from enteral feeding were at decreased risk of 60-d mortality, whereas patients receiving parenteral nutrition were at increased risk of mortality. They found that the use of a standardized ICU feeding protocol was associated with lower rates of acquired infections (OR: 0.18; 95% CI: 0.05, 0.64), regardless of energy or protein intake. These findings support the use of nutrition protocols to improve outcome.

Another study showed that resident physicians could use QI methods to improve the quality of obesity screening in the ambulatory setting (41). Laiteerapong et al (41) showed that the rate of documentation of anthropometric measurements significantly increased after a QI intervention and remained higher than baseline after 1 y. The documentation of BMI was associated with higher rates of counseling obese patients about diet and exercise. These examples show that quality of care can be improved by the use of guidelines and best practices in both inpatient and outpatient settings.

Needed tools

A resource for both learners and mentors is the *Nutrition Curriculum Guide for Training Physicians*, a comprehensive and annotated description of critical nutrition objectives for physicians that was derived from the National Heart, Lung, and Blood Institute–initiated Nutrition Academic Award (NAA) (42). The only curriculum including nutrition competencies for residency training is that for Family Medicine programs (43) available through the Association of American Medical Colleges' MedEdPortal (44). The American Academy of Pediatrics has endorsed Bright Futures, and its nutrition committee publishes a handbook of pediatric nutrition, both of which are available on their website. The American Society of Obstetrics and Gynecology regularly updates their compendium of practice guidelines, which includes nutrition practice guidelines in pregnancy and after bariatric surgery. A case book of nutrition is also regularly updated for medical education and training (45).

Medical trainees now expect resources to be easily accessible online, often with a preference for applications for mobile devices

(46), and as a result, printed textbooks and journals are rapidly losing ground to online versions. For example, *Modern Nutrition in Health and Disease* has a new electronic version (47) and *Nutrition in Medicine* continues to update modules developed specifically for Web-based delivery (16). Webinars organized by nutrition societies allow for wider dissemination of medical nutrition content. Computer-based instruction is increasingly important because it is readily accessible and content updates can be readily disseminated. Web-based refresher courses developed specifically for postgraduate trainees on specific clinical nutrition skills are available free of charge (16), whereas other online materials, such as a nutrition curriculum for pediatric residents (48), are available only locally. Online examples of curricula with a narrower subspecialty focus, such as pediatric gastroenterology, also cover nutrition content (49).

Industry and foundations provide a range of online content as do government and international groups. Cheston et al (50) conducted a systematic review of the use of social media in education for physicians and physicians in training and found improved knowledge, skills, and attitudes. The authors mentioned that such tools are used to promote learner engagement, feedback, collaboration, and professional development. Thus, media tools may be useful as adjuncts for medical nutrition education and training.

Collaboration with other health care professionals

It is important that physicians work with other health care professionals and learn to recognize when to refer their patients to other health care professionals or community resources. Dietitian consultations improve the provision of energy and nutrients for patients and reduce their length of stay in the ICU (51). Overall, a nutrition support team led by certified clinicians is associated with better health outcomes and reduced medical expenses (52). A redefinition of roles for specific nutrition tasks among different members of the health care team could improve nutrition outcomes.

QUESTION 3: WHAT ARE THE GUIDELINES FOR NUTRITION EDUCATION OF RESIDENTS AND FELLOWS?

The Association of American Medical Colleges developed a Physician Competency Reference Set in 2013, which is a list of common learner expectations used in the training of physicians and other health professionals based on previous Accreditation Council for Graduate Medical Education (ACGME)/American Board of Medical Specialties as well as national and international competencies (53). This list consists of 58 competencies in 8 domains, which includes patient care, knowledge for practice, practice-based learning and improvement, interprofessional and communication skills, professionalism, systems-based practice, interprofessional collaboration, and personal and professional development. A method for organizing nutrition learning objectives from the NAA curriculum to show student learning assessment in competency areas has been described (54).

Surprisingly, a review of current ACGME residency program accreditation guidelines found little emphasis on nutrition competencies. Residency training requirements in pediatrics contain the greatest nutritional focus, with 3 references to nutrition, 1 in the section on recommended program personnel (suggesting dietitian involvement in resident education), and 2 in medical knowledge.



Family medicine also includes a recommendation for dietitian involvement in education, although nutrition is mentioned only in the patient care competency. Program requirements for surgery include nutrition under patient care competency, whereas those for Ob-Gyn include nutrition only in the medical knowledge competency. The requirements for internal medicine training programs contain no mention of nutrition. Details on these requirements can be found on the ACGME website (55).

In addition to the competencies developed for family medicine residents (Table 2), several societies have identified nutrition as an important component in the education of future physicians and provided guidelines (eg, American Association of Clinical Endocrinologists, American Gastroenterology Association, American Heart Association). The ACGME requirements for residency in education in endocrinology, T2D, and metabolism include showing competence in the care of patients with the nutritional disorders of obesity, anorexia nervosa, and bulimia; evaluation and management of glycemic control; multidisciplinary diabetes education and treatment; and diagnosis and management of lipid and lipoprotein disorders. In addition, there must be close working relationships with dietary and nutrition services. Pediatric surgery and surgical critical care include specific nutrition objectives, whereas other subspecialty areas do not. It is likely that the limited nutrition training of the medical educators involved in creating these discipline-specific competencies has contributed to the limited guidance for training in this area. Increased availability of guidelines for nutrition education, especially in light of the shortage of nutrition specialists, further requires that competencies be developed by relevant professional societies involved with each specialty to ensure the adequacy and accuracy of selected nutrition education.

For example, the American Association of Clinical Endocrinologists published position papers addressing the role of endocrinologists in obesity medicine (56) and in clinical nutrition and health promotion (17). Recommendations include the following: 1) developing strategies for improving nutrition education from medical school through practicing clinicians, 2) establishing a nu-

cleus of physicians to create advanced educational programs in clinical nutrition, 3) professional society collaboration, and 4) recognizing the need for physician-directed nutrition practice. The core curriculum for gastroenterology fellowship training, developed in 1996 (57) and maintained by gastroenterology societies in the United States (58), includes a chapter on nutrition. Even though gastroenterologists typically address the nutrition support of their patients, major nutrition training gaps have been found (25, 26, 59, 60). The reasons for suboptimal training in nutrition include a lack of mentors, minimal exposure to clinical nutrition care, and a predominant focus on endoscopy (60). Only 1% of the content in the American Board of Internal Medicine certifying examination for gastroenterology is related to nutrition (61).

A survey of cardiology program directors and fellows (62) showed that only 24% met the Core Cardiovascular Training Symposium guidelines with a dedicated 1-mo rotation in preventive cardiology, 24% had no formalized training in preventive cardiology, and 30% had no faculty with expertise in preventive cardiology. The greatest training obstacle cited by the program directors was lack of time, whereas the greatest obstacle cited by fellows was lack of a developed curriculum. What is readily apparent from this review is that nutrition training guidelines are generally lacking, but even where they exist, adherence is poor. Although there is general recognition of the importance of nutrition knowledge and requisite skills to use in the clinical care of patients, there is little evidence of the successful internalization and adoption of these essential skills.

QUESTION 4: ARE THERE SUCCESSFUL PROGRAMS/ MODELS OF INTEGRATION OF SUBSPECIALTY TRAINING IN RESIDENCY?

Geriatrics exemplifies a medical subspecialty that has been successfully integrated into medical education (63–67) (Table 3). After a survey of residency programs showing limited clinical instruction in geriatrics, experts and members of key stakeholder organizations met to identify a concise set of essential

TABLE 2
Example of nutrition competencies: family medicine¹

Nutrition competency	ACGME ² competency
At the completion of residency training, a family medicine resident should	
Understand general principles of nutrition including the role of nutrition in disease prevention and management and translate general principles into a nutrition care plan	Patient care Medical knowledge
Be able to perform a comprehensive nutritional assessment	Patient care Medical knowledge
<ul style="list-style-type: none"> • Medical, social, and diet histories • Physical examination • Anthropometric measurements • Laboratory tests 	
Be able to counsel patients regarding nutritional recommendations in a culturally sensitive manner	Professionalism Interpersonal and communication skills
Use an evidence-based approach to assess the patient’s nutritional status and determine the effectiveness of interventions	Practice-based learning Improvement
Recognize patients who are at high risk of nutrition-related complications and refer them to nutrition consultants who can provide counseling and education	Patient care Medical knowledge Systems-based practice
Recognize his or her own nutritional biases and make attempts to compensate for possible effects on patient care	Professionalism

¹ Source: reference 43.

² ACGME, Accreditation Council for Graduate Medical Education.

TABLE 3
Geriatric model: from medical school and residency competencies to training applications¹

Steps (date)	Group	Method	Milestone
Landmark events (2000–2001) Hartford Foundation/AAMC US medical school awards (<i>n</i> = 40): to enhance geriatric curriculum	—	—	Publications
DW Reynolds Foundation: to create a national database of geriatric medicine training and practice	—	—	
DW Reynolds Foundation US medical school awards (<i>n</i> = 10): for comprehensive medical education	—	—	
Medical school competency (2007)	Steering committee (<i>n</i> = 13) Steering committee, foundation grant recipients, and educators (<i>n</i> = 48)	Curricular documents Survey and online review	52 domains 23 domains
Potential domains	Steering committee, foundation grant recipients, and societies' interest groups (<i>n</i> = 117)	Online survey for top 8 domains	8 domains
Narrow domains	Each individual in the steering committee review 1 domain (<i>n</i> = 13)	Check with other competencies	35 competencies
Domain consensus	Residency and clerkship directors AAMC/JAHF advisory committee (<i>n</i> = 98) Conference AC and participants, steering committee (<i>n</i> = 93)	Online survey 2 domains/group for 4 groups E-mails, online survey, endorse	26 competencies 26 competencies
3–5 Competencies/domain	Working group IM and FM academic educators and geriatricians (<i>n</i> = 8)	Review clinically relevant medical student competencies	52 competencies
Content validity	Geriatric educators from 36 academic institutions (<i>n</i> = 100)	Meeting 3–6 competencies/domain and survey to rate importance	46 competencies
Draft and evaluate implementation	Nongeriatric residency educators (<i>n</i> = 26)	Rate importance	7 competencies
Review and changes	Residency program directors and faculty (<i>n</i> = 12)	Review, endorse	7 competencies
Landmark IOM report (2008) “Retooling for an Aging America: Building the Health Care Workforce”; critical need to expand geriatrics competence among all physicians	Fourth-year FM medical students (<i>n</i> = 158)	Multisite interdisciplinary, team-based, 1-mo rotation, AAMC GQ evaluation	3/4 agree learned 7 competencies
Residency competency (2007–2008)	Chief residents from 13 medical and surgical disciplines (<i>n</i> = 47)	2-d offsite chief resident training, Train-the-trainer, interdisciplinary, self-assess	Improved knowledge and teaching confidence
Potential domains			
Narrow domains			
Domain consensus			
Review and changes			
Training applications (2008–2009)			
Training medical students (2008)			
Training medical residents (2009)			

¹ Sources: references 63–67. This effort included support and participants from the AAMC, the Association of Program Directors of Internal Medicine, the Association of Family Medicine Residency Directors, the American Geriatrics Society, the Society of General Internal Medicine, and the Society of Teachers of Family Medicine for recommending expert reviewers; the Donald W Reynolds Foundation; the John A Hartford Foundation; the American Medical Association; the American Board of Family Medicine; various academic centers and affiliated hospitals; and the Mount Sinai School of Medicine, Portal of Online Geriatrics Education. AAMC, Association of American Medical Colleges; AC, advisory committee; FM, family medicine; GQ, Medical School Graduate Questionnaire from the AAMC; IM, internal medicine; IOM, Institute of Medicine; JAHF, John A. Hartford Foundation.

competencies. In 2007, academic educators and geriatricians from internal medicine and family medicine with experience in geriatrics curriculum development met to develop essential competencies in geriatrics (63). These competencies were to be required for all graduating residents, based on new national competencies established for medical students, allow for standardized evaluation, and further address ACGME competencies. The group recommended competencies that were “1) unique to the care of older patients (ie, not general competencies), 2) feasible within the structure of current residency programs, and 3) endorsed key stakeholder organizations and residency programs.” Thus, lessons learned from the geriatric model (63–67) and the NAA award (68) are key in the successful dissemination of nutrition curricula.

QUESTION 5: WHAT ARE THE BARRIERS TO ADVANCING NUTRITION EDUCATION AND HOW MIGHT THESE BARRIERS BE ADDRESSED?

Multiple barriers and challenges have been identified in the literature that have contributed to inconsistent and inadequate nutrition education in medical schools and residency programs (69). The ASN surveyed nutrition educators and program directors of all US-accredited residencies to identify critical components of nutrition training during residency (70, 71). The 3 most important components identified included the presence of 1) a qualified nutrition faculty member, 2) a multidisciplinary nutrition support service, and 3) an outpatient nutrition clinic with a registered dietitian. A follow-up survey identified that the single most important feature of a “strong nutrition program” was the presence of a PNS (71). Unfortunately, there is a shortage of PNSs (72). Heimburger et al (73) identified the

following contributors to this shortage: 1) a lack of consensus standards for training and certifying PNSs, 2) inadequate institutional support for PNS faculty positions, 3) inadequate third-party reimbursement for components of clinical nutrition practice (eg, obesity management), and 4) the focus of modern medicine was on treatment rather than on wellness and prevention. The authors also noted that the number of available training programs was small and varied in their approach and that the career track for graduates was ill defined. Potential solutions to some of these barriers and novel program approaches are summarized in **Table 4**, and 2 are discussed in the following sections.

Examples of programs developing solutions to the lack of PNSs and role models

The expertise of PNSs is paramount in each of the nutrition specialty areas. With adequate support, PNSs can serve as role models and assist with curriculum development, implementation, and evaluation, while role-modeling effective practice and teaching in both graduate and postgraduate programs. Few dedicated fellowship programs exist that include clinical and academic curricula. Others are based on lectures that are often sponsored by industry and/or professional institutions.

In the absence of more PNSs, role models are needed within each medical specialty. Training models to address this deficiency include a 1-d or multiple-day course immersion, a visiting fellowship with mentors, a course similar to Advanced Cardiac Life Support and Advanced Trauma Life Support, with associated credentialing in nutrition, and a train-the-trainer approach to provide a physician nutrition leader for most residency and fellowship training programs (20). American Society for

TABLE 4
Training future physicians in nutrition: challenges, barriers, and proposed solutions¹

Challenges and barriers	Proposed solutions
Lack of faculty expertise in nutrition in medical schools and teaching hospitals leading to inadequate role modeling and insufficient resources for curriculum development and implementation	Expand the physician nutrition specialist training and certification through the ASN; use the CORE ² model for training physicians in obesity management; and develop outcomes-based incentive programs to improve patient care, reduce length of stay, and control costs
Lack of nutrition education in medical schools and residency programs	Provide a required competency-based nutrition curriculum at all medical schools followed by residency nutrition training (implemented similarly to geriatrics curriculum experience)
Inadequate practice and low self-efficacy toward diet and lifestyle intervention in treating patients with obesity, T2D, hypertension, and CVD	Recognize that the physician can be effective at initiating patient behavior change, especially with the support of allied health care professionals; demonstrate cost-savings and increased patient satisfaction from successful management of obesity in the office setting
Minimal or lack of reimbursement for nutrition and behavior services for medical and allied health care professionals	Revising malnutrition definitions, revising coding by discipline, billing for nutrition diagnosis and comorbid conditions, advocacy, and lobbying
Failure to recognize nutrition experts in the training of medical students and residents	Develop MD-RD teams for medical schools and residency training programs in primary care and specialty areas
Inadequate time in ambulatory setting and lack of confidence to address nutrition issues	Develop and use time-efficient methods and tools for patient education initiated by physicians but implemented by RDs or RNs in the office setting
Inadequate attention to nutrition support of hospitalized patients	Increased adherence to existing training guidelines (eg, those of preventive cardiology or nutrition support); required training with RDs to learn nutrition assessment, writing appropriate orders for nutrition support including enteral and parenteral nutrition

¹ CORE, Centers for Obesity Research and Education; CVD, cardiovascular disease; MD, medical doctor; RD, registered dietitian; RN, registered nurse; T2D, type 2 diabetes.

² Major US centers provide education and training about obesity to the medical community (http://www.cellinteractive.com/ucla/physician_ed/core.html).

Parenteral and Enteral Nutrition has been developing one such program. After the 2009 American Society for Parenteral and Enteral Nutrition summit addressing the PNS shortage, a symposium issue in their journal suggested that programs be tailored to institutional needs and that “toolkits” be developed to assist fellowship programs in designing nutrition and health promotion training programs (74).

Other approaches include the Centers for Obesity Research and Education, 8 nationally recognized centers that joined together to disseminate obesity treatment knowledge to the medical community through continuous education symposia for physicians and allied health professions. The Nestlé Enteral Nutrition Fellowship Program is a month-long intensive course that hosts about 30 residents and fellows annually for training in clinical nutrition. The impact of these approaches in developing new physician nutrition leaders has not been evaluated.

Examples of initiatives addressing residency nutrition education

For health care providers to work collaboratively, discipline-specific competencies must be developed, shared, and understood. In addition, clarity of nutrition competencies for each specialty and subspecialty within each of the professions is critical. Resident physicians must be able to identify nutrition risk, initiate nutrition counseling, refer to other health care professionals appropriately, understand and interpret the dietitian’s patient assessment, and write informed and accurate orders.

Many training programs have undertaken initiatives to teach nutrition to medical students and residents and have generally found inadequate prior knowledge or skills in nutrition, but published data about training effectiveness are limited. Model experiences vary from 1-wk exposures to curricula spanning all years of medical training and can be found on the Internet (20). Examples include programs with one or more of the following: advocacy experience with community nutrition providers, personal weight management experience for students including dietary and physical activity assessment and monitoring, training in behavior change models such as motivational interviewing, required rotations with nutrition support services, breastfeeding, or interinstitutional collaboratives (20, 75, 76). Many programs combine curricula in nutrition and physical activity as part of prevention teaching. Some programs assess entering resident counseling skills and assign *Nutrition in Medicine* modules to address identified deficiencies.

QUESTION 6: HOW DO WE EVALUATE NEW PROGRAMS AND THEIR SUSTAINABILITY?

Although there are many innovative education programs being developed around the country, evaluation has not been extensive. Measuring instructional efficacy is particularly difficult at the postgraduate level because health care professionals have so little time to spare for the necessary testing, and nutrition competencies can be numerous and complex. Quality assessments of medical postgraduate training programs typically rely on internal evaluations, audits by accreditation organizations, and board examinations, which lack nutrition subscores. A significant problem in regard to the evaluation of nutrition education efficacy

is that content mastery is a moving target in this rapidly evolving field, but educational goals are a necessity if content mastery is to be assessed.

Nutrition competencies can be evaluated in several ways, including direct observation by peers, mentors, and other evaluators. This can improve performance through rapid feedback and remediation for the learner. Effective evaluation by raters depends on a clear understanding of the targeted nutrition competencies, which is often lacking. The authors of a recent review of nutrition guidance given to patients by physicians noted that evaluations of counseling practices all too often fall short because they usually address only duration and not specific quality of the interactions (77). An approach that allows the assessment of specific competencies and thus the quality of clinical performance is the recording and independent rating of patient-provider interactions in clinical practice (78). Other investigators have used incognito patients to capture both mastery and actual use of nutrition competencies in clinical practice (79, 80). Ideally, the assessment of instructional efficacy should be validated by relating expected clinical outcomes to the instruction, such as greater weight loss with the teaching of effective counseling techniques (74). At the present time, these remain aspirational goals.

Computer-based assessments can avoid the very high labor cost of detailed nutrition competency assessment. Online follow-up survey questions can be used to determine whether nutrition training has led to change in practice behavior several months later. Instead of the traditional multiple-choice question format for the assessment of knowledge, more innovative online approaches can be used, ranging from gamelike challenges to case-based tasks (81) and even virtual patient interactions (82). The availability of such newer online formats for the assessment of clinical nutrition competencies is still limited and might be a high-priority focus of instructional development.

SUMMARY AND RECOMMENDATIONS

We urge the community of health care professionals, educators, and scientists involved in medical nutrition to increase awareness of gaps and advocate for medical nutrition education and training via multiple mechanisms such as the following: 1) student nutrition interest groups across the health professions, 2) presentations at professional societies’ meetings and publications, 3) work with advocacy and policy-oriented groups such as the Bipartisan Policy Center’s Nutrition and Physical Activity Initiative, and 4) review of data from third-payer payment and conduct outcome-based and cost-effective studies.

The level of nutritional knowledge and nutritional skills among the various specialties and subspecialties of medicine and surgery is not commensurate with the role and importance that nutrition has been shown to play in the etiology and management of the most common diseases that now afflict society, particularly those related to obesity and undernutrition. As a starting point and as a bare minimum, we recommend consideration of the following:

1. Each primary specialty, medicine, surgery, pediatrics, Ob-Gyn, and family practice and many subspecialties including particularly gastroenterology, endocrinology, geriatric medicine, critical care, and hospital medicine should formally adopt nutrition competencies expected of their



diplomats and develop methods of training and evaluation to ensure that these minimal competencies are achieved.

2. PNSs are an important resource to “train the trainers” of nutrition in the various specialties and subspecialties, but these desirable adjuncts to enhance the likelihood of success in achieving the nutrition goals above are contingent on the development of formal training programs necessarily funded by the government with subsequent career paths supported by academic training programs and/or government training subsidy.
3. Nutrition and Obesity Research Centers, funded by the NIH, represent a unique resource, and all such units should be required to have an education core to assist in sharing nutritional expertise at their host institution and potentially at other institutions in their geographic area.
4. There is an important role for the ACGME, which should assume leadership to assist in ensuring the level of nutritional competence of specialists and subspecialists in conjunction with the various specialty boards.
5. Because the law permits the secretary of the Department of Health and Human Services to authorize Medicare coverage for services rated A or B by the USPSTF, which affects other payers’ coverage, we urge the development of an expert panel that includes a variety of health care professionals to conduct a systematic review of nutrition intervention care in a variety of settings.

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REFERENCES

1. Naber THJ, Schermer T, de Bree A, Nusteling K, Eggink L, Kruijmel JW, van Heereveld H, Katan MJ. Prevalence of malnutrition among hospitalized non-surgical patients and its association with disease complications. *Am J Clin Nutr* 1997;66:1232–9.
2. Fuchs V, Mostkoff D, Salmeán GG, Amancio O. Nutritional status in hospitalized patients in a public hospital in Mexico City. *Nutr Hosp* 2008;23:294–303.
3. Joosten KF, Hulst JM. Prevalence of malnutrition in pediatric hospital patients. *Curr Opin Pediatr* 2008;20:590–6.
4. Kuzma-O’Reilly B, Duenas ML, Greecher C, Kimberlin L, Muijsce D, Miller D, Walker DJ. Evaluation, development, and implementation of potentially better practices in neonatal intensive care nutrition. *Pediatrics* 2003;111:e461–70.
5. Mehta NM, Bechard LJ, Cahill N, Wang M, Day A, Duggan CP, Heyland DK. Nutritional practices and their relationship to clinical outcomes in critically ill children—an international multicenter cohort study. *Crit Care Med* 2012;40:2204–11.
6. Doig GS, Simpson F, Finfer S, Delaney A, Davies AR, Mitchell I, Dobb G. Effect of evidence-based feeding guidelines on mortality of critically ill adults: a cluster randomized controlled trial. *JAMA* 2008;300:2731–41.
7. Alberda C, Gramlich L, Jones N, Jeejeebhoy K, Day AG, Dhaliwal R, Heyland DK. The relationship between nutritional intake and clinical

- outcomes in critically ill patients: results of an international multicenter observational study. *Intensive Care Med* 2009;35:1728–37.
8. Heyland DK, Heyland RD, Cahill NE, Dhaliwal R, Day AG, Jiang X, Morrison S, Davies AR. Creating a culture of clinical excellence in critical care nutrition: the 2008 “Best of the Best” award. *JPEN J Parenter Enteral Nutr* 2010;34:707–15.
9. Arora VM, Fish M, Basu A, Olson J, Plein C, Suresh K, Sachs G, Meltzer DO. Relationship between quality of care of hospitalized vulnerable elders and postdischarge mortality. *J Am Geriatr Soc* 2010;58:1642–8.
10. Askari M, Wierenga PC, Eslami S, Medlock S, de Rooij SE, Abu-Hanna A. Assessing quality of care of elderly patients using the ACOVE quality indicator set: a systematic review. *PLoS ONE* 2011;6:e28631.
11. Smith PE, Smith AE. High-quality nutritional interventions reduce costs. *Healthc Financ Manage* 1997;51:66–9.
12. Centers for Disease Control and Prevention; Council of State and Territorial Epidemiologists; Association of State and Territorial Chronic Disease Program Directors. Indicators for chronic disease surveillance. *MMWR Recomm Rep* 2004;53(RR-11):1–6.
13. Ford ES, Bergmann MM, Boeing H, Li C, Capewell S. Healthy lifestyle behaviors and all-cause mortality among adults in the United States. *Prev Med* 2012;55:23–7.
14. Russell Rodriguez S, Osborne D, Jacobellis J; Centers for Disease Control and Prevention. Health plan implementation of U.S. Preventive Services Task Force A and B recommendations—Colorado, 2010. *MMWR Morb Mortal Wkly Rep* 2011;60(39):1348–50.
15. Lesser LI, Krist AH, Kamerow DB, Bazemore AW. Comparison between US Preventive Services Task Force recommendations and Medicare coverage. *Ann Fam Med* 2011;9:44–9.
16. Adams KM, Kohlmeier M, Powell M, Zeisel SH. Nutrition in medicine: nutrition education for medical students and residents. *Nutr Clin Pract* 2010;25:471–80. Available from: <http://www.nutritioninmedicine.net> (cited 11 November 2013).
17. Martinez JA, Koyama T, Acra S, Mascarenhas MR, Shulman RJ. Nutrition education for pediatric gastroenterology, hepatology, and nutrition fellows: survey of NASPGHAN fellowship training programs. *J Pediatr Gastroenterol Nutr* 2012;55:131–5.
18. Castro MG, Pompilio CE, Horie LM, Verotti CC, Waitzberg DL. Education program on medical nutrition and length of stay of critically ill patients. *Clin Nutr* 2012;32(6):1061–6.
19. McMahon MM, Hurley DL, Mechanick JJ, Handelsman Y. American Association of Clinical Endocrinologists’ position statement on clinical nutrition and health promotion in endocrinology. *Endocr Pract* 2012;18:633–41.
20. Delegge MH, Alger-Mayer S, Van Way CW III, Gramlich L. Specialty residency training in medical nutrition education: history and proposal for improvement. *JPEN J Parenter Enteral Nutr* 2010;34(suppl):47S–56S.
21. Hark LA, Iwamoto C, Melnick DE, Young EA, Morgan SL, Kushner R, Hensrud DD. Nutrition coverage on medical licensing examinations in the United States. *Am J Clin Nutr* 1997;65:568–71.
22. Vetter ML, Herring SJ, Sood M, Shah NR, Kalet AL. What do resident physicians know about nutrition? An evaluation of attitudes, self-perceived proficiency and knowledge. *J Am Coll Nutr* 2008;27:287–98.
23. Davis NJ, Shishodia H, Taqui B, Dumfeh C, Wylie-Rosett J. Resident physician attitudes and competence about obesity treatment: need for improved education. *Med Educ Online* 2008;13:5.
24. Wolff MS, Rhodes ET, Ludwig DS. Training in childhood obesity management in the United States: a survey of pediatric, internal medicine-pediatrics and family medicine residency program directors. *BMC Med Educ* 2010;10:18.
25. Raman M, Violato C, Coderre S. How much do gastroenterology fellows know about nutrition? *J Clin Gastroenterol* 2009;43:559–64.
26. Martinez JA, Koyama T, Acra S, Mascarenhas MR, Shulman RJ. Nutrition education for pediatric gastroenterology, hepatology, and nutrition fellows: survey of NASPGHAN fellowship training programs. *J Pediatr Gastroenterol Nutr* 2012;55:131–5.
27. Heimbarger DC, McClave SA, Gramlich LM, Merritt R. The Intersociety Professional Nutrition Education Consortium and American Board of Physician Nutrition Specialists: what have we learned? *JPEN* 2010;34(6S):21S–9S.
28. Bernard ND. The physician’s role in nutrition related disorders: from bystander to leader. *Virtual Mentor* 2013;15:367–72.
29. Eaton CB, McBride PE, Gans KA, Underbakke GL. Teaching nutrition skills to primary care practitioners. *J Nutr* 2003;133(suppl):563S–6S.
30. Fluker SA, Whalen U, Schneider J, Cantey P, Bussey-Jones J, Brady D, Doyle JP. Incorporating performance improvement methods into

- a needs assessment: experience with a nutrition and exercise curriculum. *J Gen Intern Med* 2010;25(suppl 4):S627–33.
31. Ockene IS, Hebert JR, Ockene JK, Saperia GM, Stanek E, Nicolosi R, Merriam PA, Hurlley TG. Effect of physician-delivered nutrition counseling training and an office-support program on saturated fat intake, weight, and serum lipid measurements in a hyperlipidemic population: Worcester Area Trial for Counseling in Hyperlipidemia (WATCH). *Arch Intern Med* 1999;159:725–31.
 32. Jay M, Gillespie C, Schlair S, Sherman S, Kalet A. Physicians' use of the 5As in counseling obese patients: is the quality of counseling associated with patients' motivation and intention to lose weight? *BMC Health Serv Res* 2010;10:159.
 33. Hebert JR, Ebbeling CB, Ockene IS, Ma Y, Rider L, Merriam PA, Ockene JK, Saperia GM. A dietitian-delivered group nutrition program leads to reductions in dietary fat, serum cholesterol, and body weight: the Worcester Area Trial for Counseling in Hyperlipidemia (WATCH). *J Am Diet Assoc* 1999;99:544–52.
 34. Burton AM, Agne AA, Lehr SM, Davis NJ, Willett LL, Cherrington AL. Training residents in obesity counseling: incorporating principles of motivational interviewing to enhance patient centeredness. *J Grad Med Educ* 2011;3:408–11.
 35. Kolasa KM, Rickett K. Barriers to providing nutrition counseling cited by physicians: a survey of primary care practitioners. *Nutr Clin Pract* 2010;25:502–9.
 36. Story MT, Neumark-Stzainer DR, Sherwood NE, Holt K, Sofka D, Trowbridge FL, Barlow SE. Management of child and adolescent obesity: attitudes, barriers, skills, and training needs among health care professionals. *Pediatrics* 2002;110:210–4.
 37. Perrin EM, Flower KB, Garrett J, Ammerman AS. Preventing and treating obesity: pediatricians' self-efficacy, barriers, resources, and advocacy. *Ambul Pediatr* 2005;5:150–6.
 38. Bock C, Diehl K, Schneider S, Diehm C, Litaker D. Behavioral counseling for cardiovascular disease prevention in primary care settings: a systematic review of practice and associated factors. *Med Care Res Rev* 2012;69:495–518.
 39. Carpenter DM, Fisher EB, Greene SB. Shortcomings in public and private insurance coverage of diabetes self-management education and support. *Popul Health Manag* 2012;15:144–8.
 40. Fradkin JE, Roberts T, Rodgers GP. What's preventing us from preventing type 2 diabetes? *N Engl J Med* 2012;367:1177–9.
 41. Laiteerapong N, Keh CE, Naylor KB, Yang VL, Vinci LM, Oyler JL, Arora VM. A resident-led quality improvement initiative to improve obesity screening. *Am J Med Qual* 2011;26:315–22.
 42. Nutrition Academic Award Program. Nutrition curriculum guide for training physicians. Available from: http://www.nhlbi.nih.gov/funding/training/naa/curr_gde.pdf (cited 13 June 2013).
 43. American Academy of Family Physicians. Recommended curriculum guidelines for family medicine: nutrition. Available from: http://www.aafp.org/dam/AAFP/documents/medical_education_residency/program_directors/Reprint275_Nutrition.pdf (cited 23 June 2013).
 44. Association of American Medical Colleges. MedEdPORTAL. Available from: <https://www.mededportal.org/> (cited 24 June 2013).
 45. Hark L, Morrison G. Medical nutrition and disease. 3rd ed. Malden, MA: Blackwell Science, 2003.
 46. Shurtz S, von Isenburg M. Exploring e-readers to support clinical medical education: two case studies. *J Med Libr Assoc* 2011;99:110–7.
 47. Ross AC, Caballero B, Cousins RJ, Tucker KL, Ziegler TR. Modern nutrition in health and disease. 11th ed. Philadelphia, PA: Lippincott Williams & Wilkins, 2012.
 48. Roche PL, Ciccarelli MR, Gupta SK, Hayes BM, Molleston JP. Multi-school collaboration to develop and test nutrition computer modules for pediatric residents. *J Am Diet Assoc* 2007;107:1586–9.
 49. Feist M, Ciccarelli M, McFeron BA, Molleston JP. Methods and effects of a case-based pediatric gastroenterology online curriculum. *J Pediatr Gastroenterol Nutr* 2013;56:161–5.
 50. Cheston CC, Flickinger TE, Chisolm MS. Social media use in medical education: a systematic review. *Acad Med* 2013;88:893–901.
 51. Soguel L, Revelly JP, Schaller MD, Longchamp C, Berger MM. Energy deficit and length of hospital stay can be reduced by a two-step quality improvement of nutrition therapy: the intensive care unit dietitian can make the difference. *Crit Care Med* 2012;40:412–9.
 52. Boitano M, Bojak S, McCloskey S, McCaul DS, McDonough M. Improving the safety and effectiveness of parenteral nutrition: results of a quality improvement collaboration. *Nutr Clin Pract* 2010;25:663–71.
 53. Englander R, Cameron T, Ballard AJ, Dodge J, Bull J, Aschenbrenner CA. Toward a common taxonomy of competency domains for the health professions and competencies for physicians. *Acad Med* 2013;88(8):1088–94. Physician Competency Reference Set (PCRS). Available from: http://journals.lww.com/academicmedicine/Fulltext/2013/08000/Toward_a_Common_Taxonomy_of_Competency_Domains_for.21.aspx (cited 6 November 2013).
 54. Deen D. How can nutrition education contribute to competency-based resident evaluation? *Am J Clin Nutr* 2006;83(suppl):976S–80S.
 55. Accreditation Council for Graduate Medical Education. Specialty program requirements. Available from: <http://www.acgme.org/acgmeweb/tabid/158/ProgramandInstitutionalGuidelines/InstitutionalAccreditation/InstitutionalReview.aspx> (cited 13 June 2013).
 56. Mechanick JI, Garber AJ, Handelsman Y, Garvey WT. American Association of Clinical Endocrinologists' position statement on obesity and obesity medicine. *Endocr Pract* 2012;18:642–8.
 57. Anonymous. Training the gastroenterologist of the future: the gastroenterology core curriculum. The Gastroenterology Leadership Council. *Gastroenterology*. 1996;110(4):1266–300.
 58. American Association for the Study of Liver Diseases; American College of Gastroenterology; AGA Institute; American Society for Gastrointestinal Endoscopy. The gastroenterology core curriculum. Available from: http://www.gastro.org/2007_Version_Core_Curriculum.pdf (cited 24 June 2013).
 59. Singh H, Duerksen DR. Survey of clinical nutrition practices of Canadian gastroenterologists. *Can J Gastroenterol* 2006;20:527–30.
 60. Scolapio JS, Buchman AL, Floch M. Education of gastroenterology trainees: first annual fellows' nutrition course. *J Clin Gastroenterol* 2008;42:122–7.
 61. American Board of Internal Medicine. Gastroenterology: certification examination blueprint. Available from: http://www.abim.org/pdf/blueprint/gastro_cert.pdf (cited 24 June 2013).
 62. Pack QR, Keteyian SJ, McBride PE, Weaver WD, Kim HE. Current status of preventive cardiology training among United States cardiology fellowships and comparison to training guidelines. *Am J Cardiol* 2012;110:124–8.
 63. Leipzig RM, Granville L, Simpson D, Anderson MB, Sauvigné K, Soriano RP. Keeping granny safe on July 1: a consensus on minimum geriatrics competencies for graduating medical students. *Acad Med* 2009;84:604–10.
 64. Williams BC, Warshaw G, Fabiny AR, Lundebjerg Mpa N, Medina-Walpole A, Sauvigne K, Schwartzberg JG, Leipzig RM. Medicine in the 21st century: recommended essential geriatrics competencies for internal medicine and family medicine residents. *J Grad Med Educ* 2010;2:373–83.
 65. Levine SA, Caruso LB, Vanderschmidt H, Silliman RA, Barry PP. Faculty development in geriatrics for clinician educators: a unique model for skills acquisition and academic achievement. *J Am Geriatr Soc* 2005;53:516–21.
 66. Levine SA, Chao SH, Brett B, Jackson AH, Burrows AB, Goldman LN, Caruso LB. Chief resident immersion training in the care of older adults: an innovative interspecialty education and leadership intervention. *J Am Geriatr Soc* 2008;56(6):1140–5. Available from: <http://adgap.americangeriatrics.org/adgap-programs/crit/> (cited 5 May 2013).
 67. Oates DJ, Norton LE, Russell ML, Chao SH, Hardt EJ, Brett B, Kimball P, Levine SA. Multisite geriatrics clerkship for fourth-year medical students: a successful model for teaching the Association of American Medical Colleges' core competencies. *J Am Geriatr Soc* 2009;57:1917–24.
 68. Van Horn L. The Nutrition Academic Award: brief history, overview, and legacy. *Am J Clin Nutr* 2006;83(suppl):936S–40S.
 69. Touger-Decker R. Nutrition education of medical and dental students: innovation through curriculum integration. *Am J Clin Nutr* 2004;79:198–203.
 70. Boker JR, Weinsier RL, Brooks CM, Olson AK. Components of effective clinical-nutrition training: a national survey of graduate medical education (residency) programs. *Am J Clin Nutr* 1990;52:568–71.
 71. Weinsier RL, Boker JR, Brooks CM, Kushner RF, Olson AK, Mark DA, St Jeor ST, Stallings VA, Winick M, Heber D, et al. Nutrition training in graduate medical (residency) education: a survey of selected training programs. *Am J Clin Nutr* 1991;54:957–62.
 72. McClave SA, Mechanick JI, Bistrain B, Graham T, Hegazi R, Jensen GL, Kushner RF, Merritt R. What is the significance of a physician shortage in nutrition medicine? *JPEN J Parenter Enteral Nutr* 2010;34:7S–20S.



73. Heimbarger DC, McClave SA, Gramlich LM, Merritt R. The Intersociety Professional Nutrition Education Consortium and American Board of Physician Nutrition Specialists: what have we learned? *JPEN J Parenter Enteral Nutr* 2010;34:21S–9S.
74. Mechanick JI, Graham T, Gramlich L, McMahan MM, Ziegler TR. Proposal for subspecialty physician fellowship training in nutrition and health promotion. *JPEN J Parenter Enteral Nutr* 2010;34(suppl 1): 57S–62S.
75. American Academy of Family Physicians. Medical schools struggle to provide ample training in nutrition, obesity prevention. Available from: <http://www.aafp.org/news-now/obesity/20100517med-schools.html> (cited 3 August 2013).
76. Lenders C, Gorman K, Milch H, Decker A, Harvey N, Stanfield L, Lim-Miller A, Salge-Blake J, Judd L, Levine SA. Novel nutrition medicine education model: the Boston University experience. *Adv Nutr* 2013;4:1–7.
77. van Dillen SM, van Binsbergen JJ, Koelen MA, Hiddink GJ. Nutrition and physical activity guidance practices in general practice: a critical review. *Patient Educ Couns* 2013;90:155–69.
78. Pollak KI, Alexander SC, Coffman CJ, Tulsy JA, Lyna P, Dolor RJ, James IE, Brouwer RJ, Manusov JR, Østbye T. Physician communication techniques and weight loss in adults: Project CHAT. *Am J Prev Med* 2010;39:321–8.
79. Maiburg BH, Rethans JJ, Schuwirth LW, Mathus-Vliegen LM, van Ree JW. Controlled trial of effect of computer-based nutrition course on knowledge and practice of general practitioner trainees. *Am J Clin Nutr* 2003;77(suppl):1019S–24S.
80. Derkx H, Rethans JJ, Maiburg B, Winkens R, Knottnerus A. New methodology for using incognito standardised patients for telephone consultation in primary care. *Med Educ* 2009;43:82–8.
81. Sumner W Jr, O'Neill TR, Roussel G, Xu JZ, Fu H, Ivins D, Hagen MD. Family physicians' completion of scoring criteria in virtual patient encounters. *AMIA Annu Symp Proc* 2011;2011:1355–60.
82. Fleming M, Olsen D, Stathes H, Boteler L, Grossberg P, Pfeifer J, Schiro S, Banning J, Skochelak S. Virtual reality skills training for health care professionals in alcohol screening and brief intervention. *J Am Board Fam Med* 2009;22:387–98.

