

Culinary Medicine: Advancing a Framework for Healthier Eating to Improve Chronic Disease Management and Prevention

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ABSTRACT

Unsustainable increases in the prevalence and costs of chronic disease in the United States call for low-cost, high-impact interventions that can be readily incorporated into people's daily lives. Culinary medicine is one such intervention. As a practical discipline, culinary medicine integrates the art of preparing, cooking, and presenting food with the science of medicine to achieve desired health outcomes. This article describes how the underpinnings and components of culinary medicine enhance existing nutrition interventions. Evidence of improved well-being and reduced resource utilization as the result of culinary medicine interventions is compiled for easy reference by health care organizations, medical professionals, people living with or at risk for chronic disease, food industry specialists, and payers in both the public and private sectors. Suggestions for individual and organizational implementation of culinary medicine strategies are offered with a proposed lexicon for continued development of the field. (*Clin Ther.* xxxx;xxx:xxx) © 2019 Elsevier Inc. All rights reserved.

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INTRODUCTION

Diseases that require ongoing medical attention for >1 year and limit activities of daily living are considered chronic. Sixty percent of American adults have at least one chronic disease and 40% have two or more.¹ If current trends continue, >83 million people in the United States will have multiple chronic conditions by 2030, more than twice the number in 2015.² The economic implications are staggering, considering that, in 2016, direct and indirect costs of all chronic diseases equaled \$3.7 trillion, nearly 20% of the US gross domestic product.² Diseases influenced by obesity and being overweight, such as type 2 diabetes, accounted for nearly one half of this total expenditure, equivalent to 9.3% of the 2016 US gross domestic product.^{2,3}

The human toll is similarly profound. The latest data from the Centers for Disease Control and Prevention (CDC) and the National Health and Nutrition Examination Survey indicate that 1 in 3 (78 million) adult Americans and 1 in 5 (12 million) children are considered obese, with rates increasing among adults and remaining steady among youth.^{4,5} Drivers of this epidemic are the abundance of

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inexpensive, highly palatable convenience foods; more frequent eating out; larger meal portions; and the ubiquity of processed foods in the American diet.^{6–8} Although the food and beverage industry has made strides in reformulating products high in fat and sugar, the health outcomes of making unhealthy foods less unhealthy by, for example, replacing natural sweeteners with artificial substitutes, remain unclear.⁹ It is obvious, however, that multisector approaches are needed to motivate and sustain healthier eating practices in everyday life.^{4–8,10}

In response to this challenge, guidelines that inform nutrition policy are evolving away from prescriptive, nutrient-centered “dos and don'ts” toward encouraging healthful eating patterns that may be more easily carried out in real-world settings, such as homes, schools, workplaces, and neighborhoods.^{11,12} In addition, consulting chefs and other food industry specialists are joining influencers of nutrition programs, as well as health care professionals, registered dietitian nutritionists (RDNs), and others in the medical arena, to expand knowledge of the nutritional aspects of food so that individual and population wellness can be more broadly addressed. Such cross-pollination has given rise to “culinary medicine,” an evolving evidence-based field that blends the art of preparing, cooking, and presenting food with the science of medicine to achieve desired health outcomes.¹³ Specifically, culinary medicine adds to existing nutrition interventions by integrating the concept of “food pleasure” (ie, both the sensory-based experience of food in terms of taste, smell, texture, and appearance, and the emotions surrounding food) with the scientific knowledge of how food and dietary choices may influence human metabolism, immunity, and pathophysiology.

To further raise awareness of culinary medicine and the potential effect of this new field on eating behaviors and health care outcomes, a roundtable of interdisciplinary stakeholders met in Denver, Colorado, on December 1, 2018. The panel included leading endocrinologists, a neurologist specializing in Alzheimer's disease and dementia, an RDN who has served on national guideline committees, business innovators from the private and public sectors, and a World Association of Chefs Societies Global Master Chef. This article presents highlights of the roundtable presentations, discussions, and ensuing recommendations.

NUTRITION-RELATED MECHANISMS OF CHRONIC DISEASE: A BASIS FOR ACTION IN SUPPORTING CULINARY MEDICINE AS AN ADJUNCT TO PHARMACOLOGIC THERAPY

Numerous clinical studies have examined the association of obesity, eating habits, food choices, and lack of regular activity with the development and progression of chronic disease.^{14–16} According to the CDC, <1 in 5 adults eats enough fruit, and <1 in 7 eats enough vegetables.⁴ A recent comparative risk assessment model designed to quantify the role of suboptimal diet in mortality from cardiometabolic disease (heart disease, stroke, and type 2 diabetes) estimated that dietary risk factors contributed to nearly 50% of deaths in 2012.¹⁶ Excess sodium intake was associated with the highest proportion of deaths (9.5%); the other 9 factors were low intake of nuts and seeds (8.5%), high intake of processed meats (8.2%), low intake of seafood omega-3 fats (7.8%), low intake of vegetables (7.6%), low intake of fruits (7.5%), high intake of sugar-sweetened beverages (7.4%), low intake of whole grains (5.9%), low intake of polyunsaturated fats (2.3%), and high intake of unprocessed red meats (0.4%). These and other such findings support a growing understanding that different foods influence diverse and potentially modifiable risk pathways of energy metabolism, fuel selection, and body weight regulation.¹⁷

Targeting Metabesity

The metabolic processes that create the intertwining epidemics of obesity and type 2 diabetes, collectively referred to as diabesity, are now believed to be part of the broader phenomenon of “metabesity,” a relatively new term used to capture the shared metabolic roots among diverse chronic diseases. Specifically, the metabesity hypothesis states that diabetes, obesity, and cardiovascular disease, as well as neurodegenerative disorders, cancer, and even the aging process itself, share metabolic and inflammatory origins associated with food overconsumption and nutrient imbalance that may be influenced by culinary medicine and improvements in dietary intake.^{18,19} The hypothesis also proposes that metabesity-associated metabolic and inflammatory alterations impair insulin signaling in peripheral tissues/organs, such as adipose tissue, the liver, and skeletal muscles. The ensuing development of insulin resistance and visceral fat deposition over time can

trigger a vicious cycle of enhanced cytokine signaling that leads to further insulin resistance and metabolic dysfunction.²⁰ Maladaptive changes in homeostatic set points, perpetuated by nutrient-poor, energy-dense food consumption, can eventually lead to altered energy balance, abnormal weight gain, and chronic disease (Figure).²¹

Notably, this pathophysiologic spectrum is controlled by the brain, which stimulates the release of endocrine-like chemicals such as adipokines and amino acids from digestive/metabolic organs (eg,

stomach, small intestine, pancreas, liver) and “talks back” to these same organs via a neural feedback loop commonly referred to as the “gut–brain axis.”^{22–24} As part of this bidirectional communication, ligand interaction with specific “taste” receptors triggers production of gastrointestinal hormones, such as glucagon-like peptide-1 and other incretins, with their consequent neuroendocrine effects.²⁴ Irregularities in these nutrient-related signaling pathways are believed to induce a pathologic cascade that can ultimately

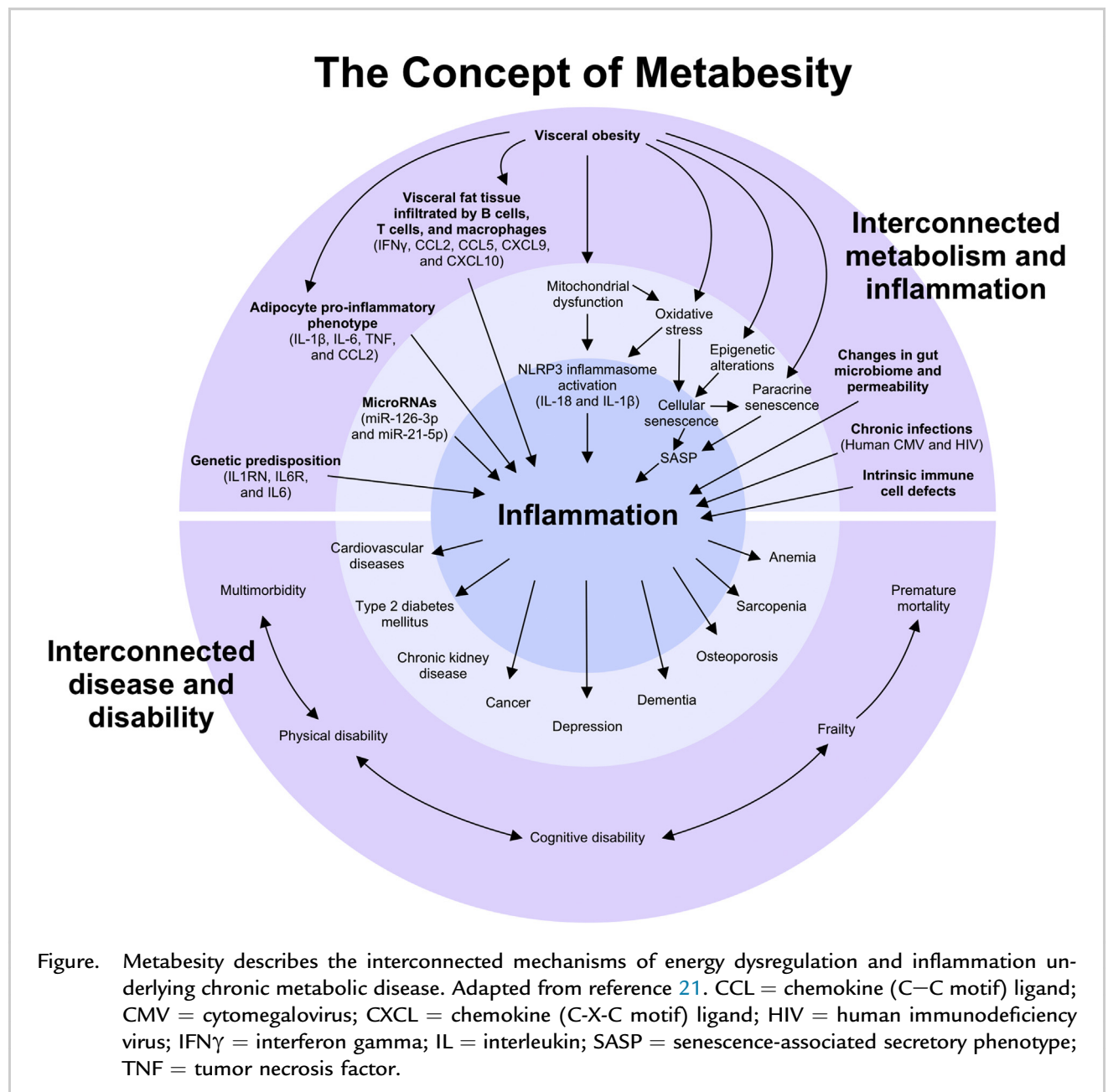


Figure. Metabesity describes the interconnected mechanisms of energy dysregulation and inflammation underlying chronic metabolic disease. Adapted from reference 21. CCL = chemokine (C–C motif) ligand; CMV = cytomegalovirus; CXCL = chemokine (C–X–C motif) ligand; HIV = human immunodeficiency virus; IFN γ = interferon gamma; IL = interleukin; SASP = senescence-associated secretory phenotype; TNF = tumor necrosis factor.

progress to obesity, diabetes, cardiovascular disease, and other chronic conditions.^{22,23}

With this in mind, food-based interventions that “reset” gut signals, similar to bariatric surgery, are now being studied as a potentially fruitful avenue in the treatment of both obesity and chronic disease, especially when combined with medical therapies such as incretin analogues and metformin in the case of diabetes.^{25–27} Another therapeutic strategy for reducing chronic metabolic dysfunction might entail minimizing or eliminating proinflammatory foods (eg, high-fructose corn syrup) that pathologically inflame key metabolic receptors.²³ Such interventions would be aimed at supporting a return to energy homeostatic balance whenever possible. Among the more well-studied eating patterns to this end are the Mediterranean-style eating plan and the DASH (Dietary Approaches to Stop Hypertension) eating plan (described later in this article).²⁸

Translation to Action: A Work in Progress

The Diabetes Prevention Program (DPP), a landmark clinical trial that compared the effect of an intensive lifestyle intervention (eating plan, physical activity, and behavior modification) or metformin versus placebo (n = 3234) in the progression from impaired glucose tolerance to diabetes, showed that lifestyle measures produced the greater reduction in subclinical inflammation (as measured by using C-reactive protein).²⁹ This finding is relevant because people with impaired glucose tolerance have been shown to have increased levels of inflammation related to obesity and insulin resistance.

More definitively, the DPP showed that lifestyle modification lowered a person's chance of developing type 2 diabetes by 58% compared with placebo, whereas metformin lowered the risk by 31%.³⁰ Based on results of the DPP, the CDC launched a public/private initiative in 2010 to implement lifestyle change programs across the United States.^{31–33} Its curriculum emphasizes self-monitoring and self-efficacy, with progress tracked through coach feedback and participant weigh-ins. Medicare began coverage for these programs in 2018, and adoption by private insurers is anticipated.³⁴

Even when covered by insurance, however, medical nutrition therapy and diabetes self-management education remain underutilized. Barriers from the provider perspective include confusion about the

value of the information provided and when and how to refer patients.^{35–37} From the standpoint of patients, the self-regulation required to change eating habits may be viewed as daunting, a reasonable perception given the aforementioned role of the modern food environment in perpetuating overeating and weight gain.³⁸

Given this reality, the imperative of moving beyond ideas of willpower and calorie counting toward a broader understanding of the interplay among food quality, eating behavior, and the physiologic basis of long-term metabolic health cannot be overstated. In this respect, culinary medicine offers a practical option for reshaping sensory-based and emotional motivations behind suboptimal food choices through the practice of “effective eating,” defined here as making choices that enhance day-to-day anticipation, planning, preparation, consumption, and enjoyment of meals in support of good health and sustained well-being.

COMPONENTS OF CULINARY MEDICINE

Highlighting the pleasure of healthy foods, rather than stressing avoidance of unhealthy ones, is a main tenet of realizing the benefit of culinary medicine. Although people today spend significantly less time cooking meals at home compared with previous decades, interest in the culinary arts is as strong or stronger than ever as shown by the popularity of celebrity chefs and cooking programs on television and other media.^{13,39} Supermarkets, restaurants, websites, and apps often showcase foods in enticing and creative ways, emphasizing aesthetics such as plating techniques.⁴⁰ Neuroimaging studies make clear that salient cortical networks are reactive to food presentation, not only when people are eating or viewing actual food but also when viewing food images.⁴¹ The studies also show that the anticipatory reward activated in “pleasure centers” of the brain can, over time, be shifted positively from response to unhealthy cues toward healthier ones, indicating that predispositions toward specific types of food are malleable.^{42,43} Such findings lend credence to the observation that encouraging the enjoyment of healthy food could be a powerful tool in using food as “medicine” for obesity and/or chronic disease management.^{12,44}

Culinary Therapy

In culinary medicine, meal recommendations provided by a health care professional to improve the health and well-being of people who have or are at risk for a chronic disease constitute culinary therapy. Culinary therapy recommendations usually focus on overall patterns of food selection that meet a person's nutritional needs rather than focusing on intakes of specific nutrients.⁴⁵ To sustain improvement over time, individuals are encouraged to take small steps, such as using vegetable oil instead of solid fats, over the course of a week, day, or even a meal.⁴⁶ The guiding principle is empowering the patient (or caregiver) to make medically sound food choices in support of pleasurable eating while factoring in the social, cultural, economic, and emotional meanings attached to food.¹³

Key elements of implementing culinary therapy are shown in [Table I](#).⁴⁷ During the initial assessment, health care professionals should consider the individual's readiness to change; who in the household makes the majority of food decisions; and whether there is the desire, ability, and physical support to plan meals, shop, and/or cook. Other factors that may come to bear are numeracy and literacy, as well as budgetary constraints or food-related religious concerns.^{48–50} An important rule of

thumb is to be cautious about assumptions when helping individuals create eating plans. A simple waiting-room questionnaire, for example, can indicate whether the individuals can read a recipe, have an oven, use cup measures, or even want to cook.

Medically Tailored Meals

In the event that an individual or his or her caregiver is unable or unwilling to plan, shop for, and prepare healthy and nutritionally adequate meals, medically tailored meals (MTMs) crafted for individuals living with or at risk for specific medical conditions are available, often through home delivery.⁵¹ The inability to prepare meals may be due to time constraints and/or simply lacking the skill to perform the necessary tasks. MTMs are pre-prepared from fresh healthy ingredients according to current recommendations for chronic conditions such as heart disease, diabetes, renal disease, and Alzheimer's disease/dementia.

Outcomes of pilot programs in major cities, as shown in [Table II](#), support a growing role for MTMs in improving health outcomes and lowering health care costs.^{52–57} In a precedent-setting Philadelphia-based program known as MANNA (Metropolitan Area Neighborhood Nutrition Alliance), individuals who received MTMs were hospitalized half as often

Table I. Healthy-eating plan fundamentals for considering culinary therapy.

Assessment

Use waiting room questionnaires or open-ended questions to assess:

- Readiness to change/motivation
- Health numeracy and literacy

Determine kitchen set-up

- Stove, cooktop, microwave, appliances, cup measures, tools

Determine desire or ability to plan meals, shop, and cook

Estimate food budget

Interventions

Individualize eating plan: collaboratively develop with patient and health team members

Determine patient's understanding

- “Based on what we talked about today, what could you cook for yourself tonight at dinner [tomorrow for breakfast and lunch]?”

If patient is unable to plan, shop for, and prepare meals appropriate for the health condition:

- Determine appropriateness of nutritionally tailored, home-delivered meals, factoring in food budget, access, and availability of type of therapeutic diet
- Consider local and commercially available programs

Table II. Medically tailored meals programs: demonstrated outcomes to-date.

Program	Hospitalization	ED Visits	Costs	Qualitative Assessments
MANNA, Philadelphia, PA ^{52,53}	<p>Mean monthly number of inpatient visits (12 mo after starting MANNA): 0.2, MANNA vs 0.4, no intervention; $P = 0.0001$</p> <p>Mean monthly inpatient length of stay: 10.7, MANNA vs 17.1, no intervention; $P = 0.0008$</p> <p>Mean percentage of individuals with discharges to home: 93%, MANNA vs 72%, no intervention; $P = 0.0001$</p>	<p>Mean monthly number of ED visits: 0.6, MANNA vs 0.3, no intervention; $P = 0.0001$</p>	<p>Overall costs: \$28,000, MANNA vs \$41,000, no intervention; $P = 0.0006$</p> <p>Mean monthly inpatient costs: \$132,441, MANNA vs \$219,639, no intervention; $P = 0.0014$</p> <p>Mean monthly ED visit costs: \$4893, MANNA vs \$3700, no intervention</p>	<p>In a 2017 survey of users conducted by MCO partner: 100% stated that food met their medical needs and they were better able to make healthier food choices; 97% met their health care goals; 75% made enduring lifestyle changes; and 95% better understood the importance of healthy eating and portion control related to their chronic condition</p>
Project Angel Heart, Denver, Colorado Springs, CO ⁵⁴	<p>↓ 13% readmission (from before to after intervention)</p>	NA	<p>Total: ↓24% Inpatient, member/mo: ↓\$111 –\$555</p>	<p>In a 2018 survey, clients reported: 82% less stress; 60% improved energy; 63% improved health; 69% improved adherence; 72% improved quality of life</p>
Project Open Hand, San Francisco, CA ⁵⁵	<p>(decrease in ≥1 admission in past 3 mo [%]): 15.7–5.77; $P = 0.11$</p>	<p>(decrease in ≥1 visit in past 3 mo [%]): 26.9 –17.3; $P = 0.15$</p>	<p>Intervention \$6.58/d</p>	<p>T2DM distress scores declined ($P < 0.001$) and perceived self-management scores increased ($P = 0.007$)</p>

Table II. (Continued)

Program	Hospitalization	ED Visits	Costs	Qualitative Assessments
Community Servings, Boston, MA ^{56,57}	↓0.3 admission (mean incidence per person vs no intervention)	↓1.5 (mean incidence per person vs no intervention)	Net: ↓\$220 per member/month vs no intervention	In a 2013 survey of HCPs: 96% reported improved client health; 94% believed program significantly improved clients' access to healthy food

ED = emergency department; HCP = health care professional; MANNA = Metropolitan Area Neighborhood Nutrition Alliance; MCO = managed care organization; NA = not applicable; T2DM = type 2 diabetes mellitus.

(0.2 mean monthly inpatient visits in the MANNA group vs 0.4 in the comparison group), and those who were hospitalized had a 37% shorter (38 days) stay compared with control subjects who did not receive MTMs.^{52,53} People in the MTM group were also 23% more likely to be discharged to their homes. Subsequent programs based in Denver (Project Angel Heart), San Francisco (Project Open Hand), and Boston (Community Servings) showed similar health care utilization results.^{54–57} In Colorado, the rate of all-cause 30-day readmissions was reduced by 13% in MTM recipients compared with control subjects, and per-person per-month total medical costs for individuals living with congestive heart failure, chronic obstructive pulmonary disease, and diabetes were significantly reduced by an average of 24%.⁵⁴ The San Francisco program likewise showed a 63% reduction in hospitalizations, 50% increase in medication adherence, and 58% decrease in client emergency department visits.⁵⁵

A Massachusetts study examining the effect of food delivery programs in a community-based health plan serving adults with complex medical, behavioral, and social needs found that participants who received either home-delivered MTMs from Boston-based Community Servings ($n = 133$) or the less medically targeted Meals on Wheels ($n = 624$) had fewer emergency department visits and less use of emergency transportation compared with matched control subjects who received no meal

intervention.^{56,57} However, those enrolled in the Community Servings MTM program had the fewest inpatient admissions and lowest medical spending. After subtracting the respective program costs from the estimated savings generated, MTM yielded a net savings of \$220 per month versus \$10 per month for the Meals on Wheels program. In addition, medical professionals reported perceived improvements in psychosocial well-being, weight, and adherence to prescribed medications among individuals receiving MTMs.⁵⁷

SAMPLE EATING PATTERNS FOR IMPLEMENTATION OF CULINARY MEDICINE

Given the diverse pathways related to metabolic homeostasis (eg, hunger, brain reward, satiety, glucose-insulin response, metabolic expenditure, the microbiome), identifying the most beneficial eating plan for any given individual with chronic disease depends, initially, on understanding the foods habitually consumed, and then ultimately guiding patients to eat more healthful foods, either of their own accord or through the provision of MTMs. Culinary medicine offers an avenue by which an individual can incorporate personal favorite foods into an individualized eating plan and, in the process, learn about new foods (eg, different types of whole grains such as farro and millet or meatless entrees) and meal preparation tips (eg, batch cooking, freezing and defrosting techniques) that enhance

Table III. Sample eating patterns for implementing culinary therapy.^{28,58,59}

DASH (Food Group and Daily Servings)		Mediterranean (Food Group and Recommendation)	
Whole grain	7 to 8	Whole grains, vegetables, fruits, seeds, olive oil, beans, nuts, legumes	Base every meal on these foods
Vegetables	4 to 5	Fish, seafood	Eat at least twice a week
Fruits	4 to 5	Poultry, eggs, yogurt, cheese	Eat moderate portions daily to weekly
Dairy, low-fat or nonfat	2 to 3	Meats and sweets	Eat less often than other foods
Lean meats, poultry, fish	2 or fewer	Wine	Drink in moderation
Nuts, seeds, dry beans	4 to 5/week		
Fats and oils	2 to 3		
Sweets	5 per week		

DASH = Dietary Approaches to Stop Hypertension.

effective eating.^{13,45} In addition, shifting the therapeutic conversation to immediate steps for action, such as asking, “Based on what we talked about today, what could you cook for yourself tonight at dinner (tomorrow for breakfast/lunch)?” offers a potentially engaging activity around which to begin behavior change (Table I). Community resources, familial norms and support, and the nature of the eating plan must also be factored in when choosing the best food intervention. Sample eating patterns amenable to culinary medicine approaches are summarized in the following sections.

DASH and Mediterranean-style Eating Patterns

The DASH and Mediterranean-style eating patterns, considered first-line therapy for people with or at risk of diabetes and/or heart disease, are associated with beneficial effects on glucose–insulin homeostasis, blood pressure, blood lipids and lipoproteins, endothelial function, inflammatory markers, arrhythmic risk, and the gut microbiome.^{17,28,58,59} Shown side-by-side in Table III, both plans are congruent with the model of culinary therapy because they permit greater flexibility and personal preference in food choices.

The DASH plan, supported by multiple professional organizations as an important component of preventing and treating hypertension, provides daily and weekly serving goals.⁵⁸ The plan emphasizes a largely plant-based meal plan of fresh fruits,

vegetables, low-fat dairy products, unrefined whole grains, poultry, fish, and nuts, and a low consumption of red meat, sweets, and sugar-sweetened beverages. The Mediterranean-style eating pattern, rather than specifying serving amounts, is based on the collective eating habits of people living near the Mediterranean Sea, who have low cardiovascular mortality.^{28,59} Daily physical activity, meals eaten in the company of family and friends, and reasonable wine consumption, if desired, are at its foundation. The plan also recommends daily consumption of fruits, vegetables, whole grains, nuts, beans, seeds, legumes, olive oil, herbs, and spices; omega-3-rich fish twice weekly; moderate intake of poultry, eggs, cheese, and yogurt; and limited amounts of sweets and red meat. For both the DASH and Mediterranean-style eating patterns, whole foods containing bioactive compounds, such as phytochemicals, that may interact with each other either additively or synergistically are considered the ideal way of achieving nutritional benefit.⁴⁵

It should also be noted that the most recent American Diabetes Association dietary guidelines, rather than recommending a specific distribution of dietary fats, proteins, and carbohydrates, advise only that macronutrient distribution be individualized and include nutrient-rich foods and portion control.⁶⁰ This recommendation suggests that even low-carbohydrate, high-fat diets may have positive metabolic effects in some individuals with resultant

weight loss and improvements in glycemic parameters; however, such “ketogenic” diets must be used with caution in ketosis-prone individuals, the elderly, pregnant and lactating women, people with renal disease, and some patients taking sodium-glucose cotransporter-2 inhibitors.

Strategies for Alzheimer's Disease and Age-related Neurocognitive Impairment

Epidemiologic studies indicate a protective effect of the Mediterranean-style eating pattern and the DASH eating plan on cognitive decline and dementia, which share risk factors with hypertension, type 2 diabetes, and obesity.^{61–64} Discerning the levels and types of foods that optimize brain health has produced a hybrid of the Mediterranean and DASH eating plans called Mediterranean–DASH Intervention for Neurodegenerative Delay (MIND).^{65,66} Like its precursors, the MIND program emphasizes natural plant-based foods and limited intake of foods high in saturated fat but also specifies higher consumption of berries, nuts, and green leafy vegetables.⁶⁷ A daily eating plan includes at least 3 servings of whole grains, a salad, and one other vegetable, as well as a glass of wine. Poultry, nuts, and berries are recommended at least twice a week and fish at least once a week. In one study, the MIND eating plan lowered the risk of Alzheimer's disease by as much as 53% in participants who were strict followers, and by ~35% in those who followed it moderately well.⁶⁷ These outcomes may be due in part to the mechanistic effects of plant-derived phytochemicals on gut inflammation, microbial imbalances, gut–brain signaling, and neuroinflammatory processes. As such, addressing these pathways via the tools of culinary medicine represents a low-cost, low-risk, achievable, and potentially gratifying option for patients and caregivers facing Alzheimer's disease and other age-related, as yet incurable, cognitive disorders.^{68,69} Moreover, the modest beneficial effects of current symptomatic therapies and the abject absence of disease-modifying treatments for Alzheimer's disease underscore the increasing importance of interventions that emphasize prevention.

Chronic Kidney Disease: A Culinary Approach

As with type 2 diabetes and Alzheimer's disease, the prevalence of chronic kidney disease (CKD), defined as the presence of structural or functional renal

impairment for ≥ 3 months, is high and increasing.² Approximately 40% of people with diabetes develop CKD, which is the leading cause of end-stage renal disease and is also associated with increased risk of cardiovascular mortality.^{70,71} Metabolic hallmarks are altered protein and energy homeostasis, abnormal protein catabolism, hormonal dysfunction, and acid-based derangements.⁷² Due to the progressive decline in kidney function that often occurs in people with varying stages of CKD, the individual dietary components, such as total caloric intake, protein, sodium, potassium, phosphorous, calcium, and fluid, must be continually monitored. The stages, based on estimated glomerular filtration rate, range from mild kidney damage without symptoms through frank and advancing CKD to the need for hemodialysis or peritoneal dialysis.

Eating plans for CKD must be customized to the degree of kidney failure, type of treatment, presence of residual renal function, comorbidities such as diabetes, and the interrelationships among different nutrients at any given time.^{73,74} For example, if a plan includes a decrease in protein, there must be a corresponding increase in the intake of other nutrients to maintain adequacy of calories. The requirement for calories may in turn be affected by the development of insulin resistance and impairment of carbohydrate and lipids utilization.⁷⁵ From the standpoint of a person with CKD, adhering to the scope and frequent changes to such nutritional prescriptions can be difficult, especially when taking into account individual preferences (eg, personal, cultural, religious) and lifestyle factors (eg, food availability, budgetary considerations, kitchen facilities, cooking skills, physical ability to shop, the need for convenience). In addition, taste and smell, driving factors in food selection and appetite, may be distorted in people with CKD, further affecting food choices.⁷²

A recent meta-analysis of 7 studies involving 15,285 participants with CKD found that a whole food dietary pattern (ie, one that encompasses increases in fruits and vegetables, fish, legumes, whole grains and fiber, and reductions in red meat, sodium, and refined sugar) resulted in 46 fewer deaths per 1000 people over 5 years (based on an estimated 5-year mortality of 17% in people with CKD).^{73,76} This finding, consistent with that of an earlier study showing benefit of a Mediterranean-style eating pattern on

long-term kidney function, represents a gradual shift in focus from single-nutrient or food group prescriptions to more flexible plans featuring whole dietary patterns that are easier for patients to follow and potentially enjoy. In the context of culinary medicine, this approach might mean, for example, exploring ways to use sauces and food seasonings that contain sodium levels in smaller quantities or substitute other nonsodium-containing seasonings to enliven taste.^{74,77} Likewise, actively seeking out healthy food options that can be integrated into the flow of daily life (eg, personalized kidney-friendly “frozen sandwiches” or MTMs) can encourage adherence and provide a foundation of daily nutrition on which to build. Because adherence is necessary to improve outcomes, such patient-centered and cost-effective measures applied systematically over time could lessen disease progression while creating lifelong habits of healthy eating.

OPERATIONALIZING CULINARY MEDICINE: FUTURE DIRECTIONS

Mounting evidence connecting the chosen eating plans of individuals, metabolic pathways, and both the incidence and outcomes of chronic disease is sparking renewed appreciation of the power of food in promoting health and well-being. Culinary medicine offers an opportunity to operationalize this understanding, using the pleasures derived from healthy food as a catalyst to promoting high-quality, high-value health care. The 3 examples given here show the hands-on approaches that are gaining credibility among stakeholders, including health care professionals and administrators; public and private insurers; leaders in academia; chefs and other leaders in the food service industry; entrepreneurs; and patients and their families.^{52,53,78}

Medical School–based Teaching Kitchen

Most medical schools in the United States teach <25 h of nutrition over 4 years.⁷⁹ Training in the mechanisms by which food influences metabolism, pathophysiology, and well-being is also lacking. However, a growing number of US medical schools are now offering elective courses in culinary medicine, paralleling an increase in Continuing Medical Education offerings on the topic. Together, these trends reflect the surging demand for actionable advice on the role of food in meeting health care

goals.¹³ A small proof-of-concept pilot study designed to evaluate the clinical efficacy of a cooking and nutrition curriculum implemented in a medical school–based teaching kitchen randomized individuals with type 2 diabetes to either a control group receiving standard nutrition education (n = 9) or participation in cooking classes based on Mediterranean-style eating (n = 18).⁷⁸ After 6 weeks, the cooking class participants showed a significantly greater reduction in diastolic blood pressure compared with the control group (−4 mm Hg vs 7 mm Hg; $P = 0.37$), as well as a greater decrease in total cholesterol levels (−14 mg/dL vs 17 mg/dL; $P = 0.044$). Gains in dietary habits, attitudes, and competencies for healthy shopping, meal preparation, eating, and storage were also reported. Future trials are planned with the hope of confirming the feasibility and clinical efficacy of these findings and replicating this model at medical schools nationally.

Partnering With Payers

Building relationships between nutrition-service providers and health insurance companies is considered a key element in establishing implementation of culinary medicine–based initiatives. The first such partnership between the Philadelphia-based managed care organization Health Partners Plan (HPP) and the medically tailored meal program MANNA, mentioned previously, is considered the prototype for similar collaborations across the country.⁵³ The partnership initially targeted 200 HPP Medicaid members with diabetes but has since expanded to serve nearly 2000 members, including Medicare beneficiaries with chronic conditions. Before initiating the program, which has gained nationwide recognition, HPP and MANNA defined workflow, contract, billing, and operational aspects to ensure a solid foundation.⁵³ An HPP study of members who completed MANNA services by May 2017 showed lower glycosylated hemoglobin scores in 26% (n = 194) when measured 6 months after the program. Decreases in inpatient admissions (−27.68%), emergency department visits (−6.91%), and visits to primary care and specialist physicians (−15.90% and −7.08%, respectively) were also reported (Table IV). Peer communication further served to champion the culinary medicine concept, leading to the formation of the Food is Medicine Coalition, an advocacy group that supports access to

Table IV. Medical utilization costs of “food as medicine” coverage model.

Variable	Before	During	After	% Change
PCP visits per 1000	5258	5021	4421	-15.90
Specialist visits per 1000	10,944	12,065	10,169	-7.08
Admits per 1000	1634	1332	1182	-27.68
ED visits per 1000	2487	2376	2315	-6.91

ED = emergency department; PCP = primary care physician.

Adapted from Health Partners Plans.⁵³

food and nutrition services for people with chronic illnesses.⁸⁰ The model provided by HPP and MANNA, its shared “lessons learned,” and ongoing monitoring of the program's medical results are expected to guide future policy for culinary therapies in chronic care.⁸¹

Referral to an RDN for Individualized Medical Nutrition Therapy

Considering the time constraints in medical appointments for both established and new patients (20–40 min) with health care providers (eg, physicians, nurse practitioners, physician assistants), an important option for people requiring development of an individualized eating plan for chronic health conditions is referral to an RDN. This health care team member is uniquely qualified to determine, for example, that an individual might lack the ability to prepare meals appropriate for his or her chronic condition. Nutrition intervention in such cases could begin with the use of MTMs on a short-term basis, with future educational sessions focusing on planning, shopping for, and cooking medically

appropriate meals. In other situations, such as the presence of CKD requiring dialysis, long-term use of MTMs might be required. Unfortunately, services provided by RDNs are underutilized despite benefit coverage often being available. For example, one study of 18,404 individuals with diabetes in a health system revealed that only 9.1% had at least one nutrition visit within a 9-year period.³⁶ The National Health and Nutrition Examination Survey data from 2007 to 2010 show that about one half of people (52.5%) with diabetes achieved glycosylated hemoglobin levels <7.0%, which may be due to lack of diabetes and nutrition education and/or inappropriate medical care.⁸²

CONCLUSIONS AND RECOMMENDATIONS

Advances in medical science have provided a wealth of insight into the underpinnings of diet-related risk pathways leading to chronic disease. In light of the health and economic impacts of these relationships, nutrition scientists, policy makers, and clinicians are now more attuned than ever to opportunities afforded by the relatively low-cost, potentially high-

Table V. Culinary medicine terms and definitions.

Culinary Medicine: An evolving evidence-based field that blends the art of preparing, cooking, and presenting food with the science of medicine to achieve desired health outcomes.
Culinary Therapy: Meal recommendations provided by a health care professional to improve the health and well-being of people who have or are at risk for a chronic disease.
Effective Eating: Making choices that enhance day-to-day anticipation, planning, preparation, consumption, and enjoyment of meals in support of good health and sustained well-being.
Medically Tailored Meals: Meals crafted for individuals living with or at risk for specific medical conditions.

impact intervention of culinary medicine. Many in the food industry, too, are paying attention and have demonstrated responsiveness by using price, packaging, labeling, marketing, and convenience to promote a variety of healthier foods in ways that are more enticing to the general public. Health systems and payers can do their part by advocating for policies that promote the maintenance of healthful behaviors over the life span and proactively address the behavior-change needs of at-risk populations.⁸³ Such policies might include expanding dietary and nutritional education at all levels, restructuring quality benchmarks, adapting electronic health record systems to schedule and track initial and follow-up visits for health behavior change, providing financial incentives for improving high-risk factors, and implementing decision support tools to alert clinicians when a referral to culinary therapy or MTMs may be warranted. Evidence-based, payer-supported and clinician-initiated approaches that can be readily assimilated are helping patients connect with neighborhood resources such as community center programs or farmer's markets, as well as with online communities, that promote healthy lifestyle change. Enlisting allied health professionals and/or training existing staff members in culinary medicine strategies, applying the working terms and definitions shown in Table V, can fortify and sustain clinician-driven efforts. More holistically, attitudinal shifts that move beyond the prevailing assumption that the individual is making the “wrong” food choices, and instead stress the pleasures of healthy food consumption, should be proactively encouraged as people's relationships with and responses to food evolve along a continuum of self-sufficiency, ranging from hands-on food preparation to the provision of prepared MTMs in outpatient situations as needed.

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