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*The authors reported no potential conflict of interest relevant to this article.*

## ORIGINAL RESEARCH

# A way to reverse CAD?

Though current medical and surgical treatments manage coronary artery disease, they do little to prevent or stop it. Nutritional intervention, as shown in our study and others, has halted and even reversed CAD.

### ABSTRACT

**Purpose** ▶ Plant-based nutrition achieved coronary artery disease (CAD) arrest and reversal in a small study. However, there was skepticism that this approach could succeed in a larger group of patients. The purpose of our follow-up study was to define the degree of adherence and outcomes of 198 consecutive patient volunteers who received counseling to convert from a usual diet to plant-based nutrition.

**Methods** ▶ We followed 198 consecutive patients counseled in plant-based nutrition. These patients with established cardiovascular disease (CVD) were interested in transitioning to plant-based nutrition as an adjunct to usual cardiovascular care. We considered participants adherent if they eliminated dairy, fish, and meat, and added oil.

**Results** ▶ Of the 198 patients with CVD, 177 (89%) were adherent. Major cardiac events judged to be recurrent disease totaled one stroke in the adherent cardiovascular participants—a recurrent event rate of .6%, significantly less than reported by other studies of plant-based nutrition therapy. Thirteen of 21 (62%) nonadherent participants experienced adverse events.

**Conclusion** ▶ Most of the volunteer patients with CVD responded to intensive counseling, and those who sustained plant-based nutrition for a mean of 3.7 years experienced a low rate of subsequent cardiac events. This dietary approach to treatment deserves a wider

test to see if adherence can be sustained in broader populations. Plant-based nutrition has the potential for a large effect on the CVD epidemic.

In a 1985 program initiated at the Cleveland Clinic, we examined whether plant-based nutrition could arrest or reverse advanced coronary artery disease (CAD) in 22 patients.<sup>1</sup> One patient with restricted myocardial blood flow documented by positron emission tomography (PET) showed reperfusion on a repeat scan just 3 weeks after starting our nutritional intervention (FIGURE 1).<sup>2</sup> Within 10 months of the start of treatment, another patient with severe right calf claudication and a quantifiably diminished pulse volume experienced total pain relief and exhibited a measurably increased pulse volume amplitude.<sup>2</sup> Thus encouraged, we followed the small cohort of patients (adding cholesterol-lowering drugs in 1987) and reported results after 5 and 12 years of follow-up.<sup>1,3</sup> Of the 22 patients, 17 were adherent to the protocol, and their disease progression halted. In 4 of the 12, we angiographically confirmed disease reversal,<sup>4</sup> which can be striking (FIGURE 2).<sup>4</sup>

■ **The significance of these findings.** CAD remains the number one killer of women and men in western civilization despite 40 years of aggressive drug and surgical interventions.<sup>5</sup> These approaches can be lifesaving in the midst of a heart attack. However, the

## FIGURE 1 Restoration of myocardial perfusion<sup>2</sup>

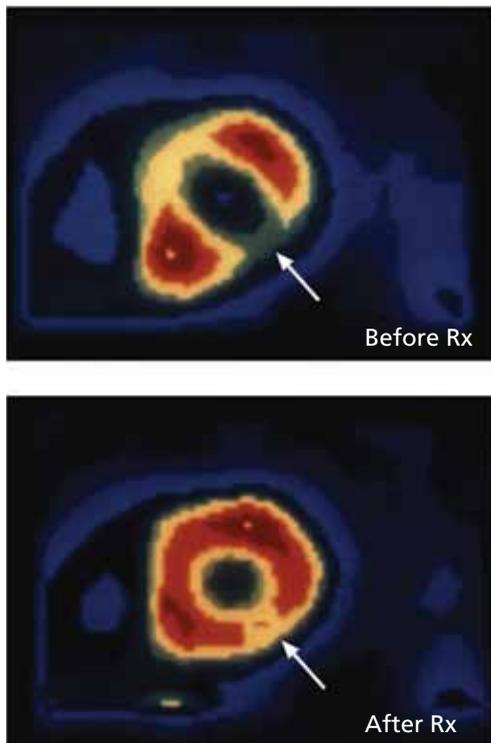


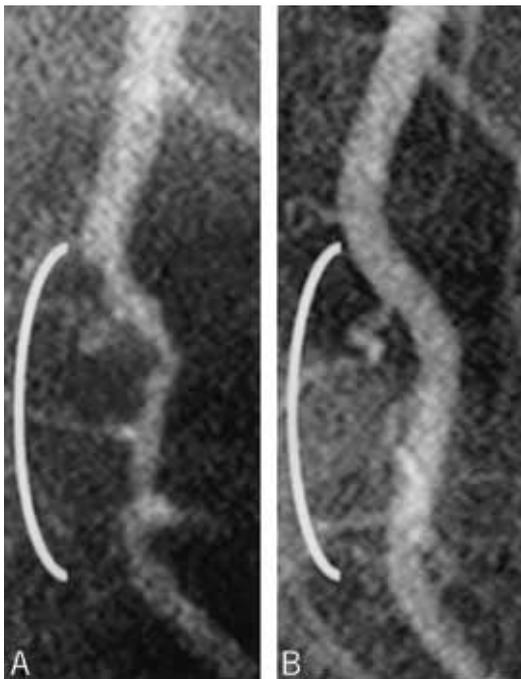
FIGURE 1 FROM: PREVENT AND REVERSE HEART DISEASE BY CALDWELL B. ESSELSTYN, JR., M.D., COPYRIGHT © 2007 BY CALDWELL B. ESSELSTYN, JR., M.D. USED WITH PERMISSION OF AVERY PUBLISHING, AN IMPRINT OF PENQUIN GROUP (USA) LLC.

Positron emission tomography performed on a patient with coronary artery disease shows an area of myocardium with insufficient blood flow (top). Following only 3 weeks of plant-based nutritional intervention, normal blood flow was restored (bottom).

elective use of percutaneous coronary intervention (PCI) shows little protection from future heart attacks or prolongation of life,<sup>6</sup> perhaps because it does not treat the major cause of this disease. Such palliative treatments also carry significant risk of morbidity and mortality and lead to unsustainable expense.<sup>7</sup>

■ **Getting at the root cause of CAD requires a different approach.** CAD begins with progressive endothelial injury,<sup>8</sup> inflammatory oxidative stress, diminution of nitric oxide production, foam cell formation, and development of plaques that may rupture to cause a myocardial infarction (MI) or stroke.<sup>9</sup> This cascade is set in motion in part by, and is exacerbated by, the western diet of added oils, dairy, meat, fowl, fish, sugary foods (sucrose, fructose, and drinks containing those,

## FIGURE 2 Reversal of coronary artery disease<sup>4</sup>



Coronary angiography reveals a diseased distal left anterior descending artery (A). Following 32 months of a plant-based nutritional intervention without cholesterol-lowering medication, the artery regained its normal configuration (B).

refined carbohydrates, fruit juices, syrups, and molasses) that injures or impairs endothelial function after each ingestion, making food choices a major, if not *the* major, cause of CAD.<sup>8,10-12</sup>

■ **The study we report on here.** In a continuation of the clinical strategy employing a plant-based nutrition intervention for CAD, we studied a separate cohort of 198 participants to determine if they could voluntarily adhere to the necessary dietary changes and to document their cardiovascular outcomes.

## METHODS

### Participants

This report reviews the outcomes of 198 consecutive nonsmoking patients with multiple comorbidities of hyperlipidemia (n=161), hypertension (n=60), and diabetes (n=23) who voluntarily asked for counseling in plant-



**The impetus for this study was an earlier small trial in which 17 patients with CAD had their disease halted after following a plant-based nutritional intervention.**

based nutrition for disease treatment. These self-selected participants requested consultation after learning about the program through the Internet, the media, prior scientific publications, the senior author's book (CBE Jr), other authors' supportive comments, or word of mouth.<sup>2,13</sup> A preliminary 25- to 30-minute telephone conversation established disease presentation and severity by eliciting reports of symptoms, history of MI, stress test and angiogram results, interventions undertaken, family history, lipid profile, and the presence of comorbid chronic conditions. In these calls, we outlined the program, established rapport, and documented the need for additional patient information. The Cleveland Clinic Institutional Review Board determined that these were acceptable outcome measurements to evaluate the nutrition program.

#### **Intervention**

We explained to each participant that plant-based nutrition typically succeeded in arresting—and sometimes reversing—CAD in our earlier study.

■ **The core diet.** Whole grains, legumes, lentils, other vegetables, and fruit comprised the major portion of the diet. We reassured patients that balanced and varied plant-based nutrition would cover their needs for amino acids, and we encouraged them to take a multivitamin and vitamin B12 supplement. We also advised the use of flax seed meal, which served as an additional source of omega-6 and omega-3 essential fatty acids.

■ **Foods prohibited.** Initially the intervention avoided all added oils and processed foods that contain oils, fish, meat, fowl, dairy products, avocado, nuts, and excess salt. Patients were also asked to avoid sugary foods (sucrose, fructose, and drinks containing them, refined carbohydrates, fruit juices, syrups, and molasses). Subsequently, we also excluded caffeine and fructose.

Exercise was encouraged but not required. The plan also did not require the practice of meditation, relaxation, yoga, or other psychosocial support approaches. Patients continued to use cardiac medications as prescribed, monitored by their (other) physicians.

■ **Pre-intervention training.** Each participant attended a single-day 5-hour coun-

seling seminar (9 am-2 pm) with, at most, 11 other participants. Each participant was encouraged to invite a spouse or partner. The 5-hour program profiled plant-based cultures that have virtually no cardiovascular illness, in contrast to non-plant-based cultures where CAD is ubiquitous (confirmed by autopsy of young adults).<sup>14</sup> We referenced the plummeting death rates from strokes and heart attacks in Norway during World War II when the German occupying forces confiscated their livestock, limiting Norwegians to plant-based nutrition.<sup>15</sup>

We emphasized the cellular components and mechanisms responsible for vascular health: the endothelial cell, endothelial progenitor cell, high-density lipoprotein cholesterol (HDL-C), and inhibition of dimethylarginine dimethylaminohydrolase that causes vasoconstriction. These were discussed in considerable detail, as were nutrition strategies to enhance endothelial health and to avoid endothelial dysfunction and injury. Participants viewed angiograms of CAD reversal from prior intervention participants.

An associate with several decades of experience with plant-based nutrition discussed plant food acquisition (including food label reading) and preparation. Participants learned how to alter common recipes to meet program standards. They received a 44-page plant-based recipe handout, 2 scientific articles confirming plant-based nutrition effectiveness,<sup>4,16</sup> and, after 2007, a copy of *Prevent and Reverse Heart Disease*.<sup>2</sup> The seminar concluded with a testimonial by a prior participant, a plant-based meal, and a question-and-answer session. We asked participants to complete and return a 3-week diet diary following the seminar. They were invited to communicate concerns via e-mail or phone, and to forward copies of subsequent lipid profiles, stress tests, cardiac events, angiograms, and interventions.

#### **Study data acquisition**

In 2011 and 2012 we contacted all participants by telephone to gather data. If a participant had died, we obtained follow-up medical and dietary information from the spouse, sibling, offspring, or responsible representative. Patients who avoided all meat, fish, dairy, and, know-

TABLE 1

## Baseline characteristics of study participants

Total, N	198
Men, N (%)	180 (91)
Age, mean $\pm$ SD	62.9 $\pm$ 10.0
Months follow-up, mean $\pm$ SD	44.2 $\pm$ 24.1
Adherent to intervention, N (%)	177 (89)
Diagnosis of CAD, N (%)*	195 (98)
Angiography/CT angiography <sup>†</sup>	180
Stress test	74
Myocardial infarction	44

CAD, coronary artery disease; CT, computed tomography; SD, standard deviation.

\* Three patients had documented peripheral artery disease or cerebral or carotid vascular stenosis, but no CAD.

† Many patients had more than one test done to establish the diagnosis of CAD.

ingly, any added oils throughout the program were considered adherent. We inquired about weight change, lipid profiles, further stress tests or angiograms, major cardiac events, interventions, and any change in symptoms.

## RESULTS

### Characteristics of participants

Baseline characteristics of participants are shown in TABLE 1. (Two patients from the original group of 200 were lost to follow-up.) The remaining 198 participants for whom data were available had CVD, were mostly men (91%), averaged 62.9 years of age, and were followed for an average of 44.2 months (3.7 years).

Three patients had noncoronary vascular disease: 1 cerebral vascular disease, 1 carotid artery disease, and 1 peripheral arterial disease. In the remaining 195 patients, angiogram results confirmed the diagnosis of CAD in 180 (92%). With the other 15 participants, electrocardiography, failed stress tests, or a history of enzyme-documented MI confirmed the diagnosis of CAD. Of the 195-patient cohort, 44 (23%) had an MI prior to counseling.

### Outcomes for nonadherent CVD participants

Twenty-one patients (11%) were nonadher-

ent with dietary intervention. Thirteen of these patients experienced at least 1 adverse event each—2 sudden cardiac deaths, 1 heart transplant, 2 ischemic strokes, 4 PCIs with stent placement, 3 coronary artery bypass graftings (CABGs), and 1 endarterectomy for peripheral arterial disease—for a patient event rate of 62% (TABLE 2).

### Outcomes of adherent CVD participants

In the group of 177 (89%) adherent patients, 112 reported angina at baseline and 104 (93%) experienced improvement or resolution of symptoms during the follow-up period. An additional patient with claudication also experienced symptom relief (TABLE 2). Of adherent patients with CAD, radiographic or stress testing results were available to document disease reversal in 39 (22%). Twenty-seven CAD participants were able to avoid PCI or CABG that was previously recommended. Adherent patients experienced worse outcomes significantly less frequently than nonadherent patients ( $P < .001$ , Fisher's exact test). In addition, for 135 patients for whom body weight was available, the average weight loss was 18.7 lbs.

Among the 177 patients who reported adherence to the dietary intervention, there were 5 noncardiac deaths (3 cancers, 1 pulmonary embolus, and 1 case of pneumonia).

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The core diet included whole grains, legumes, lentils, other vegetables, and fruit, and avoidance of all oils, fish, meats, dairy products, avocado, nuts, sugary foods, and excess salt.

➤  
**Only 1 major cardiovascular event (stroke) was related to disease progression in patients adherent with the dietary intervention.**

Also, 9 CAD patients required vascular intervention: 1 CABG for disease progression, 1 CABG for malpositioned dissecting stents placed just prior to enrollment into the program, 1 stenting procedure and 2 CABGs before valve repair, 2 stenting procedures to correct grafted artery closing, and 2 CABGs for asymptomatic patients persuaded of the need by their primary caregivers. Two patients experienced a nonfatal stroke (one after refusing warfarin for atrial fibrillation, the second because of progression of CVD, and one had stent thrombosis with acute MI after discontinuing clopidogrel as advised by the primary care physician. One patient had 3 stents placed before entering our study; 1 occluded at 3 years into the study, necessitating restenting (TABLE 2).

Thus, only 1 major cardiovascular event (stroke) was related to disease progression in patients adherent with the dietary intervention. This is a recurrent event rate of 0.6%. Thus, 99.4% of adherent patients avoided major cardiac events. This result clearly contrasts with that of other key peer-reviewed studies of nutrition interventions for patients with CAD<sup>6,17-22</sup> (TABLE W3 at [www.jfponline.com](http://www.jfponline.com)), although the disease burden and the presence of comorbid conditions may not be comparable. Even if all events had been attributable to diet, the 10% (18/177) event rate (“Worse” group in TABLE 2) over an average of 3.7 years is much below that reported in the literature<sup>23</sup> and the 62% of the nonadherent group.

## DISCUSSION

This program of treating the presumed cause of CAD has yielded significant findings and raised practice implications. First, and quite compelling, is that 89% of patients were willing to make a substantial lifestyle transition to plant-based nutrition and sustain it for an average of 3.7 years (for some patients up to 13 years). Most participants saw this as taking control of their disease (anecdotal reports).

Second, the results of this evaluation provide further evidence that plant-based nutrition may prevent, halt, and reverse CAD. This process of halting and reversing CAD

has been validated with a high probability by epidemiologic studies, including those of wartime deprivation, our previous noncontrolled study, and both randomized and nonrandomized controlled studies where a similar plant-based diet was a part of a comprehensive lifestyle modification in conjunction with otherwise standard pharmaceutical medical therapy.<sup>3,15,17,18,24-26</sup>

■ **Large cohort studies support nutritional intervention.** In addition, 2 large prospective cohort studies have recently emphasized the importance of nutrition in decreasing the risk of recurrent CVD events in people with CVD or diabetes and decreasing the risk of developing CVD among healthy individuals. Dehghan and colleagues<sup>27</sup> followed 31,546 participants with CVD or diabetes over 4.5 years and divided them into quintiles of nutritional quality. Reduction in CVD-related risk within the healthiest quintile was 35% for death, 14% for MI, and 19% for stroke. They found this protective association was maintained whether or not patients were receiving medications.

Crowe and colleagues<sup>28</sup> followed 44,561 men and women enrolled in the European Prospective Investigation into Cancer and Nutrition. Thirty-four percent (15,151) were vegetarians, consuming neither meat nor fish. During an 11.6-year follow-up, they found vegetarians had a lower mean body mass index, lower non-HDL-C level, lower systolic blood pressure, and a 32% lower risk of developing ischemic heart disease.<sup>28</sup> These combined studies of 76,107 individuals support an assertion of the power of nutrition for primary and secondary prevention of cardiovascular illness.

By way of contrast are findings associated with a typical western diet. Wilkins and colleagues<sup>29</sup> assessed lifetime risk and years lived free of total CVD by reviewing data from 905,115 person-years from 1964 to 2008. They assessed risk factor presence and subsequent CVD. While lifetime risk estimates for total CVD for all individuals was >30%, the study found that even those men and women 55 years of age with optimal risk factors had a 40% and 30% likelihood of total CVD, respectively, by age 85. It would appear that even optimal risk factors are no guarantee that the

TABLE 2

## Outcomes for patients enrolled in nutritional intervention for CVD

Characteristics		Adherent patients	Nonadherent patients
Total, N (%)		177 (89)	21 (11)
Men, N (%)		164 (93)	16 (76)
Age (mean ± SD)*		63.0 ± 10.1	62.3 ± 9.0
<b>Outcomes</b>			
Improved		144 (81)	0 (0)
Symptom reduction		105 (94) <sup>†</sup>	0 (0)
Reversal <sup>‡</sup>		39 (22)	
Stable		15 (8)	8 (38)
Worse <sup>§</sup>		18 (10)	13 (62)
Adverse outcomes unrelated to nutritional intervention		9	0
1	Patient stopped clopidogrel on PCP recommendation, resulting in stent closure and MI.		
1	Patient with atrial fibrillation refused warfarin and suffered a nonfatal stroke.		
2	Asymptomatic patients with stable CAD persuaded by their PCP to undergo CABG.		
2	Patients underwent CABG to qualify for valvular repair surgery.		
1	Patient underwent PCI with stenting to qualify for valvular repair surgery.		
2	Patients underwent PCI with stenting for occluded grafted LIMA.		
Disease progression		4	11
1	Stroke		2
2	CABG <sup>¶</sup>		4
1	Restenting <sup>#</sup>		3
			1
			1
Death		5	2
Noncardiac**		5	0
Cardiac		0	2

CABG, coronary artery bypass grafting; CAD, coronary artery disease; CVD, cardiovascular disease; LIMA, left internal mammary artery; MI, myocardial infarction; PAD, peripheral arterial disease; PCI, percutaneous coronary intervention; PCP, primary care physician; SD, standard deviation.

\* Data missing for 5 adherent patients and 1 nonadherent patient.

<sup>†</sup> Percentage of 112 patients who complained of angina at the start of intervention.

<sup>‡</sup> One patient with atrial fibrillation had documented angiographic reversal after 5 years in the study, then refused warfarin 2 years after last angiogram and suffered a nonfatal stroke.

<sup>§</sup> Adherent patients experienced worse outcomes significantly less frequently than nonadherent patients ( $P < .001$ , by Fisher's exact test).

<sup>¶</sup> One patient enrolled into the program with malpositioned dissecting stents that required CABG.

<sup>#</sup> Before study enrollment, the patient had 3 stents placed; one occluded at 3 years in the study and was restented.

\*\* Includes 3 cancer-related deaths, 1 fatal pulmonary embolism, and 1 case of pneumonia.



**For adherent participants, the adverse event rate was, at most, 10%.**

typical western diet won't eventually result in CVD.

■ **Why are our results particularly favorable?** While nutritional modification is beneficial, the question remains whether it has been optimized to its fullest potential in other studies. First, no other nutrition study has completely eliminated oils (including food products that may contain even small quantities of added oil of any kind), and all animal, fish, and dairy products, which would avoid foods known to injure endothelial cells, as well as exogenous cholesterol and saturated fat. In avoiding exposure to lecithin and carnitine contained in eggs, milk and dairy products, liver, red meat, poultry, shellfish and fish, participants in our study were unlikely to have intestinal flora capable of producing trimethylamine oxide (TMAO), a recently identified atherogenic compound produced by the intestinal flora unique to omnivores that ingest animal products.<sup>30-32</sup> (Vegans do not possess the detrimental bacterial flora.)

A second reason for our favorable results is the intensive, single-day, 5-hour counseling seminar that conveyed the message of nutritional intervention with depth, clarity, power, and completeness through a Power-Point presentation, recipe handouts, books, video, strategies for plant food acquisition and preparation, and testimonials by prior participants. Thus informed, participants grasped in detail the importance of the endothelial cell and its product, nitric oxide. They were educated to fully comprehend which foods injure endothelial cells and how transitioning to a whole-food, plant-based diet empowers them as the locus of control to halt and potentially reverse their disease. The pre-seminar phone consultation, the seminar itself, and follow-up psychological support resulted in an adherence of 89% during this 3.7-year-long follow-up.

We believe food may be the most important lifestyle factor in establishing the presence or absence of disease.<sup>15,24-26</sup> The adverse event rate among nonadherent participants was 62%. For adherent participants (119 experienced intervention prior to counseling; 75 had PCI with stent placement, and 44 suffered MI), the adverse event rate was

at most 10% ("Worse" group in TABLE 2). An additional 27 counseled participants did not require previously recommended interventions. These data on required interventions and interventions recommended but found to be unnecessary (146/177; 82%), testify to the severity of illness in this cohort and illustrate the remarkable comparative lack of subsequent cardiovascular events in the 89% who complied with plant-based nutrition.

■ **Less need for stenting?** The prompt improvement (within 3 weeks) confirmed by PET scan documentation of myocardial reperfusion (FIGURE 1), resolution of angina, and angiographic evidence of disease reversal (FIGURE 2) demonstrated in our earlier studies involving plant-based nutritional intervention argue against elective deployment of stents for reperfusion. Successful nutritional treatment of CVD, coupled with standard medical therapy, may extinguish major cardiac event progression in the vast majority of patients.

■ **Enabling the body to correct harmful processes.** Future discoveries may help to explain why plant-based nutrition is so effective, yet we can postulate likely mechanisms. When foods that injure or cause endothelium dysfunction are avoided, the body readily restores the capacity of endothelial tissue to produce nitric oxide. Such change reduces production of vasoconstricting endothelin and thromboxane by injured endothelial cells.

Our insistence on daily ingestion of generous portions of green leafy vegetables favors an improved population of endothelial progenitor cells.<sup>33</sup> Moreover, reductions in lipid, homocysteine, and triglyceride levels and insulin resistance enhance dimethylarginine dimethylaminohydrolase to enzymatically reduce asymmetric dimethylarginine and optimize nitric oxide synthase availability in nitric oxide production. The blood level of HDL-C may decrease with this anti-inflammatory, plant-based nutrition. Nevertheless, the efflux capacity of HDL-C may be unrelated to blood concentration and could be significantly enhanced by the intervention to enable disease arrest or reversal.<sup>34,35</sup> Consumers of plant-based nutrition do not harbor the intestinal flora unique to om-

nivores that enables production of proathrogenic TMAO. The standard nutritional, pharmaceutical, and surgical interventions of present cardiovascular medicine may not sufficiently address these protective mechanisms.

■ **This study had several limitations.**

First, it included self-selected, very determined patients. Without a control group, it is challenging to establish causality and assess how much of the observed changes are specifically due to the diet. Only some of the observed beneficial outcomes may have been due to the diet. This study was not prospectively randomized. Nevertheless, this fact does not detract from proof of concept that major cardiovascular events occurred in probably <1% (and certainly <10%) of the entire adherent cohort, compared with 62% of the nonadherent cohort (TABLE 2). These data convey a strong message of patients accepting empowerment to be the locus of control to arrest their disease and confirm that patients will adopt a significant lifestyle transition to plant-based nutrition to halt and regress what we believe is a largely food-borne illness.

The past several decades have witnessed a substantial and sustained reduction in CAD. Nevertheless, CAD remains the number one killer of women and men in this country. Thousands of stable patients having stents experience no reduction in major cardiac events.<sup>6</sup> While drugs have some effects on

disease initiation and progression, these interventions do not address disease causation. Not surprisingly, most patients experience disease progression, more drugs, more imaging, repeat interventions, progressive disability, and, too often, death from a disease of western malnutrition, the cause of which has been largely left untreated. We have in press several patient experiences that exemplify the repeated failure of present-day cardiac drugs and procedural interventions, and that confirm the capacity of whole-food plant-based nutrition to restore health in “there is nothing further we can do” situations.<sup>36</sup>

In summary, the present cardiovascular medicine approach tested beyond 40 years can neither cure the disease nor end the epidemic and is financially unsustainable. The safety, diminished expense, and prompt, powerful, and persistent results in treating the cause of vascular disease by whole-food plant-based nutrition offer a paradigm shift from existing practice. We think the time is right for a controlled trial. But in the meantime, the data are sound and strong enough that patients should be informed of this option. **JFP**

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**ACKNOWLEDGEMENTS**

We are grateful to all participants in the program, Jacqueline Frey, Ann Crile Esselstyn, and Jim Perko.

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➤ **The present cardiovascular medicine approach can neither cure the disease nor end the epidemic and is financially unsustainable.**

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TABLE W3

## Key peer-reviewed studies of nutritional intervention for CAD patients

Trial	Population	Dietary intervention	Outcomes	Significance of changes
Burr ML et al, Diet and Reinfarction Trial (DART), 1989 <sup>21</sup> Randomized, 2 yrs	2033 men who survived MI	Advice or no advice (controls) on 3 dietary factors: reduced fat, increased fish, increased fiber	All deaths, ischemic heart disease deaths, and nonfatal MI	No significant differences in incidence of reinfarction plus cardiac death by any of the dietary regimens
Ornish D et al, The Lifestyle Heart Trial, 1998 <sup>17</sup> Randomized, 5 yrs	48 patients with moderate to severe CAD		Cardiac events (MI, coronary angioplasty, CABG, cardiac-related hospitalizations, and cardiac-related deaths)	
	28	Experimental diet was vegetarian with 10% calories from fat*	25 events; 0.89 events per patient	
	20	Control diet per advice of patients' personal physician	45 events; 2.25 events per patient	Risk ratio=2.47; 95% CI, 1.48-4.20; P<.001
Ornish D et al, Multicenter Lifestyle Demonstration Project, 1998 <sup>18</sup> Nonrandomized, 3 yrs	333 patients eligible for revascularization by medical and insurance criteria		Cardiac events (MI, stroke, noncardiac death)	No significant difference in cardiac events per patient-year of follow up
	194	Experimental diet was vegetarian with 10% calories from fat*	31 patients underwent PTCA and 26 had CABG	Average savings in avoiding revascularization, \$29,529/patient
	139	Control diet per advice of patients' personal physician	66 patients underwent PTCA and 73 underwent CABG	
de Lorgeril M et al, Lyon Diet Heart Study, 1999 <sup>19</sup> Randomized, 3.7-4 yrs	423 consecutive patients who survived a first MI		Composite outcome of MI + CVD death	
	219	Experimental group followed Mediterranean diet	1.24 <sup>†</sup>	Risk ratio=0.28; 95% CI, 0.15-0.53; P=.0001
	204	Control group followed dietary advice per patients' physicians	4.07 <sup>†</sup>	
Singh RB et al, Indo-Mediterranean Diet Heart Study, 2002 <sup>20</sup> Randomized, 2 yrs	1000 patients with angina, MI, or surrogate risk factors for CAD		Total cardiac endpoints (nonfatal MI + fatal MI + sudden cardiac death)	
	499	Experimental diet was NCEP step I diet plus fruits, vegetables and nuts, whole grains, legumes, mustard seed and soybean oil (Indo-Mediterranean diet) <sup>‡</sup>	39	Adjusted risk ratio= 0.48; 95% CI, 0.33-0.71; P<.001
	501	Control NCEP step I diet	76	

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**TABLE W3**

**Key peer-reviewed studies of nutritional intervention for CAD patients (cont'd)**

Kappagoda CT et al, 2006 <sup>22</sup> Dietary intervention vs nonadherent patients, 2 yrs	134 consecutive patients with angiographically confirmed CAD		Cardiac events (cardiac death, MI and stroke)	
	77	Vegetarian diet, <10% calories from fat*	1.5%	<i>P</i> <.02
57	Nonadherent patients	18%		
Boden WE et al, COURAGE Study, 2007 <sup>6</sup> Randomized, 4.6 yrs	2287 patients with myocardial ischemia and significant CAD		Cumulative primary event (composite of death from any cause and nonfatal MI) rates	
	1138	Optimal medical therapy (diet and exercise per recommended practice guidelines)	19.5%	No significant difference in recurrent major cardiac events
1149	Optimal medical therapy plus PCI	20%		
Esselstyn C et al, 2014  Dietary intervention vs nonadherent patients, 3.7 yrs	198 consecutive patients with CAD		Cardiac events (MI, stroke, CABG, PCI, CVD death)	
	177	Adherent patients followed a vegan diet with 10% of calories from fat and no added oil	2.2%	<i>P</i> <.001
21	Nonadherent	62%		

CABG, coronary artery bypass grafting; CAD, coronary artery disease; CI, confidence interval; CVD, cardiovascular disease; MI, myocardial infarction; NCEP, National Cholesterol Education Program; PCI, percutaneous coronary intervention; PTCA, percutaneous transluminal coronary angioplasty.

\* Patients in the experimental group also participated in exercise, stress management, and support group.

† Per 100 patients per year of follow-up.

‡ In both groups 2/3 of patients were vegetarians.