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Intensive Cardiac Rehabilitation: an Underutilized Resource

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Abstract

Purpose of Review To review evidence-based lifestyle modification strategies for secondary prevention and explore how they are incorporated in traditional cardiac rehabilitation (CR) and intensive cardiac rehabilitation (ICR) programs.

Recent Findings While physical activity is an important element of cardiac rehabilitation, more recent studies support a variety of methods, including stress management and plant-based diets, to reduce cardiovascular risk factors. Patients who participate in traditional CR programs demonstrate clinical improvement, which are significantly greater in intensive CR (ICR). Yet, there is still a disparity in numbers between those who are eligible and those who ultimately enroll.

Summary Research into non-surgical and non-pharmacological health management approaches continues to validate the effectiveness of multidisciplinary intensive CR programs, but there is an increasing need to connect patients with these opportunities.

Keywords Cardiac rehabilitation · Secondary prevention · Coronary heart disease · Stress management · Physical activity

Introduction

In the last 30 years, the age-adjusted mortality rate and total mortality from coronary heart disease (CHD) in the USA have largely declined. While advances in the treatment of acute CHD events account for about half of this decline, the other half can be attributed to preventive therapies aimed at those with or at high risk for CHD [1]. There are many modes of care which have proved effective such as pharmacotherapies—including aspirin, statins, beta-adrenergic blockers, and angiotensin-converting enzyme inhibitors (ACEIs) that significantly reduce the relative risk of recurrent CHD events and, in some cases, total mortality—as well as lifestyle interventions including diet change, physical activity, and smoking cessation which have equally large effect sizes, some also with mortality benefits [2–4].

Programmatic delivery of these in formal cardiac rehabilitation (CR) and secondary prevention programs has been demonstrated to improve cardiovascular mortality and quality of life in secondary prevention patients with the highest risk due to recent CHD events [5•]. While the role of percutaneous coronary intervention (PCI) cannot be ignored, especially in the setting of acute coronary syndromes [6–10], the role of PCI in stable ischemic heart disease is now less compelling and in several studies has been either equivalent or inferior to the optimal medical therapy [11, 12]. However, the optimal medical therapy in these studies includes evidence-based medications and surprisingly does not include a rigorous regimented lifestyle modification approach.

Large gaps exist in the control of coronary heart disease risk factors, adherence to cardio-protective medications and lifestyles, and participation in cardiac rehabilitation by eligible coronary patients [13], even though optimal medical therapy for stable CHD has been demonstrated to be equivalent to revascularization. Unfortunately, only 34% of patients who are referred to CR actually enroll in the program [14]. Contributing factors to this poor utilization include lack of a

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centralized method for referral, inadequate communication among treatment teams, patients, and CR facilities, unfamiliarity with cardiac rehabilitation programs among potential referring physicians, and perceived inconvenience for the patient (e.g., co-pays and transportation to and from the facility).

The lack of utilization of cardiac rehabilitation can be linked in part to both patient factors (e.g., lower socioeconomic status (SES) [15]) and to provider and health system factors, and almost all are associated with poorer CHD outcomes [16]. These barriers must be addressed as the prevalence of coronary heart disease, and its associated health costs are projected to rise sharply in the coming decades, the latter to an anticipated $1.1 trillion USD by 2035 [17]. Reducing this massive public health and economic burden will require a greater emphasis on cardiovascular health promotion and disease prevention within healthcare systems and communities [18]. Cardiovascular teams in particular will be asked to increase their emphasis on cost-effective, evidence-based diet and lifestyle interventions, close gaps in clinically proven medical therapies, and increase participation in CR and secondary prevention programs.

Diet for Secondary Prevention of CHD

Evidence

In the mid-1950s, the Seven Countries Study demonstrated that CHD mortality varied across cultures and was linked to differences in the intake of dietary fats [19–21] and, later, to blood cholesterol levels [20, 22–24]. Controlled metabolic studies [21, 25] followed which showed that substituting polyunsaturated fatty acids for saturated fatty acids significantly reduced serum cholesterol levels [26], and randomized clinical trials (RCTs) showed that this strategy reduced cardiovascular endpoints [27, 28]. These data were followed by large prospective cohort studies that documented that numerous dietary components impact CHD risk [29–31].

Specifically, these diets that had more intake of liquid vegetable oils, fruits, vegetables, leafy greens, whole grains, fish, legumes, nuts, and seeds were associated with reduced CHD risk with hazard ratios (HRs) in the range of 0.76 to 0.95. Consumption of refined grains, added sugars, and red and processed meats, on the other hand, has been associated with increased coronary heart disease risk, with a HR for cardiovascular disease mortality of 1.24 for processed red meats, and of 1.17 for sugar-sweetened beverages (SSB) [32]. Further, meta-analyses have shown that some dietary substitutions (e.g., polyunsaturated fatty acids for saturated fatty acids and whole grains for refined grains) are associated with mortality benefits [33, 34]. Global awareness of the importance of a healthy diet evolved between 1950 and 2000 and was most evident in the higher economic classes of developed countries [35, 36].

RCTs and observational studies of whole dietary patterns of several cardio-protective diet patterns have emerged [37], among them the Mediterranean diet pattern, the Dietary Approaches to Stop Hypertension diet, a whole-foods plant-based, i.e., vegetarian/vegan diet pattern, and the American College of Cardiology/American Heart Association dietary pattern. Though differences exist, each of these diet patterns is centered on nutrient-dense whole foods (particularly fruits, vegetables, and whole grains), lean proteins, and restriction of saturated fats, added sugars, and sodium.

Data in support of a Mediterranean diet pattern for CHD patients comes from the 1999 Lyon Diet Heart study in 600 plus subjects who were post-myocardial infarction (MI), and the 2002 Indo-Mediterranean study in 1000 subjects with mostly stable coronary heart disease. In both, those randomized to a Mediterranean diet (supplemented with alpha-linoleic acid in the Lyon Diet Heart study) had a markedly reduced risk of major adverse cardiovascular events (MACE) (52 to 72% relative risk reduction) compared to control diet groups at follow-up, which extended to 46 months in the Lyon Heart Diet Study [30, 31]. The large effect size from adherence to a Mediterranean-style diet pattern also has been demonstrated in large, prospective cohort studies [11, 12]. Among 31,546 subjects in the Ongoing Telmisartan Alone and In Combination with Ramipril Global Endpoint Trial/Telmisartan Randomized Assessment in ACE Intolerant Subjects with Cardiovascular Disease (ONTARGET/TRANSCEND registry) in patients with congestive heart failure or diabetes, those with diet scores in the highest quintile of the Alternative Healthy Eating Index (AHEI), which reflects a Mediterranean-style diet pattern, had a 22% reduced risk of cardiovascular disease [12, 38].

Translational studies have also indicated that diet impacts cardiovascular outcomes via numerous mechanisms, including effects on blood lipids, blood pressure, body weight, blood glucose, insulin sensitivity, arrhythmogenesis, and the regulation of oxidative stress, which may in turn favorably impact vascular and platelet reactivity, inflammation, and atherogenesis [39–45]. Plant-based diets rich in polyphenols and other anti-oxidants have been the subject of many of these studies. Plant-based and vegetarian diets [46, 47] have been associated with reduced blood pressure [48, 49], improved glycemic control [49, 50], improved endothelial function [51], lower LDL-C levels and LDL-C oxidation [49, 52, 53], improved HDL efflux capacity [54], less inflammation [51, 55], reduced serum levels of myeloperoxidase [56], and trimethylamine [57], all of which impact vascular function [58]. Accordingly, the Dietary Guidelines Advisory Committee (DGAC) supports a healthy vegetarian-eating pattern [59].

Physical Activity for Secondary Prevention of CHD

Physical activity (PA) in patients with CHD or at risk is well established to reduce mortality based on observational and clinical trial data [60–62]. In those with established CHD, these benefits are positively dose-response associated with the amount of exercise [63]. In an analysis of 15,486 subjects with coronary heart disease from the multi-country Stabilization of Atherosclerotic Plaque by Initiation of Darapladib Therapy (STABILITY) study, a doubling of the volume of PA was associated with a 10% relative risk reduction for all-cause mortality (adjusted HR 0.90, 95% CI 0.87–0.93). The association was even more pronounced in those with a higher ABC-CHD (Age, Biomarkers, Clinical Coronary Heart Disease) risk score and in those with a sedentary lifestyle at baseline [63]. In another analysis, 10,690 subjects with occult CHD by coronary artery calcium (CAC) scoring whose PA levels were followed for 8.9 years, a significant benefit from PA was found in those with a CAC score of ≥ 400 Agatston Units, in whom more intense PA was associated with a lower adjusted HR for all-cause mortality of 1.23 (95% CI 0.47–3.23) compared to those without PA, in whom the HR was 3.1 (95% CI 1.35–7.11), with the referent being patients with a CAC score of zero [64].

Physical activity levels that change over time also appear to impact CHD outcomes. In 1746 patients with stable CHD followed for 2 years, a decrease in PA from active to inactive was associated with a 2.4-fold (95% CI 1.3–4.5, $p < 0.01$) increase in the risk of cardiac death compared to those who remained active (when controlling for covariates) [65, 66]. Further, patients with coronary heart disease who went from inactive to active had a significant decline in the risk of CHD mortality. Also of note, low-level PA was not associated with a significant reduction in CHD mortality [67]. Altogether, this data emphasizes the importance of PA for reducing mortality in secondary prevention.

One caveat: there does appear to be a U-shaped curve associated with exercise where extreme exercise has been noted to be associated with increased cardiovascular events. As such, it appears that extreme exercise in high-risk individuals should be avoided or very limited [68].

The Role of Bio-behavioral Therapies in Secondary Prevention of CHD

Evidence

Numerous studies demonstrate that emotional stress, depression, and social isolation increase the risk of premature cardiovascular and all-cause mortality 3–10-fold over non-affected individuals [69]. Purported mechanisms include over-activation of the sympathetic nervous system, which triggers arterial wall inflammation and subsequent cardiovascular events [70]. In one study, patients who met criteria for major depression 6 months post-MI had a 4-fold higher risk of death independent of other factors [71]. Another study of patients with CHD showed that depressive symptoms were associated with a higher probability of mental stress-induced myocardial ischemia [72]. In contradistinction, patients who report feeling loved and supported by a spouse have lower burdens of coronary atherosclerosis, independent of diet, smoking, family history, and other risk factors [73].

Yoga

All yoga varieties employ a series of postures that build strength and foster rhythmic breathing and meditation. Studies in patients with CHD show that yoga is associated with increased exercise capacity [74], reduced angina episodes [75], and other measures of atherosclerosis [76]. Cardiometabolic effects are believed to be mediated by the autonomic nervous system and include reductions in blood pressure, heart rate [77], cortisol levels [78], and inflammatory markers, including interleukin-6 and hs-CRP [79–81]. Benefits of yoga also have been demonstrated in patients with paroxysmal atrial fibrillation, in whom yoga therapy was associated with reductions in atrial fibrillation episodes [82], and with implantable cardioverter defibrillators, in whom yoga was associated with a 32% lower risk of device-related firings and a significantly lower level of shock anxiety after 6-months [83]. Finally, in two RCTs in patients with chronic heart failure with reduced EF, yoga was associated with increases in treadmill exercise time and peak oxygen consumption (VO2 max) [81].

Meditation

The benefits of mindfulness meditation techniques are thought to be mediated by the autonomic and parasympathetic nervous systems [84]. Transcendental meditation (TM) is a chant-based mindfulness meditation that has been well-studied in CHD patients. In one randomized clinical trial of TM versus health education in 201 blacks with CHD, those randomized to TM twice daily for 20 min (after introductory sessions) had a 48% reduction in the relative risk of MACE over a mean follow-up of 5.4 years [85]. In a non-randomized study with intravascular ultrasound endpoints, 123 patients with documented coronary artery disease were placed on a high-fiber, vegetarian diet and moderate aerobic exercise and educated on a certain type of meditation intervention for 6 months. Coronary arteries were evaluated after 2 years and 51% had plaque regression of at least 10% [86]. In another RCT in 30 patients with coronary heart disease, those randomized to

meditation vs. usual care had significant decreases in measures of depression and anxiety, plus blood pressure and body mass index, compared to usual care [87].

Cardiac Rehabilitation (CR) for Secondary Prevention of CHD

Multi-modality intervention has also been studied and has formed the basis for CR post-myocardial infarction. In the 1970s, inpatient, stepped-exercise protocols became standardized into "Phase I" CR [88–90]. The stated goal of this phase was patient-centered and comprehensive: optimize physical, medical, psychological, social, emotional, vocational, and economic status after a myocardial infarction [91]. After the completion of sub-maximal stress testing and earlier hospital discharge, post-MI were deemed safe in the 1980s; the focus shifted to outpatient programs—phase 2 cardiac rehabilitation [92]. However, the mainstay of therapy was primarily limited to exercise training. Finally, in the 1990s, with more understanding of the role of risk factor modification, phase 2 CR evolved into a multidisciplinary secondary prevention care model [93, 94].

Cardiac Rehabilitation Delivery: Models and Indications

Currently, there are two distinct models to deliver outpatient, phase 2 cardiac rehabilitation and secondary prevention programs: traditional cardiac rehabilitation (TCR) and, more recently, intensive cardiac rehabilitation (ICR) (Fig. 1). Both models receive reimbursement from the Centers for Medicare and Medicaid Services (CMS) and other third-party payers.

Indications for traditional and intensive cardiac rehabilitation are largely similar. Patients are eligible for these services if they have at least one of the following:

1. Stable angina pectoris
2. Prior coronary artery bypass surgery
3. Prior angioplasty or stent
4. Prior heart valve repair or replacement
5. Prior heart transplant or heart-lung transplant or LVAD
6. Acute myocardial infarction within the last 12 months
7. Systolic congestive heart failure provided that the patient has New York Heart Association class II to IV symptoms, left ventricular ejection fraction $\leq 35\%$, has been on optimal medical therapy for at least 6 weeks, and has not had recent (< 6 weeks) or planned (< 6 months) hospitalizations or procedures
8. Peripheral Arterial Disease (standard only)

Traditional Cardiac Rehabilitation (TCR)

Exercise training, education, and risk factor assessment and modification became the framework of the 36-session model and its core components as defined by the American Association of Cardiovascular and Pulmonary Rehabilitation [95]. Though exercise training is the foundation of TCR services, programs are also encouraged to offer multi-modality intervention which is done with variable success.

TCR services are delivered in 1-h sessions that can be either exercise or educational sessions. Most program models, however, focus on 36 1-h exercise sessions, 3 days per week, over 12 weeks.

Currently, CMS requires that a physician provides direct supervision while exercise sessions are ongoing. However, beginning in 2024, advanced practice providers will be able to fulfill this direct supervision requirement. Most patients are prescribed 36 total sessions with telemetry monitoring used during the exercise sessions. Patients usually attend three 1-h sessions per week for a total of 12 weeks to complete a course of 36 sessions. However, many lower-risk patients may be prescribed fewer than 36 sessions and not require telemetry monitoring during exercise. TCR programs are found nationwide and there is significant variation in what is offered in these programs.

Intensive Cardiac Rehabilitation

Over decades, with new data documenting the importance of the non-exercise components of cardiac rehabilitation, the model of intensive cardiac rehabilitation (ICR) was born. ICR is a benefit category established by CMS in August 2010 which began reimbursement in January 2011.

As noted above, traditional cardiac rehabilitation (TCR) is primarily 36 1-h sessions of aerobic exercise. What distinguishes ICR from TCR is that, as the name indicates, it is more intensive and includes more than predominantly exercise. Since there are three additional modalities, 72 h of coverage is provided.

In brief, exercise-based traditional cardiac rehabilitation slows progression of atherosclerosis but does not reverse it [96]. It is effective in reducing total and cardiovascular mortality, but not reducing total MI or revascularization.

Intensive cardiac rehabilitation causes greater improvements in risk factors than TCR programs, greatly decreases angina, increases myocardial perfusion, decreases cardiac events, markedly reduces costs, and often causes reversal of coronary atherosclerosis [93, 97].

In one study that directly compared outcomes of TCR with ICR, patients who participated in an ICR program had significantly greater reductions in anginal frequency, body weight, body mass index, systolic blood pressure, total cholesterol,

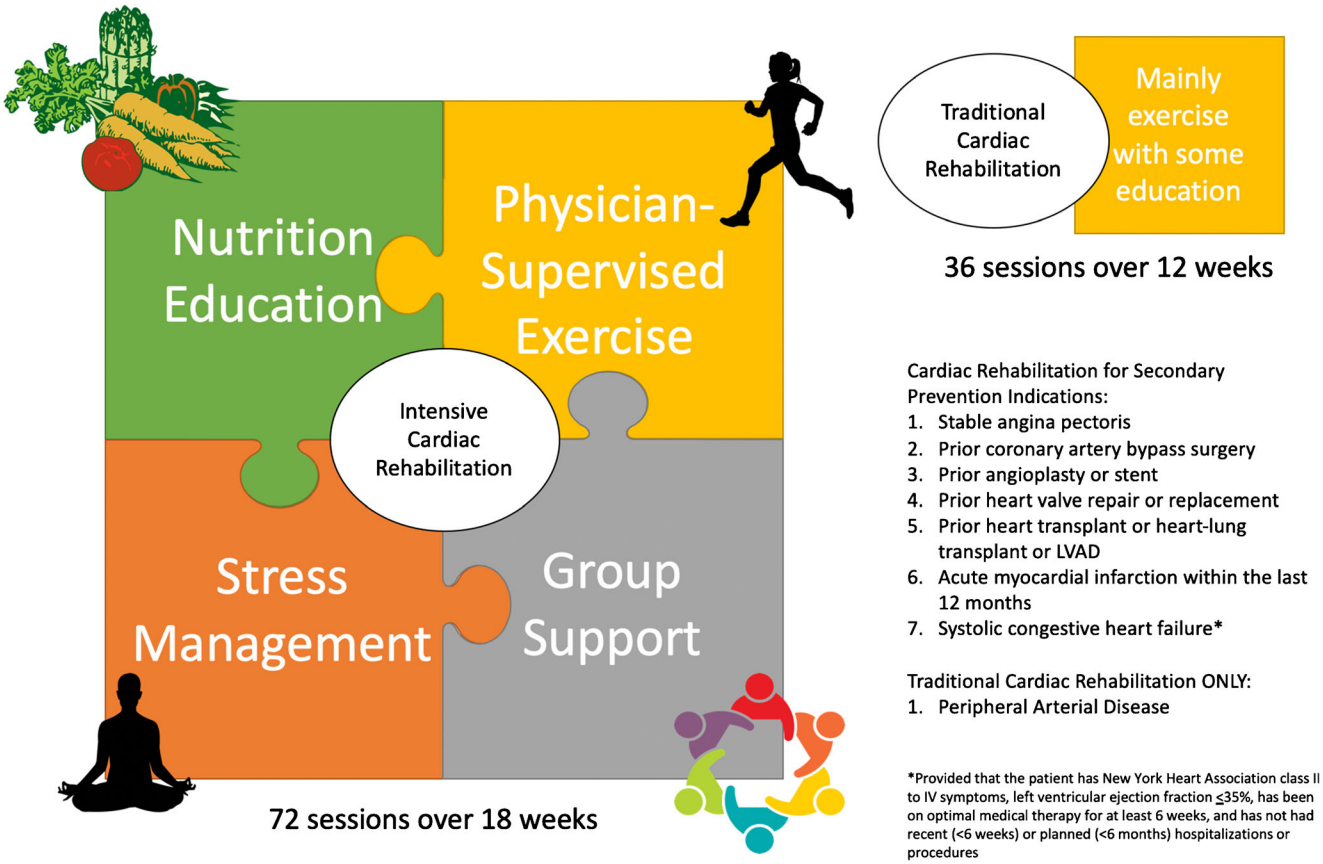

Fig. 1 Core components of intensive cardiac rehabilitation versus traditional cardiac rehabilitation

low-density lipoprotein cholesterol, blood glucose, and dietary fat than those who were in a traditional cardiac rehabilitation program or in a control group [98].

Intensive cardiac rehabilitation is offered in a structured class model (usually around 4 h), twice weekly that runs over a 9-week period (72 h). There are two currently active ICR programs in the USA (Table 1): the Ornish Lifestyle Medicine program [98] and the Pritikin program [101], which are offered at centers across the country.

The Ornish program has an equal focus on nutrition education, exercise, stress management, and social support. The physician is "quarterback" and provides clinical oversight in a multidisciplinary team approach. Each team includes a registered nurse, exercise physiologist, stress management specialist such as a certified meditation/yoga teacher, psychologist or clinical social worker, and a registered dietitian. All therapeutic decisions (e.g., medications, revascularization) are deferred to the referring physician.

During each 4-h session, patients receive 1 h of supervised exercise as in a TCR program. In addition, they receive an hour of stress management (meditation and gentle yoga-based stretching and breathing techniques), a 1-h group support session with an emphasis on feeling safe and sharing authentic feelings, and a 1-h group meal with a lecture—a whole-foods plant-based diet naturally low in both fat and refined carbohydrates with no animal products other than optional egg whites and up to one cup/day of nonfat dairy. Also, patients who smoke are provided support in quitting.

The Pritikin program includes 36 h of aerobic exercise plus 36 h of watching instructional videos. This program does not offer support groups or stress management classes with meditation or yoga. The diet is predominantly a whole-foods plant-based diet naturally low in fat and refined carbohydrates but includes red meat once/month and fish twice/week (based on the initial work of Nathan Pritikin, an engineer).

Randomized controlled trials of the Ornish ICR program documented that patients with moderate to severe coronary heart disease who made these lifestyle changes showed statistically significant and clinically significant reversal of coronary heart disease and its ischemic manifestations in all measures of coronary anatomy and physiology.

In the first randomized controlled trial, exercise radionuclide ventriculography revealed that the ejection fraction response from rest to peak exercise fell at baseline but rose appropriately after only 24 days of making these diet and lifestyle changes, whereas the randomized control group showed continued decline in ejection fraction response. Regional wall motion also showed significant improvement, and there was a 91% reduction in angina during that time in the experimental group [102].

Table 1 Overview of ICR programs

	Omish	Pritikin
Total number of Sessions covered* *72 (max per day is 6 sessions) over 18 weeks	72 sessions (usually divided into 18 sessions that are 4 h each, 2 days/week for 9 weeks)	72 sessions (usually divided into 36 sessions that are 2 h each, 3 times/week for 12 weeks)
Diet	100% plant-based other than optional egg whites and 1 cup/day nonfat dairy	Allows for limited lean meat and fish
Format	Patients are in groups of 15 and stay with the same cohort throughout, allowing bonding, and often continue to meet virtually after completing the 72-h program. All components are with live instructors: • 1 h of exercise • 1 h of nutrition education with cohort meal • 1 h of stress management (meditation & gentle yoga) • 1 h of group support	36 h of exercise plus 36 h of video instruction. No stress management training or group support.
Outcome Data	The randomized Lifestyle Heart Trial showed significant regression of coronary atherosclerosis measured by angiography after 1 year and even more after 5 years [99]. Also, a 400% increase in myocardial perfusion measured by cardiac PET scans and 2.5 fewer cardiac events after 5 years, and a 40% reduction in LDL-cholesterol.	Data from Pritikin residential treatment centers showed greater improvement in lipids, A1c, blood pressure, and weight than TCR [100] but no randomized clinical trial evidence showing regression of coronary heart disease.

Reduction in demonstrable ischemia may have several mechanisms, including repetitive stunning, improved endothelial function, improved collateral flow, and/or reduced microvascular ischemia. Thus, it was important to demonstrate a reduction in anatomic severity of disease in order to document regression of coronary heart disease.

The Lifestyle Heart Trial was a randomized controlled trial using quantitative coronary arteriography and cardiac PET imaging as well as cardiac events to assess the effects of this ICR intervention [99]. Percent diameter stenosis showed some reversal (regression) after 1 year [103] and even more reversal after 5 years, whereas the randomized control group showed continued worsening (progression) of coronary atherosclerosis during this time [97]. There were also 2.5 times fewer cardiac events in the experimental group after 5 years. Additionally, there was a statistically significant correlation between degree of adherence to the lifestyle program after 1 year and also after 5 years and changes in percent diameter stenosis. Coronary flow reserve increased and arterial modeling improved [104].

Using cardiac PET imaging, there was a 400% improvement in myocardial perfusion in the experimental group when compared to the randomized control group after 5 years. Ninety-nine percent of the experimental group patients were able to stop or reverse the progression of their heart disease whereas only 5% of the randomized control group patients showed improvement [93].

A larger demonstration project of this program in almost 3000 patients showed significant improvements in all metrics after 12 weeks and after 1 year at 24 hospitals and clinics in West Virginia, Nebraska, and Pennsylvania. These include LDL, weight, emotional depression, systolic blood pressure, diastolic blood pressure, and hemoglobin A1C even though medications were often reduced by their own referring physicians during this time because they had less need for them [105].

In another demonstration project of 333 patients from four academic medical centers and four community hospitals who were eligible for revascularization, almost 80% were able to safely avoid surgery by making these comprehensive lifestyle changes [106]. Mutual of Omaha calculated saving almost $30,000/patient in the first year. Highmark Blue Cross Blue Shield found that overall health care costs were decreased by 50% after 1 year in patients who went through this program. In the subgroup of patients in whom Highmark had spent more than $25,000 in the preceding year, there is a 400% reduction in overall health care costs in the year following the completion of this lifestyle medicine program.

Patients who have gone through the Pritikin program have shown reductions in angina and improvement in traditional risk factors greater than those seen in TCR programs. There are no published randomized controlled trials showing that the Pritikin program can cause reversal of coronary

atherosclerosis, improvements in myocardial perfusion, or reductions in cardiac events.

Adherence

A common misconception among many physicians is that patients will take their statins but are unlikely to make significant changes in diet and lifestyle. However, the majority of patients discontinue statins within 1 year of treatment initiation [107]. Approximately 20–30% of prescriptions are never even filled [108].

Why? Because statins do not make patients feel better but these diet and lifestyle changes usually do. Since the underlying biological mechanisms that affect health are so dynamic, most people who make intensive lifestyle changes often feel so much better, so quickly, it reframes the reason for making these changes from fear of dying (e.g., "take your statins now so you reduce the risk of a heart attack or stroke years down the road") to joy of living (e.g., a 91% reduction in the frequency of angina in the first few weeks). What they gain very quickly is more than what they give up, which makes it sustainable [109]. For this reason, paradoxically adherence is usually higher in ICR than TCR programs because the perceived benefits in quality of life are better, justifying the more intensive intervention.

Adherence to this ICR program has been remarkably high. Despite the time commitment of 4-h sessions, patients completed 94% of the 72 h of the Ornish ICR program over 9 weeks [110]. Approximately 85–90% of patients have continued to adhere to this program after 1 year since intensive cardiac rehabilitation coverage began even though the program is only 9 weeks long. Although ICR requires more effort than TCR, adherence to ICR is paradoxically higher because the greater benefits to patients (e.g., marked reductions in angina in the first few weeks) usually make it worth doing.

Increased emphasis on the bio-behavioral components of ICR is a pivotal component. The group support sessions are usually very meaningful for patients and greatly enhance adherence. Following the 72 h of ICR training, patients in the Ornish program continue to meet "virtually" using video conferencing for 1 h once/week. This enables patients to continue and deepen their group experience and support for one another without leaving their home.

A recent Cochrane review demonstrated that patient education and psychological counseling are associated with lower cardiac-specific mortality (RR 0.79), a trend towards lower all-cause mortality (RR 0.90), and improvements in depressive symptoms, anxiety, and stress [111]. In a recent clinical trial, the incorporation of stress management techniques to exercise-based traditional cardiac rehabilitation was associated with improvements in anxiety, distress, and perceived stress [112•]. Furthermore, individuals who received stress management in addition to TCR had a 51% reduction in clinical events when compared to those receiving only TCR [112•].

Both traditional and intensive cardiac rehabilitation are reimbursed the same hourly rate but TCR is reimbursable for a maximum of 36 1-h sessions whereas ICR is reimbursable for a maximum of 72 1-h sessions. Also, ICR is reimbursed at the same level when provided at a physician's office as when it is provided at a hospital. In contrast, TCR is reimbursed at a substantially lower rate when provided at a physician's office than in a hospital.

Conclusion

Patients now have two choices: traditional and intensive cardiac rehabilitation programs. TCR programs are more widely available at this time and are predominantly based on 36 h of supervised exercise. A minority of TCR programs include some degree of dietary education, stress management, and/or social support. ICR programs provide a more comprehensive lifestyle intervention which results in more clinical improvement and better outcome measures. Both TCR and ICR programs are reimbursable by Medicare and many commercial insurance companies, making them an economically sustainable source of revenue for providers.

Cardiac rehabilitation as an evidence-based strategy has evolved rapidly over the past 30 plus years, but like many secondary prevention interventions, is significantly underutilized [113, 114]. Recently, its establishment as a performance measure (perhaps tied to provider remunerations), and its prevention-oriented, outcomes-driven, and easily tailorable and scalable delivery model make it well suited for population management of CHD in the era of value-based care.

In the end, we have the tools to stop the problem—so let us get to using them regularly, in everyday practice!

Compliance with Ethical Standards

Conflict of Interest Pam R. Taub has no disclosures related to this paper. However, she is a consultant and speaker for Sanofi/Regeneron, Novo-Nordisk, Boehringer-Ingleheim, Janssen, Pfizer, Amarin, and Amgen. She is a stock holder of Cardero Therapeutics. She is also medical director of the Ornish/ICR program at UC San Diego Health System.

Hannah C. Lo declares no conflict of interest.

Andrew M. Freeman does non-promotional speaking for Boehringer-Ingleheim. He is also medical director of the Ornish/ICR program at National Jewish Health.

Dean Ornish receives royalties from books, fees from Sharecare, and sometimes honoraria from lecturing.

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