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EXPERT REVIEWS

Transforming cardiac rehabilitation into broad-based healthy lifestyle programs to combat noncommunicable disease

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The current incidence and prevalence of noncommunicable diseases (NCDs) is currently a cause for great concern on a global scale; future projections are no less disconcerting. Unhealthy lifestyle patterns are at the core of the NCD crisis; physical inactivity, excess body mass, poor nutrition and tobacco use are the primary lifestyle factors that substantially increase the risk of developing one or more NCDs. We have now come to recognize that healthy lifestyle interventions are a medical necessity that should be prescribed to all individuals. Perhaps the most well-established model for healthy lifestyle interventions in the current healthcare model is cardiac rehabilitation. To have any hope of improving the outlook for NCDs on a global scale, what is currently known as cardiac rehabilitation must transform into broad-based healthy lifestyle programing, with a shifted focus on primordial and primary prevention.

Keywords: Fitness • nutrition • obesity • smoking cessation • prevention

The current incidence and prevalence of noncommunicable diseases (NCDs) is cause for great concern on a global scale; future projections are no less disconcerting.[1,2] The NCD with the highest incidence and prevalence is cardiovascular (CV) disease (CVD).[3] Globally, more than 36 million people die from NCDs annually, equating to 63% of annual global deaths.[4] The estimated global cost of NCDs was $6.3 trillion (US dollars) in 2010 and is projected to increase to $13 trillion by 2030.[5] Unhealthy lifestyle patterns are at the core of the NCD crisis; physical inactivity, excess body mass, poor nutrition and tobacco use are primary factors that, if left unchecked, substantially increase the risk of developing one or more NCDs.[3] The aforementioned unhealthy lifestyle characteristics are commonplace in those at risk for or diagnosed with CVD. Table 1 lists key global statistics for key unhealthy lifestyle characteristics from the World Health Organization (WHO).[6] In addition to unhealthy lifestyle characteristics, three unfavorable health factors, hyperglycemia, hypertension (HTN) and dyslipidemia also significantly contribute to a raised risk for NCD development and associated adverse events.[7,8] These seven health metrics complexly interact and, when they manifest in a cluster, which is commonly the case, exponentially increase NCD risk. The American Heart Association (AHA) has characterized these four lifestyle characteristics and three health factors as Life's Simple 7 (LS7).[9] Each component of LS7 is categorized into either a poor, intermediate or ideal category, which is described in Table 2. Unfortunately, a small percentage of the US population emulate a favorable LS7 profile; less than 18% of US adults have ≥5 ideal CV health metrics. This percentage declines with aging to where less than 6% of the US adult population ≥60 years of age have ≥5 ideal CV health metrics. This is an important and disconcerting trend as individuals who have few

Table 1. Unhealthy lifestyle statistics from the World Health Organization.[6]

Physical inactivity	• 31% of those 15 and older were not sufficiently active (2008 data) • Approximately 3.2 million deaths attributable to insufficient physical activity each year
Overweight and obesity	• Global obesity has more than doubled since 1980 • 1.9 billion individuals 18 and over were overweight in 2014; 13% of global population is obese • 42 million children 5 and under were overweight or obese in 2013
Poor nutrition	• Approximately 16 million disability adjusted life years and 1.7 million global deaths due to low fruit and vegetable consumption
Tobacco use	• Tobacco causes nearly 6 million deaths annually; more than 5 million from direct use and 600,000 from second hand exposure • Approximately 80% of the 1 billion smokers globally live in low- and middle-income countries

to no ideal CV health metrics are at significantly higher risk for NCDs and poor prognosis.[3,10] Action must urgently be taken to improve the health profile of the global population. Without such action, the global impact of NCDs will be devastating from both a population health and economic perspective.[1]

There is a wealth of literature demonstrating that leading a healthy lifestyle significantly reduces the risk of developing NCDs (i.e., primordial and primary prevention).[3,7] Risk reductions for CVD-related adverse have been shown to be as high as 80% in individuals adopting an ideal healthy lifestyle.[3,11,12] Moreover, in those individuals who have been diagnosed with an NCD, the risk of subsequent events and poor health outcomes is significantly reduced if healthy lifestyle patterns are adopted (i.e., secondary prevention).[13] We have now come to recognize that healthy lifestyle interventions (HLIs) are in fact a very potent medicine that should be prescribed to all individuals.[14] In many countries around the world, health-care systems have followed a *reactionary* model when it comes to implementing a healthy lifestyle care plan; even in this model, the vast majority of patients receive very little if any HLIs.[15]

Perhaps the most well-established model for HLIs in the current health-care model is cardiac rehabilitation (CR). For individuals who have been diagnosed with some form of CVD, CR provides a means to move toward a healthier lifestyle.[16] While the benefits of CR are numerous, there are substantial shortcomings with the current model for delivering HLIs as it is presently offered. Specifically, this model is not proactive; an individual must be diagnosed with CVD and commonly suffer a life-altering event before gaining entry into CR. To have any hope of improving the outlook for NCDs on a global scale, CR must transform into something new, with a shifted focus on expanding target populations and delivery models. The main objective of the CR programs of the future is to prevent CVD from ever occurring in as many individuals as possible. Moreover, present-day CR programs should broaden their focus to address all NCDs through HLIs. If this model were to be followed, present-day CR would carry forward the basic tenets of improving healthy lifestyle characteristics but evolve into something different and much more impactful to a substantially larger percentage of the population. The purpose of this review is to describe current practice patterns for CR and present challenges; provide an overview of the CR body of literature; and present a future model that transforms CR into comprehensive and diverse healthy lifestyle initiatives and programming.

Present-day cardiac rehabilitation: what is it, who participates and where is it delivered?

The current CR model has two components: inpatient and outpatient programming. There is more variability in how inpatient CR programs are delivered although a principle component is resuming mobilization and low-level exercise acutely following a CVD event. Long-standing AHA guidelines also recommend a submaximal exercise test (up to 5 metabolic equivalents (METs); an estimate of oxygen consumption where 1 MET = 3.5 $mlO_2 \bullet kg^{-1} \bullet min^{-1}$) be performed prior to discharge in order to assess the response to a level of exertion that is needed for activities of daily living.[17] This information is used to identify and address abnormal CV responses prior to discharge as well as provide guidance on an early exercise program and general physical activity (PA) recommendations. Recently, an AHA policy statement also reinforced the need for inpatient health professionals to strongly advocate for and facilitate referral to outpatient CR in qualified patients.[18] This is in addition to efforts centered on integrating CR referral to the AHA "get with the guidelines" initiative and designating it as a quality indicator.[19]

In the US as well as other countries, supervised outpatient CR is most commonly delivered over 12 weeks with 36 sessions offered over that timeframe. Outpatient CR programs are commonly multidisciplinary in nature, addressing all components of LS7 listed in Table 2. Health professions involved in administering outpatient CR include physicians, nurses, dieticians, behavioral counselors, exercise scientists, physical therapists, social workers and other allied health professionals. The ultimate goal of the CR team is for participating individuals to achieve ideal health for all LS7 components; this may not be a realistic goal for many individuals participating in CR over a 12-week period. Even so, any migration toward improved CV health has significant implications for improved clinical outcomes and prognosis.[3]

Despite position papers advocating strong endorsement [18,20] as well as other clinical initiatives,[19,21] referral and participation in outpatient CR by patients discharged form inpatient services remains low. Even if a significant increase in participation by eligible patients were possible, the current CR infrastructure would not be able to accommodate the added volume.[15,22] There is also a well-documented inequity in the characteristics of individuals who participate in outpatient CR.

Table 2. Life's Simple 7 from the American Heart Association: definition of poor, intermediate and ideal cardiovascular health.

	Level of health for each metric		
	Poor	Intermediate	Ideal
Current smoking	Yes	Former ≤12 months	Never or quit >12 months Never tried; never smoked whole cigarette
BMI[†]	≥30 kg/m^2	25–29.9 kg/m^2	18.5–25 kg/m^2
PA[‡]	None	1–149 min/week moderate or 1–74 min/week vigorous 1–149 min/week moderate + 2× vigorous >0 min <60 min of moderate or vigorous every day	≥150 min/week moderate or ≥75 min/week vigorous ≥150 min/week moderate + 2× vigorous ≥60 min of moderate or vigorous every day
Healthy diet pattern, number of components[§]	0–1	2–3	4–5
Total cholesterol	≥240 mg/dl	200–239 mg/dl or treated to goal	<200 mg/dl
Blood pressure	SBP ≥140 mm Hg or DBP ≥90 mm Hg	SBP 120–139 mm Hg or DBP 80–89 mm Hg or treated to goal	<120 mm Hg/<80 mm Hg
Fasting plasma glucose	≥126 mg/dl	100–125 mg/dl	<100 mg/dl

[†]Represents appropriate energy balance (i.e., appropriate dietary quantity and PA to maintain normal body weight).
[‡]Proposed questions to assess PA: (1) "On average, how many days per week do you engage in moderate to strenuous exercise (like a brisk walk)?" and (2) "On average, how many minutes do you engage in exercise at this level?"[91] Other options for assessing PA available. [92]
[§]In the context of a healthy dietary pattern that is consistent with a Dietary Approaches to Stop Hypertension (DASH)–type eating pattern, to consume ≥4.5 cups/day of fruits and vegetables, ≥2 servings/week of fish and ≥3 servings/day of whole grains and no more than 36 oz/week of sugar-sweetened beverages and 1500 mg/day of sodium.
AHA: American Heart Association; BMI: Body mass index; DBP: Diastolic blood pressure; PA: Physical activity; SBP: systolic blood pressure.
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Specifically, women, minority groups, the elderly and those with comorbidities and advanced disease severity are referred to and participate in CR at lower rates.[23,24] The reasons for these disparities in CR participation are complex, heterogeneous across different regions and communities, and most certainly multi-factorial in all instances; factors associated with decreased CR participation include lower socioeconomic status and education level, family responsibilities, poor social support, limited to no physician endorsement/support, CR program hours of operation and challenges with transportation.[25]

The cardiac rehabilitation body of evidence: what do we know? What do we need to improve?

There is a robust body of evidence demonstrating the value of outpatient CR; the majority of this literature is from work done in the US, Canada and Europe.[26,27] Even so, there is global interest in CR and countries around the world have programs in place.[16]

Previous research has consistently found an improvement in survival and reduced risk of major adverse health events as aerobic capacity increases in a given individual.[13,28,29] For each one MET in aerobic capacity, reductions in mortality and adverse event risk ranges from 13–15%.[27,29] The protective effect of aerobic capacity persists across the health spectrum, from those who are apparently healthy to those who are diagnosed with a chronic disease. Simply stated, aerobic fitness matters and individuals with a poor aerobic capacity should strive to improve upon this vital health metric. Cardiac rehabilitation clearly and significantly improves aerobic and functional capacity in participating individuals.[13,28,29] This is the result of numerous physiologic improvements in one or more systems integral to the aerobic exercise response (i.e., CV, pulmonary and skeletal muscle).[27] A recent meta-analysis indicates the mean improvement in peak METs following CR is 1.55.[30] The degree of improvements in aerobic capacity seems to be influenced by baseline status where individuals with poorer baseline fitness appear to realize the greatest improvements post CR.[29] It is important to recognize that a relatively modest increases in aerobic capacity (i.e., as little as 1 MET increase) equates to substantial improvements in outcome; a primary aerobic fitness goal should be to move individuals as

far away from 5 peak METs as possible and strive to approach, achieve or surpass 10 peak METs.

The most common aerobic exercise training model assessed in the CR literature is one of moderate exercise capacity, conducted 3–7 days per week, using 30–60 min continuous exercise bouts on a cycle ergometer or treadmill. This approach is well established as being safe and producing significant improvements in aerobic and functional capacity.[31] There is a growing body of literature that demonstrates the positive impact of high intensity interval training (HIIT) in patients with CVD.[32,33] This HIIT approach to aerobic training entails short bouts of aerobic exercise (30 s to 4 min) at near maximal aerobic capacity (≈90%) interspersed with equally timed bouts at a substantially lower workload (≈50% of aerobic capacity) or complete rest. This cycle is repeated for exercise bouts lasting approximately 40 min. A number of studies have found the improvement in aerobic capacity is substantially higher using HIIT compared to moderate-intensity training.[34,35] These enhanced improvements in aerobic performance seem to be paralleled by greater positive physiologic adaptations. In a heart failure model, for example, HIIT appears to significantly improve cardiac function and output, something not commonly seen as a result of moderate intensity exercise training.[33] Questions remain regarding the broad clinical applicability of HIIT, particularly with respect to safety in patients of varying degrees of disease severity and age as well as long term compliance.[36]

Moderate intensity resistance training is also a common component of CR and results in significant improvements in muscular strength and endurance, as a result of physiologic enhancements to the skeletal musculature and motor excitability patterns.[37,38] A common resistance training program employed in CR entails 1–2 sets of 8–10 upper and lower extremity, preferably multi-joint, exercises. Each set entails 10–15 repetitions at ≈50–60% of 1-repetition maximum. The physiologic improvements brought about by resistance training are somewhat unique to those derived from aerobic exercise training. Therefore, participation in both aerobic and resistance training synergistically act to enhance functional capacity beyond what either form of training can achieve separately.

There are numerous other documented benefits associated with CR, facilitating migration toward a healthy lifestyle, emulated in AHA's LS7.[13,39] Dietary patterns, the likelihood of smoking cessation, medication compliance as well as control of blood glucose, lipids and HTN are all improved to a significantly greater degree in those how participate in CR compared to those who do not.[39,40] Quality of life is also significantly improved in patients who participate in CR.[41,42] Traditionally, weight loss, in those who have excess body mass, through CR has been less than optimal.[43] This may be the result of a discordance between tracking of caloric intake and output and ensuring a negative caloric balance. Research shows that, when a negative caloric balance is ensured, significant weight loss is achievable.[44]

Participants in CR consistently demonstrate a significant reduction in mortality and risk for future adverse events compared to those who do not participate; risk reductions have been found to be ≈20% or higher.[13,26,45,46] Recent evidence suggests there is a greater prognostic benefit in those individuals who enter CR with a poorer clinical status; they seem to have more room to improve with respect to clinical trajectory.[29] A more recent analysis indicates that patients entering CR with a concomitant diagnosis of diabetes mellitus (DM) experience significant mortality and hospitalization risk reductions, comparable to CR completers without DM.[47] In another study comparing women to men participating in CR, while both groups demonstrated a significant risk reduction, the one observed in women was significantly better.[48] These studies highlight important points for CR moving forward as patients who have a poorer clinical status, comorbidities, or are female, are less likely to participate in CR.[18,25] Suffice to say, all individuals who are clinically stable and eligible for CR services should be referred and encouraged to participate. Moreover, ensuring long-term maintenance of improvements in LS7 characteristics gained during participation in a CR program is vitally important to optimizing prognosis; home-based telemonitoring/telerehabilitation, utilized once the supervised CR program is complete, may play an important role in enhancing adherence to a healthier lifestyle over the long-term.[49,50]

From an economic perspective, although CR requires an up-front investment, this HLI is viewed as cost-effective, with eventual lower health-care expenditures in those who participate.[13,51] The approach to assessing the cost-efficacy/cost-savings of CR varies considerably across studies (e.g., quality adjusted life years, cost per life year gained, cost per life year saved and total health-care costs). A recent economic analysis indicates that CR may be most cost-effective in those who are older and are at higher risk for subsequent events[52], which are unfortunately characteristics that currently align with less frequent referral and participation.[25] Irrespective of patient characteristics or method of cost-assessment, participation in widely CR is widely viewed as an economically viable endeavor.

In conclusion, traditional CR has a robust body of literature demonstrating numerous benefits, including improvements in healthy lifestyle characteristics and prognosis in an economically advantageous way. The CR literature clearly supports the premise that programs focused on increasing one's healthy lifestyle profile should be viewed as a vital medical intervention that all would benefit from receiving. The key question for the future is how does this proven model evolve to become available to a much greater proportion of the overall population?

The future: transforming cardiac rehabilitation into broad-based healthy lifestyle programing for the global population

In laying the framework for the future, it is of upmost importance to make the point that outpatient CR in its current form is part of the reactionary health-care model. That is to say, for an individual to participate in outpatient CR, they must be

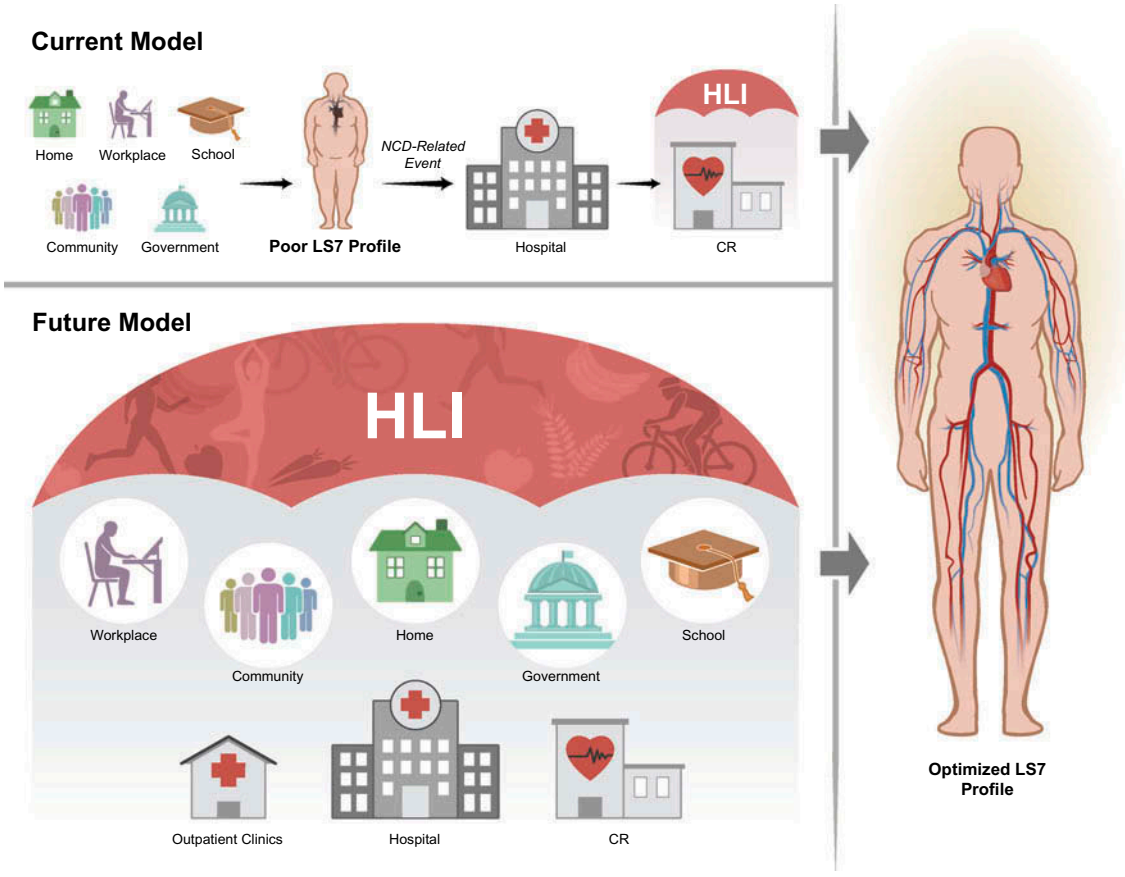

Figure 1. Current and future healthy lifestyle intervention models.
CR; Cardiac rehabilitation; HLI: Healthy lifestyle intervention; LS7: Life's simple seven; NCD: Noncommunicable disease.

diagnosed with CVD. The majority of those diagnosed with CVD manifest a cluster of unhealthy lifestyle characteristics for decades prior to the actual confirmed diagnosis and associated adverse event.[3] Although outpatient CR clearly produces a multitude of benefits, as described in previous sections, the reactionary model is suboptimal. Moving the core goals of CR downstream, to a place and time before unhealthy lifestyles are established, must be an integral part of the future solution to the CVD and broader NCD epidemic.[1,9,11,53–55] Figure 1 illustrates the current and future model for HLIs. Currently, numerous societal factors allow for a poor LS7 profile to manifest in a large percentage of the population, leading to a higher incidence and prevalence of NCDs, associated adverse events and costly medical care. The current model then delivers HLIs in the form of programs such as CR in a small percentage of the population. In the future model proposed herein, stakeholders participating in the delivery of HLIs are expanded; the societal factors that have contributed to the current NCD crisis must become part of the solution. The collective goal is to optimize the global population's LS7 profile, ideally at an early stage and maintained throughout the lifespan (i.e., primordial prevention). Subsequent sections discuss this future model in greater detail.

The common theme: Life's Simple 7

The AHA LS7 initiative described in Table 3 is an important development in the characterization of lifestyle behaviors and CV health factors.[9] As part of this initiative, the AHA set a 2020 goal of improving CV health of all Americans by 20% while reducing CV and stroke mortality by 20% in the same time frame. The WHO has put forth global goals for improving healthy lifestyle characteristics as well.[4] While not conceptualized with this intent, LS7 encapsulates the long-established desired outcomes of CR. LS7 migrates the goals of CR to a broad-based prevention model on the population level, from primordial to secondary prevention. While the AHA has packaged LS7 as a CV health model, achievement of ideal lifestyle characteristics significantly reduces the risk of a broader list of NCDs (e.g., certain cancers, pulmonary disease, etc.).[1] Optimally, ideal CV health as defined by LS7, in particular the lifestyle components, are integrated at an early age, before poor health behaviors and factors have even developed. Primordial prevention must become an essential component of health care moving forward; waiting for NCDs to develop and then treat them (i.e., reactionary care) is a flawed model that is not sustainable from a health or economic perspective moving forward.[56–58] The body of research in support of the CR

Table 3. Key healthy lifestyle stakeholders and their overarching role(s).

Stakeholder	Overarching Role(s)
Professional organizations	Advocacy: Championing healthy lifestyle thought leaders; dissemination of scientific knowledge and practice guidelines; professional meetings
Educational systems	Providing an appropriate healthy lifestyle curriculum at all levels of education: Creating a healthy lifestyle environment within the educational setting
Government	Creating, supporting and implementing legislation and programs that support healthy lifestyle initiatives on a population level
Health-care organizations	Integrating healthy lifestyle interventions into the medical model as a standard of care
The insurance industry	Providing mechanisms for coverage of healthy lifestyle initiatives
Nonprofit and community organizations	Advocacy: Creating, supporting and implementing healthy lifestyle initiatives
Media outlets	Disseminating credible healthy lifestyle information to the lay public
Mobile health and technology companies	Bringing technological inventions/advances that support healthy lifestyle initiatives to market
Employers	Creating a healthy lifestyle environment within the workplace: Offering healthy lifestyle programming to employees
Food industry	Making healthy food choices available: Providing health-conscious nutrition labeling
Health and fitness industry	Providing an infrastructure and professionals capable of offering healthy lifestyle programming to the public
The individual and family unit	Consumers of healthy lifestyle initiatives

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model that is now in place provides strong evidence that a well-planned HLI is effective; expansion of the CR footprint and transformation into broad-based, individually tailored, healthy lifestyle programming is necessary. In the future, healthy lifestyle programs will look different depending on the target audience, resources and infrastructure available, and stakeholders who will partner to deliver the program or initiative. This is admittedly a complex task, but one that is achievable given the medicine being delivered; the healthy lifestyle polypill is one that can come in various dosages and compositions while still being highly effective. There may not be another medical intervention that can boast such a claim while producing such a positive effect. The following sections will present a healthy lifestyle program model for the future.

Who are the key stakeholders for healthy lifestyle programs?

Recently, the AHA, European Society of Cardiology, European Association for Cardiovascular Prevention and Rehabilitation, and American College of Preventive Medicine jointly published a policy statement entitled "Healthy Lifestyle Interventions to Combat Non-Communicable Disease: A Novel Non-Hierarchical Connectivity Model for Key Stakeholders".[1] This policy statement advocates a broader approach to HLIs; key stakeholders and their overarching role(s) from this policy statement are listed in Table 3. These stakeholders will come together to create a new model, the healthy lifestyle health-care system. This healthy lifestyle health-care system, previously housed within a silo (i.e., CR), will function, in large part, outside of the boundaries of the traditional health-care model we are currently familiar with. The primary goal of this health-care system will be preventing NCDs and associated risk factors from ever manifesting. While each stakeholder listed in Table 3 plays an important independent role, collaboration is crucial. The policy statement supports a flexible collaborative approach where stakeholders partner and create healthy lifestyle programs and initiatives that are tailored for optimal success at a local level. A flexible approach enables global applicability of the recommendations provided; all countries regardless of infrastructure and resources will find relevance in the way stakeholders are defined and encouraged to collaborate. There is no hierarchical stakeholder structure; all are on an equal level and encouraged to create innovative HLIs. Moreover, not all stakeholders are needed for a given healthy lifestyle initiative. In this way, countries can work with what is available, creating a specifically tailored healthy lifestyle polypill with ingredients and dosages that are readily available. The policy statement also recommends each stakeholder listed in Table 3 formally designates one or more *Healthy Lifestyle Ambassadors* (HLAs). The HLA for each stakeholder will be responsible for creating a healthy lifestyle mission, vision and strategic plan; leading communication amongst stakeholders; and leading or participating in collaborative development and implementation of healthy lifestyle programs and initiatives. This is a significant paradigm shift in identifying stakeholders that have a meaningful role in the development and implementation of healthy lifestyle programs and initiatives. The individual and family units are the ultimate recipient of HLIs; they should also be engaged as key

stakeholders. Ideally, these stakeholders will work together to focus on the primordial prevention of NCDs as a primary objective; primary and secondary prevention strategies will also play an integral role as appropriate. This expansion of key healthy lifestyle stakeholders is a primary component of the transformation of CR, they will work together to become the new providers of healthy lifestyle medicine. The primary goal of traditional CR that has been in place for several decades remain, improving healthy lifestyle behaviors and health metrics as outlined in Table 2. The primary goal shared by all stakeholders is to migrate individuals to as many ideal health characteristics as possible.

Where will healthy lifestyle programs be implemented?

To accommodate successful implementation in various settings, healthy lifestyle programs will assume many forms.[53,54,59] However, regardless of the approach, the common theme of these programs will be to improve one or more lifestyle characteristics and health metrics (Table 2). Combating NCDs will require a comprehensive preventative approach, from primordial to primary to secondary prevention. As mentioned previously, a major focus must be directed toward primordial and primary prevention, decreasing the risk of NCD onset. This will require a strong program presence where people live, go to school and work.[1] The following sections will describe settings where healthy lifestyle programs and initiatives should be implemented.

School system

Children and young adults spend a significant amount of time in school, providing for a key opportunity to immerse these individuals in a healthy lifestyle culture at an early age.[1,60] There currently is a lack in health literacy within the K-12 population, particularly for racial and ethnic minorities.[61] As such, school systems should ensure that healthy lifestyle programming is an integral part of the curriculum and school culture; a school system's ability to demonstrate a high level of student health literacy is an important metric. A robust physical education program as well as routine recess periods should be an integral component of K-12 education. Intramural sport activities, and walk or bike to and from school programs provide other opportunities to increase daily PA. A broader health education curriculum should be implemented to address other aspects of leading a healthy lifestyle, including proper nutrition, appropriate body weight and the importance of never smoking. Offering healthy food options in school is vital; both cafeteria and vending machine options should be health conscious and affordable. Promoting family participation in school-based healthy lifestyle education and broader initiatives, through communication early in the planning process to discuss goals and responsibilities, is also recommended.[62] The government on the federal, state and local level plays an important role in establishing policies that require public school systems adopt healthy lifestyle programing in their curriculum and culture.[1,63]

Many high school graduates progress onto college where the continuation of a healthy lifestyle culture and programing should be commonplace. Evidence indicates healthy lifestyle initiatives can improve key LS7 characteristics in college-aged individuals.[64] This is a critical juncture as there is evidence to indicate an increased risk for adoption of unhealthy lifestyle characteristics during the K-12 to college transition.[65,66] College campuses should be entirely smoke-free. The campus should also strive to create an infrastructure where walking and biking is a highly viable and preferable transportation option. Recreational centers should be readily available, providing a host of opportunities to engage in a physically active lifestyle. Nutritious food options should be readily available throughout the campus, in the cafeteria, restaurants and vending machines. A robust healthy lifestyle messaging campaign, using highly visible signage (i.e., take the stair posters), newsletters, text messaging, websites, social media, and so on, is recommended. General undergraduate education, regardless of major, should consider requiring coursework directed toward instruction on leading a healthy lifestyle.

Community

The community where people live and carry out a number of their daily activities provides for numerous opportunities to implement HLIs and programs; a growing body of evidence demonstrates the potential for significantly improving healthy lifestyle characteristics and health-related outcomes through community-based initiatives.[67–71] A community should strive to create an environment where inhabitants are immersed in a healthy lifestyle. A smoke-free environment throughout the community is of paramount importance. A community should be designed in a way that fosters PA by creating a pedestrian friendly environment; safe bike lanes and paths; and an accessible, safe and affordable public transportation infrastructure. Public parks are also an excellent location for planned events to promote PA, such as morning yoga, spin class and fun runs. There should be healthy food options in all venues (i.e., grocers, restaurants, farmers markets, etc.) within a community. Community centers, public libraries and grocery stores can host health screenings focused on lifestyle characteristics and health metrics. Public messaging campaigns can also focus on the importance of leading a healthy lifestyle and achieving/maintaining the ideal health metrics listed in Table 2.[72]

Worksite health and wellness

The workplace provides an ideal opportunity to continually engage a large percentage of the population in HLIs and immerse employees in a culture of health and wellness during working hours.[16,73] It has recently been proposed that worksite health and wellness programs may serve as primary and extended secondary prevention CR programs.[74] Worksite health and wellness programs should include the following components: 1) at least annual health and wellness screenings; 2) opportunities for PA during working hours via walking paths, exercise facilities, promoting use of staircases

and so on; 3) a smoke-free environment; 4) healthy food choices through a workplace cafeteria (if available) and vending machines; and 5) smoking cessation and weight loss programs as needed. Strong support from business leadership is imperative. Employers may choose to operate their own program or contract with an external entity to provide services. Studies have shown that well-designed worksite health and wellness programs significantly improve healthy lifestyle characteristics and health metrics.[74,75] They also have a favorable return on investment and reduce absenteeism and pre-absenteeism. In 2014, the AHA published a policy statement on worksite health screening, providing guidance on key measures and procedures as well as potential legal issues surrounding such practices.[76] In 2015, the AHA published a presidential advisory proposing a model for a workplace wellness recognition program based on tracking and improving the CV health of employees as defined by LS7.[77] These recent efforts by the AHA are a clear indication of the recognized potential of worksite health and wellness to improve CV health on a large scale. Moreover, in the US, the Affordable Care Act has incorporated substantial financial incentives for employers who offer worksite health and wellness programs, providing further evidence of the recognized value.[75,78] This is not a trend localized to the US as countries around the world are demonstrating a great interest in worksite health and wellness, with the number of employers offering programs continually increasing.

Primary care outpatient clinics

Primary care physicians and the multidisciplinary team they oversee are commonly responsible for the care of patients with a host of NCD risk factors. They also provide care for patients who are already diagnosed with one or more NCDs. Thus, primary care outpatient clinics are an ideal setting for the implementation of primary and secondary prevention HLIs. Arena and Lavie recently proposed the concept of embedding "healthy lifestyle teams" in primary care settings.[14] These teams would include exercise scientists, registered dieticians and behavioral modification experts. Physicians, nurses and other allied health professionals would also be expected to be knowledgeable on the critical importance of HLIs to the overall care plan. In this scenario, physicians would appropriately diagnose patients with unhealthy lifestyle habits when detected and refer to appropriate members of the healthy lifestyle team to prescribe the appropriate interventions; physical activity, healthy nutrition, weight loss and/or smoking cessation.

Inpatient care

The vast majority of individuals who find themselves requiring inpatient care have been diagnosed with a medical condition; the incidence and prevalence of patients with NCDs are high in this setting. As such, there is a critical need for HLIs during inpatient care. Typically, the inpatient stay does not extend beyond several days. HLIs in this setting should focus on intensive education regarding the importance of PA and healthy nutrition as well as weight loss and smoking cessation as needed. HLI efforts in the inpatient setting should serve as a primer for the outpatient care these patients will receive; informational packets without follow-up and continued programming upon discharge are insufficient. Discharge planning with respect to follow-up HLIs is critical. A recent AHA policy statement describes the vital role of the inpatient team in ensuring eligible patients are referred to and more importantly participate in outpatient CR.[18] However, outpatient CR is just one avenue for outpatient HLIs following inpatient discharge. Patients with diagnoses that preclude outpatient CR eligibility, but still manifest poor lifestyle characteristics and health metrics (i.e., present with poor CV health as defined in Table 2), should also receive a healthy lifestyle discharge plan. This would include referral to outpatient clinics that employ health professionals (e.g., exercise scientists, registered dieticians and behavioral counselors) with the expertise to deliver HLIs. A multidisciplinary inpatient health-care team should establish formal relationships with outpatient entities that can deliver such interventions; such an approach would increase the likelihood for a seamless continuum of care, enhance quality of care and patient satisfaction and improve outcomes for key health metrics (e.g., readmission rates). Lastly, while the inpatient multidisciplinary team will designate certain health professionals to oversee and deliver healthy lifestyle programing and the outpatient care plan, all members of the team should strongly endorse and stress the importance of improving lifestyle characteristics. A unified message coming from all involved (i.e., physicians, nurses, physical/occupational therapists, registered dieticians, social workers, etc.) is needed for patients to understand the importance of compliance with HLIs upon discharge. Moreover, facilitating rapid initiation of HLIs following discharge enhances the likelihood of participation.[79]

Secondary prevention outpatient clinics

The current outpatient CR model is the most well-established model focusing on HLIs following a CV diagnosis, event and/or surgical procedure. As discussed in previous sections, the clinical benefits of the current outpatient CR model are numerous and supported by a robust body of literature. As such, the current outpatient CR model will continue to serve a vital role in improving healthy lifestyle characteristics and health metrics in those individuals already diagnosed with a CV condition. However, the current model limits access to patients diagnosed with CVD. Moreover, certain countries limit diagnoses covered within the CVD population as a whole. For example, outpatient CR is currently not covered for patients diagnosed with heart failure—preserved ejection fraction in the US. Clearly, improving healthy lifestyle characteristics is a vital medicine that all individuals would benefit from and, given this unequivocally factual premise, the current CR model should be allowed to expand its scope within the current health-care infrastructure. Established outpatient CR programs should become secondary prevention Healthy Lifestyle Centers (HLCs). A diagnosis of leading an unhealthy lifestyle, regardless of other concomitant

medical diagnoses (e.g., metabolic, CV, pulmonary, orthopedic, neurologic, endocrine, etc.), would be the only criteria needed to receive a referral to a HLC. The body of literature on the benefits of HLIs in patient populations that extend beyond the CV realm clearly support consideration of this transformation. [1] The basic principles of leading a healthy lifestyle, increased physical activity, a healthy diet, maintaining a healthy body weight and not smoking is a universal medicine for all patient populations. These basic tenants of outpatient CR can and should be prescribed to all patients. Admittedly, this proposed transformation is ambitious and will require a significant expansion of infrastructure to offer HLIs to a significantly greater pool of patients; flexibility in the way HLIs are delivered (i.e., one size will not fit all); and altering current coverage policies and reimbursement models in some countries. This transformation, if embraced, will take a considerable amount of time to occur and be fully implemented. Even so, our current failure in effectively addressing the global NCD crisis in conjunction with the evidence supporting the value of HLIs warrants strong consideration of implementing the approach we are proposing herein.

Lifestyle economics: who should invest in healthy lifestyle interventions?

Currently, unhealthy lifestyle characteristics, defined as poor CV health by the AHA's LS7, is causing substantial economic hardship around the world.[1,56,80] The finances needed to treat the conditions that result from physical inactivity, poor nutrition, obesity and smoking are substantial and current projections indicate costs will continue to rise. Regardless of a country's health-care payment system, a higher proportion of the gross domestic product (GDP) committed to health care for the treatment of NCDs, which in large part manifest from leading an unhealthy lifestyle, has a significant negative consequence on a countries economy. Given the current financial connectivity amongst countries, the negative implications for rising health care costs due to conditions resulting from an unhealthy lifestyle on the global economy are very real and disconcerting.

Individuals who lead a healthy lifestyle undeniably have fewer medical conditions that warrant the most costly types of health care (i.e., emergency room visits, inpatient admissions, surgical procedures and chronic disease management). As such, there is a compelling economic rationale for financial investments directed toward improving healthy lifestyle behaviors by the stakeholders listed in Table 3.[81–83] Finances that are invested in HLIs that improve behaviors demonstrate a highly favorable return on investment: 1) a government that invests in HLIs will reduce funds needed to provide health care to its citizens; 2) an employer that implements a workplace health and wellness program will reduce the money it needs to commit to health-care expenditures for its workforce as well as increase productivity; 3) health-care systems that operate under a covered lives model (i.e., fixed pool of money to provide care to a population of individuals) that provide interventions that improve healthy lifestyle behaviors will decrease hospital admissions and high-cost medical procedures; and 4) a family unit that improves their healthy lifestyle behaviors reduce their out of pocket health-care expenditures. In summary, investments that improve healthy lifestyle behaviors is a sound financial model for all stakeholders.

Leveraging technology for healthy lifestyle interventions

The use of technology in health care is rapidly expanding and will continue to do so for the foreseeable future.[55,84,85] The use of the Internet, smartphones and wearable devices create a wealth of opportunities to provide stand-alone HLIs as well as complement and significantly augment face-to-face interventions. By 2020, smartphone subscriptions are expected to exceed 6 billion[86], creating the ability to digitally interact with the majority of the global population on a continual basis. Examples of how technology can be used with respect to HLIs include: 1) tracking lifestyle characteristics through an electronic health record; 2) communicating with health-care professionals; 3) daily monitoring of health metrics such as blood pressure; 4) tracking progress with prescribed HLIs (e.g., daily step count, exercise program, nutritional diary, weight control, etc.); 5) health coaching; and 6) social networks. The body of literature assessing technology-based HLIs is very promising, although continued research is needed in this area to determine optimal delivery models.[85] Numerous studies have found significant improvements in healthy lifestyle behaviors and outcomes are realized through well designed technology-based programming. An important consideration during the planning phase is to determine the type(s) of technology available to the target population and the comfort level the target population has with the technology that will be utilized. Determining this information may be achieved through various approaches including individual surveys and consumer market analyses. For example, individuals in middle- and low-income countries have much greater access to mobile phones as compared to the Internet.[55] As such, HLIs using mobile phones as opposed to the Internet have the potential to reach a much larger percentage of the population in these areas. Moving forward, all HLIs, regardless of the setting or group of stakeholders leading the initiative, would most certainly be enhanced through the use of technology.

Academic training for health professionals and beyond

Academic training in the health professions and other disciplines will require varying degrees of transformation if the concepts presented in this review have any hopes of becoming a reality. [1,87] Many of the health professions currently have limited exposure, both didactically and practically, to lifestyle assessment and interventions during their academic training.[88,89] Physicians, nurses and physical/occupational therapists are amongst the disciplines who are currently licensed that have the opportunity to significantly improve healthy lifestyle behaviors through their practice. To do so, however, these disciplines would have to revise their respective curricula to prepare health

professionals to effectively contribute to the healthy lifestyle team. Other disciplines, such as exercise physiologists and registered dieticians, have advanced training in core lifestyle components. As such, ensuring these disciplines are incorporated into the healthy lifestyle team is essential. Moving forward, health-related academics may want to consider creating a new discipline that trains individuals to comprehensively perform lifestyle assessments and administer HLIs. Such a health practitioner would require training and expertise in exercise and nutritional sciences as well as behavioral modification as core components. A thorough understanding of lifestyle economics and etiology, healthy lifestyle program development and implementation in a broad array of settings and knowledge in how to utilize technology would be additional attributes with high value. There would be clear advantages to a single health professional, a healthy lifestyle practitioner (HLP) if you will, a concept described in a companion commentary in this edition of *Expert Review of Cardiovascular Therapy*[90], who could take a lead role in lifestyle assessments and interventions.

From a broader perspective, academic training in numerous other areas would benefit from discipline-specific customized education on the impact of lifestyle behaviors as part of the core curriculum. Examples include 1) business majors to understand the importance of creating a culture of health and wellness in the workplace; 2) political science majors to understand the importance of population lifestyle behaviors on health-care policy and legislation; 3) computer science, health informatics and health information systems majors to understand the role of technology in lifestyle assessment and interventions; 4) economic majors to understand the financial impact of lifestyle behaviors from a global to individual level; and 5) all general education undergraduate degrees to understand the importance of leading a healthy lifestyle from a personal perspective.

Conclusions

Clearly, CR is a well-established intervention with proven benefits in patients diagnosed with CVD. In parallel, a body of literature has come to fruition clearly demonstrating individuals, irrespective of health status (i.e., apparently healthy to chronic disease), who lead a healthier lifestyle have improved health outcomes. Moreover, the greater number of healthy lifestyle characteristics, the greater the health benefit. This indicates that individuals with the poorest lifestyle profile can make minimal change initially and still derive significant health benefits. This allows health-care professionals to set realistic short-term goals with respect to lifestyle behavior change while striving for the ultimate long-term goal of progressing individuals toward an ideal lifestyle profile. The paths of CR and broader HLIs are intersecting at a point in time where drastic change is needed to combat the global NCD crisis. It is time for CR, a proven model for improving health outcomes, to transform into something that will impact a much broader proportion of the population, with a focus on optimizing lifestyle behaviors before NCD risk factors manifest. Such a transformation is ambitious but needed if we hope to alter the future ominous NCD projections. Healthy lifestyle is medicine and there is a need to develop broad-based effective modes of delivery; healthy lifestyle programs, previously known as secondary prevention CR, have the potential to transform a vital aspect of health care in the future.

Expert commentary

NCDs are the primary health-care concern in a majority of the countries around the world. The risk of NCD development and the subsequent deleterious impact on health and cost of care is dramatically increased when an individual leads an unhealthy lifestyle. Alternatively, leading a healthy lifestyle dramatically decreases NCD risk. We are now increasingly recognizing that promoting healthy lifestyle behaviors, from the population to individual level, is a global imperative. Healthy lifestyle medicine must be broadly distributed with the intent of decreasing NCD incidence and prevalence and improving health outcomes in those already diagnosed with a NCD. A meaningful increase in healthy lifestyle behaviors, which is a major goal for numerous organizations including the AHA and WHO, will take a major paradigm shift in infrastructure, stakeholders and program delivery. The literature clearly supports the value of HLIs; we must now ensure this medicine is delivered to the global population.

Five-year view

Within five years, HLIs and programing will be significantly increased on a global scale. Stakeholders from the multiple sectors that are listed in Table 2 will start to collaborate on new and innovative healthy lifestyle programs and initiatives. In the US, accountable care organizations will increasingly embrace HLIs and programming on all levels, from primordial to secondary CVD prevention, in an effort to decrease hospital admissions and costs while providing excellent care. Worksite health and wellness programs will continue to expand around the world in an effort to increase healthy lifestyle behaviors in working adults. The use of technology to track healthy lifestyle behaviors and deliver HLIs will continue to increase. Lastly, the body of literature reporting on HLIs will significantly expand in the next 5 years, which will help to determine best practice models.

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Key issues

- Unhealthy lifestyle behaviors, such as excess body mass, physical inactivity and poor nutrition, are of great concern on a global scale.
- Noncommunicable diseases (NCDs), in large part brought about by an unhealthy lifestyle, are at epidemic proportions on a global scale.
- Leading a healthy lifestyle substantially decreases the risk for NCDs.
- A large body of literature demonstrates that healthy lifestyle interventions (HLIs), delivered through secondary prevention CR programs, elicit a host of clinical benefits.
- There is now a global recognition that we must substantially increase efforts to increase healthy lifestyle behaviors if there is any hope of altering the NCD trajectory that is currently projected.
- It is the view of this writing group that expanding the current CR model to provide HLIs across the prevention spectrum (i.e., primordial to secondary) would be advantageous.
- In the future, HLIs and programing will become more flexible in their approach to optimize effectiveness; ongoing research is needed to determine best practice models.
- Utilizing technology to enhance HLIs and programming will be critical moving forward.

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