Focus on Cardiovascular Health Promotion and Disease Prevention: Opportunities for Improvement

Devinder S. Dhindsa, Anurag Mehta, and Laurence S. Sperling

Summary

- Prior reductions in cardiovascular mortality have seen stagnation and even a reversal in that trend despite modern and expensive technologies and therapies.
- This trend is due in part to an increase in the prevalence of obesity and diabetes, with resultant impact on other cardiovascular risk factors.
- The need for prevention is imperative and requires a comprehensive approach on a continuum of care from individual patients to large-scale public policy initiatives.

1 Introduction

The latter part of the twentieth century in the United States was notable for an unprecedented reduction in cardiovascular deaths. Importantly, most of the decrease in cardiovascular deaths, particularly between 1980 and 2000, was attributable to preventive efforts through improved awareness and treatment of traditional cardiovascular risk factors (smoking, dyslipidemia, hypertension, diabetes) [1]. Unfortunately, in recent years there has been stagnation in these gains with trends demonstrating a concerning increase in cardiovascular mortality, particularly in younger adults, due in part to a rise in obesity and diabetes in the United States [2–5]. Currently, there are 30 million Americans living with diabetes, 84 million with pre-diabetes, and 75 million with hypertension, and nearly 40% of Americans are obese [6, 7]. Disturbingly, the development of these cardiovascular risk factors

D. S. Dhindsa · A. Mehta · L. S. Sperling (✉)
Department of Medicine (Cardiology Division), Emory University School of Medicine, Atlanta, GA, USA
e-mail: lsperli@emory.edu

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is largely preventable. Our current healthcare system is inadequate in promoting healthy behaviors and incentivizes disease-focused care, often at advanced stages.

Despite outspending any other country with 18% of our gross domestic product on healthcare, the United States is ranked last among industrialized nations in healthcare value, measured as a composite of care process, access, efficiency, equity, and healthcare outcomes [8]. In 2016, cardiovascular disease spending was estimated at $555 billion [9]. By 2035, this cost is expected to increase to $1.1 trillion [10]. Although spending on technology for cardiovascular care had value in prior decades, the current trends in cardiovascular outcomes suggest this trend may no longer be true [5, 10–12]. As such, a greater focus on primordial and primary prevention is critical for the health and well-being of our communities and our future economy.

2 Defining Cardiovascular Health

A definition of cardiovascular health is useful for guiding efforts geared toward health promotion and disease prevention. In 2010, the Goals and Metrics Committee of the Strategic Planning Task Force of the American Heart Association (AHA) envisioned ideal cardiovascular health as a combination of three key factors: (1) absence of cardiovascular disease (CVD), (2) favorable levels of cardiovascular health factors, and (3) presence of favorable health behaviors [13]. The committee developed objective definitions for "ideal," "intermediate," and "poor" cardiovascular health based on these principles incorporating a combination of seven distinct cardiovascular risk factors and health behaviors [13]. These modifiable cardiovascular risk factors have been colloquially termed Life's Simple 7 and consist of blood pressure, total cholesterol, fasting blood glucose, smoking, physical activity, body mass index, and healthy diet (Table 1) [13]. Ideal cardiovascular health was defined as the presence of ideal levels of all seven metrics, intermediate cardiovascular health as the presence of at least one intermediate metric without any poor metrics, and poor cardiovascular health as the presence of at least one poor health metric [13].

Over the past decade, several studies have reported that individuals with ideal cardiovascular health are rare in American communities. The estimated prevalence of ideal cardiovascular health ranged from 0.5% to 12% in a systematic review conducted in 2016 [14]. A seminal investigation from the National Health and Nutrition Examination Survey (NHANES) revealed that the proportion of American adults meeting all seven ideal cardiovascular health metrics declined over time from 2.0% [95% CI, 1.5–2.5%] in 1988–1994 to 1.2% [95% CI, 0.8–1.9%] in 2005–2010 [15]. Women, non-Hispanic whites, and those with higher education levels were more likely to meet a greater number of these cardiovascular health metrics than their male, ethnic minority, and less educated counterparts. Furthermore, this investigation and several other epidemiologic studies have demonstrated the direct association of ideal cardiovascular health with favorable long-term cardiovascular outcomes [14, 15]. These findings illustrate the urgent need for cardiovascular health

Table 1 Modifiable risk factors and behaviors comprising the definitions of poor, intermediate, and ideal cardiovascular health

Metric	Poor	Intermediate	Ideal
Blood pressure	SBP ≥140 or DBP ≥90 mm Hg	SBP 120–139 or DBP 80–89 mm Hg or treated to goal	SBP <120 or DBP <80 mm Hg
Total cholesterol	≥240 mg/dl	200–239 mg/dl or treated to goal	<200 mg/dl
Fasting glucose	≥126 mg/dl	100–125 mg/dl or treated to goal	<100 mg/dl
Smoking status	Current smoker	Former smoker or quit ≤12 months ago	Never smoker or quit >12 months ago
Physical activity	None	1–149 min/week moderate intensity or 1–74 min/week vigorous intensity or 1–149 min/week moderate + vigorous intensity	≥150 min/week moderate intensity or ≥75 min/week vigorous intensity or ≥150 min/week moderate + vigorous intensity
Body mass index	≥30 kg/m^2	25–29.9 kg/m^2	<25 kg/m^2
Healthy diet score*	0–1 component	2–3 components	4–5 components

Adapted from American Heart Association's Life's Simple 7
*The Goals and Metrics Committee of the Strategic Planning Task Force selected five aspects of diet to define a healthy dietary score, which is detailed in their American Heart Association Special Report [13]
SBP systolic blood pressure, *DBP* diastolic blood pressure, *mm HG* millimeters of mercury, *mg/dl* milligrams per deciliter, *min* minutes, *kg/m^2* kilogram per meter squared

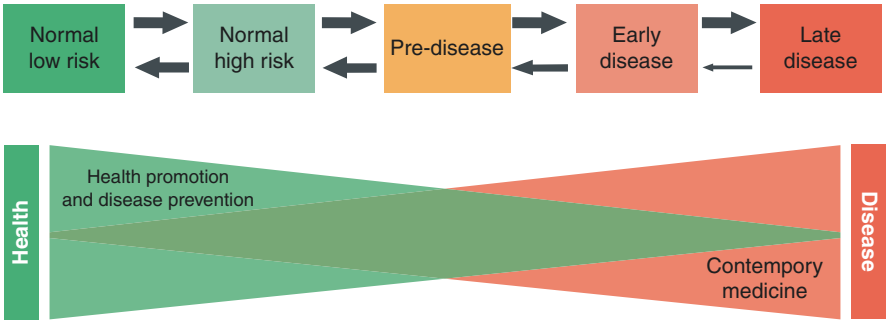

Fig. 1 The cardiovascular health/disease continuum. (Reprinted from Knapper et al. [16]. With permission from Elsevier)

promotion to help shift the cardiovascular health/disease continuum in favor of health (Fig. 1) [16].

A comprehensive, multifaceted approach that involves concerted efforts from key stakeholders is needed for promoting cardiovascular health. We will structure this chapter using the paradigm of the "three buckets of prevention": (1) traditional

clinical prevention, (2) innovative clinical prevention, and (3) community-wide prevention [17]. This framework is a useful means of approaching the continuum of prevention to discuss the challenges and opportunities related to cardiovascular prevention.

3 Bucket 1: Traditional Clinical Prevention

3.1 Improvement in Utilization and Adherence to Guideline-Recommended Therapies

Evidence-based guidelines are designed to guide clinicians and patients toward favorable outcomes for those with, or at risk for, atherosclerotic cardiovascular disease (ASCVD) [18, 19]. Unfortunately, current registries demonstrate inadequate uptake of recommendations, even those with a Class I indication. As an example, 28–36% of patients in the ACC National Cardiovascular Data Registry's (NCDR) Practice Innovation and Clinical Excellence (PINNACLE) Registry who were identified as high-risk benefit groups by current guidelines were not prescribed statins [20]. Additionally, other challenges include clinicians not prescribing the appropriate dose of statins despite supportive evidence for high-intensity statins in high-risk patients [21, 22]. In addition, there is significant lack of adherence among patients. In clinical trials and registries, nonadherence to statins is reported in up to 40% of subjects [23–26]. Together, between patient and clinician-related approaches to care, a large percentage of at-risk patients are not receiving guideline-directed medical therapy [27].

Importantly, lack of adherence poses both short-term and potential long-term risk. Younger patients accrue incremental benefit from early preventive therapy, yet are less likely to have hypertension diagnosed and treated, use statins as recommended, and are more likely to use tobacco [28–30]. Notably, in a high-risk secondary prevention cohort, 20% did not fill at least one of their prescribed cardiac medications within a month of hospital discharge after a myocardial infarction (MI), and of concern, nearly 50% of patients did not fill their antiplatelet therapy afterward [31]. Additionally, although lifestyle management remains the cornerstone of cardiovascular disease risk reduction, implementation remains a challenge, despite guideline recommendations. Americans have high rates of poor diet quality and physical inactivity [15, 28, 32]. Over one-fourth (28%) of US adults aged 35–64 are physically inactive, defined as never getting 10 min or more of leisure-time physical activity per day [28].

Multiple factors impact adherence. Out-of-pocket costs are a significant factor, although studies have shown that adherence does not improve substantially when medication copays are eliminated [33]. Additionally, clinicians and their patients, especially younger adults, may hesitate to start a medication regimen that could be lifelong, despite a strong indication to do so [34]. These challenges highlight multiple opportunities to address risk through better understanding and overcoming

barriers to adherence [23]. Whenever possible, clinicians should minimize patient cost, reduce barriers to obtaining medications, and simplify regimens [35]. Prescribing medication electronically reduces risk that a patient may lose a prescription. Pharmacy-initiated text reminders and automated refills are beneficial as well. Additionally, lower dosing frequency (i.e., utilizing long-acting formulations where possible) can improve adherence [36–38].

Evidence suggests that patients are more likely to make a lifestyle modification if their clinician recommends they do so [39]. One readily available lifestyle modification program is the National Diabetes Prevention Program, which enables people at risk for type 2 diabetes to participate in evidence-based lifestyle change programs that have shown significant long-term improvements on cardiovascular risk factors [40]. Registered dieticians, exercise physiologists, or promising community-based programs like Walk With a Doc should be utilized as well [41]. Engaging patients through involvement in shared decision-making, in which clinical guideline-based approaches in the context of individualized care, can strengthen therapeutic relationships, boosting patient engagement and medication adherence [42].

A systems approach to care, using protocols and electronic-medical record alerts, may be useful in overcoming some of the barriers on the part of physicians to implementation of guideline-directed therapy. Treatment protocols can help systematically identify patients who are eligible for intensification of clinical management, reduce variation between patients, simplify medication initiation and intensification, reinforce counselling on lifestyle modifications, and help in scheduling timely follow-up [34, 43]. Protocol implementation has been effective in improvement in performance on chronic disease quality indicators including hypertension control and may serve a critical role in cardiovascular risk reduction in our increasingly electronic and protocolized health system [44, 45].

3.2 Improving Utilization of Cardiac Rehabilitation

As a further example of challenges in implementation of guideline recommendations into clinical practice, cardiac rehabilitation (CR) remains significantly underutilized [46]. Cardiac rehabilitation (CR) services are an integral component in the care of patients with cardiovascular disease [47–49]. Referral to CR is a Class IA recommendation for secondary prevention established by the American Heart Association (AHA) and American College of Cardiology (ACC) after myocardial infarction (MI), percutaneous coronary intervention (PCI), or coronary artery bypass graft surgery (CABG), stable chronic heart failure, stable angina, cardiac transplantation, peripheral arterial disease, and cardiac valve surgery [50]. A meta-analysis of 34 randomized controlled trials showed that exercise-based CR programs in secondary prevention patients are associated with a lower risk of reinfarction (odds ratio [OR] 0.53; 95% confidence interval [CI] 0.38 to 0.76), cardiac mortality (OR 0.64; 95% CI 0.46 to 0.88), and all-cause mortality (OR 0.74, 95% CI 0.58 to 0.95), and CR also leads to improvements in cardiovascular risk

factors (i.e., lipid levels, blood pressure, tobacco use), as compared to usual care [51, 52]. Despite this, only about 60% of patients undergoing PCI are referred for cardiac rehabilitation [53] and even less enroll in CR. The safety and effectiveness of the traditional medically supervised, center-based CR is well established, but unfortunately CR remains substantially underused among eligible patients [54].

Data from several registries and databases indicate patient participation remains low across most demographic groups [49, 55]. Between 2007 and 2011, only 16.3% of Medicare patients and 10.3% of veterans participated in CR after hospitalization for MI, PCI, or CABG [55]. Improving referral rates through education and/or automatic generation of referrals following a hospitalization for a cardiac diagnosis is one possible solution to poor referral rates, but lack of access and other barriers including competing responsibilities, cost/financial viability, and perceived inconvenience for the patient require innovative solutions.

3.3 Improving Identification and Treatment of Familial Hypercholesterolemia

Familial hypercholesterolemia (FH) is the most common autosomal dominant genetic disorder, affecting one in 250 people worldwide in heterozygous form and approximately one in one million in homozygous form [56]. FH is caused by mutations in genes responsible for low-density lipoprotein (LDL) receptor and if left untreated places affected individuals at high risk for premature cardiovascular disease. FH is suggested to account for nearly 20% of myocardial infarctions before the age of 45, and the first presentation of the disease may be MI or sudden death, with homozygous FH resulting in significant ASCVD in childhood [57]. As such, early identification of this disease is critical, as starting therapy with statins and other lipid-lowering medications has been shown to attenuate this risk [58].

Despite the danger presented by this genetic disease, FH remains underdiagnosed and undertreated [59]. Public awareness and implementation of the recommendations from the World Health Organization regarding FH care have lagged substantially behind other advancements made within cardiovascular medicine [60]. Clinicians underestimate the prevalence, high level of risk, importance of treatment initiation within the first two decades of life, and the autosomal dominant inheritance pattern necessitating cascade family screening. Limited understanding by affected individuals of their disease process, economic ramifications of living with and affording lifelong care, and pragmatic concerns surrounding possible genetic discrimination pose additional barriers to care in those who are able to receive an accurate diagnosis [61]. Use of registries, such as the CASCADE FH Registry, and public awareness campaigns are critical to improving detection of this disease estimated to affect 34 million individuals worldwide [62]. Groups such as the FH Foundation have made significant progress in helping increase awareness and identify affected patients [63].

4 Bucket 2: Innovative Clinical Prevention

4.1 New Care Models

The prior discussion on the poor utilization of CR highlights the need for new care models in the modern era. Potential approaches include alternative site-, home-based, or hybrid models of CR, which can be carried out in the home or other non-clinical settings, alleviating access-related barriers for patients. European guidelines on CVD prevention state that "home-based rehabilitation with and without telemonitoring holds promise for increasing participation and supporting behavioral change" [63]. Comparisons of center-based CR and home-based CR show similar effects on quality of life and cost among patients with recent MI or PCI, with low rates of adverse events [49, 64, 65]. Theoretically, these types of programs can be used for other preventive strategies including management of risk factors, increasing physical activity, and maintenance of a healthy dietary pattern.

The increasing use of mobile technology serves as another opportunity to reduce gaps in access to CR through mobile health or "M-health" [66]. Mobile technology is widely utilized in the United States, with approximately 95% of adults owning a cellular device, and smartphone ownership estimated to be at 77%, an increase from 35% in 2011 [67]. This rise in smartphone adoption provides an opportunity to leverage advances in mobile technology, especially in capturing data regarding patient behaviors, physical activity, and enhanced two-way communication. Early research suggests "mCR" may be associated with greater utilization as post-MI patients assigned to a smartphone-based CR program had greater uptake (80% vs 62%), adherence (94% vs 68%), and completion (80% vs 47%) of a CR program compared to those assigned to traditional, center-based CR [68]. Both groups showed similar improvements in physiological and psychological outcomes suggesting equivalent benefits could be achieved with potential reductions in mortality and morbidity commensurate with those observed with center-based programs, with much greater reach [66].

Furthermore, the potential utility of m-health also extends to the promotion of healthy behavior modification beyond CR [69, 70]. A randomized controlled Tobacco, Exercise and Diet Messages (TEXT ME) trial showed that the use of lifestyle-focused text messaging resulted in significant reduction in low-density lipoprotein cholesterol, systolic blood pressure, body mass index, and smoking rates and an increase in physical activity compared to usual care in patients with established cardiovascular disease [71]. Patient education via social media and Internet sources has been shown to increase adherence in patients with non-cardiovascular conditions and could similarly impact cardiovascular care [5, 72, 73].

Systematic reviews indicate benefits of digital health interventions (telemedicine, web-based strategies, e-mail, mobile applications, text messages, remote monitoring) on improving cardiovascular risk [74]. An important area of future investigation will be exploring opportunities to optimize other emerging technologies (i.e., smartphone applications) to improve access, reach, and effectiveness of cardiovascular risk reduction strategies [66].

4.2 Improving Risk Assessment and Treatment of Cardiovascular Disease

Estimation of risk is the first step in cardiovascular disease prevention. In the 2018 ACC/AHA Cholesterol Guidelines, risk calculation guides initiation and intensity of therapy [75]. However, it is important for clinicians to recognize the limitations of population-based risk calculators for individual risk estimation. The 2018 Cholesterol Guideline recommends the identification of risk-enhancing factors beyond traditional cardiovascular risk factors and appropriate consideration of cardiac CT calcium scoring to reclassify risk with the goal of a more accurate and personalized assessment of risk (Table 2) [18]. Advances in genomics and biomarkers may enhance our ability to further assess risk facilitating tailored therapies. Polygenic risk scores may help identify patients at highest cardiovascular risk, even in the absence of traditional cardiovascular risk factors, who may benefit from earlier or more aggressive interventions [76, 77]. Large longitudinal studies, such as the NIH-funded *All of Us Research Program*, which is enrolling one million individuals, can collect the detailed genotypic and phenotypic data needed for this type of research [78]. Initiatives such as this will be invaluable in research and innovation moving forward to usher in an era of precision medicine with refined risk prediction and individualized targeted therapies.

4.3 Improving Partnerships and the Use of Registries

Registries offer clinicians and health systems the capability to evaluate real-world data to monitor practice patterns and trends. Use of the ACC's National Cardiac Data Registry (NCDR) and the Diabetes Collaborative Registry (tracking eight diabetes-related metrics and six either ACC/AHA-endorsed or Physician Quality

Table 2 Risk-enhancing factors in the 2018 ACC/AHA Cholesterol Guidelines

Family history of premature ASCVD (males <55 years; females <65 years)
Primary hypercholesterolemia (LDL-C 160–189 mg/dL; non-HDL-C 190–219 mg/dL)
Metabolic syndrome (three of the following: increased waist circumference, elevated triglycerides ≥150 mg/dL, elevated glucose, low HDL-C)
Chronic kidney disease
Chronic inflammatory conditions
*History of premature menopause (before 40 years) and history of pregnancy-associated conditions (*i.e., *preeclampsia)*
High-risk ethnicities (i.e., South Asian ancestry)
Elevated biomarkers (high-sensitivity C-reactive protein ≥2 mg/L; lipoprotein (a) ≥50 mg/dL or ≥ 125 nmol/L; apo B ≥130 mg/dL)
Ankle-brachial index < 0.9

Based on data from Ref. [75]
ASCVD atherosclerotic cardiovascular disease, *LDL-C* low-density lipoprotein cholesterol, *HDL-C* high-density lipoprotein cholesterol, *apoB* apolipoprotein B

Reimbursement System (PQRS) measures) can increase awareness of gaps in care and may lead to improvements in reaching these quality metrics [79, 80]. Similarly, the CASCADE FH Registry provides similar data among FH patients with the goal of improving detection and care of FH patients [62].

5 Bucket 3: Community-Wide Prevention

5.1 Public Policy

Public policy and legislation are perhaps the most powerful tools that can help promote cardiovascular health on the local and national level [81]. A key set of public policies that have an outsized impact on cardiovascular health pertains to taxation of unhealthy consumables, particularly cigarettes [81]. Previous research has shown that higher cigarette taxes are associated with a decrease in consumption, especially among young individuals [82]. Simulation experiments suggest that a 40% tax-induced increase in cigarette prices would reduce smoking prevalence from 21% in 2004 to 15.2% in 2025 [83]. This change would translate into 13 million quality-adjusted life-years gained and $682 billion in total savings [83]. In addition to cigarette taxes, banning public smoking, improving access to healthy affordable foods, taxing sugar-sweetened beverage, restricting trans-fat use, and mandating calorie counts on chain restaurant menus are important public policy avenues that can help promote cardiovascular health.

5.2 Public Health Initiatives

Several public health initiatives geared toward promoting cardiovascular health are operational at the local and national level. Among these, Million Hearts®, a national initiative co-led by the Centers for Disease Control and Prevention (CDC) and the Centers for Medicare and Medicaid Services (CMS), is one of the most ambitious. The initiative has set a goal of preventing one million heart attacks and strokes within 5 years by focusing on a small set of priorities selected for their ability to reduce heart disease, stroke, and related conditions [84]. These priorities include (1) keeping people healthy by reducing daily sodium consumption, prevalence of tobacco use, and physical inactivity; (2) optimizing care by increasing appropriate aspirin use, blood pressure control, cholesterol management, smoking cessation, and cardiac rehabilitation use; and (3) focusing on priority populations such as African Americans with hypertension, people aged 35–64 years, patients with a history of heart attack or stroke, and patients with mental or substance use disorders that consume tobacco [85]. Other publicly focused initiatives like the Let's Move campaign, AHA Go Red for Women, and National Institutes of Health's Heart Truth are focused on promoting cardiovascular health in specific populations.

5.3 Mass Media Campaigns

Mass media campaigns have the ability of promoting cardiovascular health by impacting large population segments. Smoking cessation campaigns are perhaps the best studied and have been associated with increased quitting rates among smokers [86]. Additionally, the Stanford Heart Disease Prevention Program and the Minnesota Heart Health Program were two large studies conducted focused on preventing CVD [86]. The results of these studies suggest that media campaigns can not only promote physical activity and healthy diet but also help increase CVD awareness [86].

5.4 Environmental Interventions

Environmental interventions are important methods for promoting cardiovascular health because building designs and city plans can encourage and facilitate physical activity among residents [81]. For instance, the Task Force on Community Preventive Services has observed that creating or improving access to places where physical activity is feasible results in a 25% increase in the proportion of people who are physically active at least three times a week [87]. Physical activity can be fostered through innovative land use and community design interventions to make it safe and convenient to be physically active [88]. Places for physical activity can be created or developed using existing spaces through enhanced access via shared use agreements [89]. Designing a community to support physical activity through activity-friendly routes to everyday destinations is a critical intervention in a country where over one-fourth (28%) of US adults aged 35–64 state they are not engaging in even 10 min or more of leisure-time physical activity per day [28].

5.5 School-Based Interventions

Schools can play an instrumental role in promoting cardiovascular health at an early age, as nearly 55 million American children spend a majority of their time in schools [81]. The structured framework in schools can be leveraged to provide health education and encourage children to participate in healthy activities on a daily basis. The SPARK (Sports, Play, and Active Recreation for Kids) and CATCH (Coordinated Approach To Child Health) programs are prime examples of such school-based interventions [90, 91]. In addition to promoting physical health, these programs have been shown to improve academic performance and decrease disciplinary problems [92, 93]. The programs are generally cost-effective and lead to an overall improvement in school environment.

5.6 Workplace Interventions

Employee healthcare costs are an important cause of financial strain for employers and improving employee cardiovascular health serves as a significant financial incentive. Several workplace interventions such as smoke-free zones, healthy food and beverage options, worksite wellness programs, and treadmill workstations can be helpful for promoting cardiovascular health at the workplace [94].

6 Conclusion

Improvements in health promotion and disease prevention are critical to turning the tide of rising cardiovascular mortality. Although technological and therapeutic advancements will accelerate, relying on these alone will be inadequate without addressing the main drivers of ASCVD. Despite significant challenges, there is tremendous opportunity for preventive cardiologists and cardiovascular preventive specialists to be at the forefront of new care models, important partnerships, and initiatives. Integrated strategies that encompass each of the three buckets of prevention are essential to the health of individuals and communities and to reducing the burden of cardiovascular diseases on society.

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