Chapter 1

Cardiovascular, Respiratory, and Related Disorders: Key Messages and Essential Interventions to Address Their Burden in Low- and Middle-Income Countries

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INTRODUCTION

Adults living today are most likely to die from a cardiovascular, respiratory, or related disorders (CVRDs). The World Health Organization (WHO) data for 2012 indicate that 44 percent of overall deaths and 52 percent of adult deaths globally were due to CVRDs (WHO 2012). The relative contribution of each disorder differs, but in every region except Sub-Saharan Africa, these closely related disorders are the leading causes of death.

Most of these disorders are preventable or, if they occur, can be medically treated to improve longevity and reduce disability. Optimal prevention and treatment—which require resources, certainly, but also consistent and persistent therapeutic compliance—remain a challenge even in high-income countries (HICs). Additionally, in low- and middle-income countries (LMICs), the limited capacity to detect these silent diseases and provide early treatment contributes to the rapid emergence of advanced complications and premature death.

Cardiovascular, Respiratory, and Related Disorders, volume 5 of the third edition of *Disease Control Priorities (DCP3)*, covers three of the four major noncommunicable diseases (NCDs) prioritized by the United Nations' (UN) high-level meeting on health in 2011:

- Cardiovascular diseases (ischemic heart disease and its risk factors, such as obesity, physical inactivity, tobacco use, high blood pressure and abnormal lipids, stroke, peripheral artery disease, structural heart disease, and congestive heart failure)
- Respiratory diseases
- Diabetes (United Nations 2011).

In addition, we include kidney disease as a related condition; cancers and mental health (also typically grouped among NCDs) are covered in other volumes of *DCP3* (box 1.1). These CVRDs are closely related precursors or sequelae for the others, and they share many risk factors and therefore similar prevention and control measures. Box 1.2 summarizes the key messages from *DCP3*'s volume 5 and provides a framework for systematically addressing CVRDs in LMICs. We present several evidence-based strategies for prevention of CVRDs. We also address the reality that the burden of

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Box 1.1

History of the *Disease Control Priorities* Initiative

Budgets constrain choices. Policy analysis helps decision makers achieve the greatest value from limited available resources. In 1993, the World Bank published *Disease Control Priorities in Developing Countries* (*DCP1*), an attempt to assess the cost-effectiveness (value for money) of interventions in a systematic way that would address the major sources of disease burden in low- and middle-income countries (Jamison and others 1993). The World Bank's 1993 *World Development Report* on health drew heavily on the findings in *DCP1* to conclude that specific interventions against noncommunicable diseases were cost-effective, even in environments in which substantial burdens of infection and undernutrition persisted (World Bank 1993).

DCP2, published in 2006, updated and extended *DCP1* in several respects, including explicit consideration of the implications for health systems of expanded intervention coverage (Jamison and others 2006). One way that health systems expand intervention coverage is through selected platforms that deliver interventions that require similar logistics but address heterogeneous health problems. Platforms often provide a more natural unit for investment than do individual interventions, but conventional health economics has offered little understanding of how to make choices across platforms. Analysis of the costs of packages and platforms—and the health improvements they can generate in given epidemiological environments—can help guide health system investments and development.

The third edition of *DCP* is being completed. *DCP3* differs substantively from *DCP1* and *DCP2* by extending and consolidating the concepts of platforms and packages, and by offering explicit consideration of health systems' financial risk protection objective. In populations lacking access to health insurance or prepaid care, medical expenses that are high relative to income can be impoverishing. Where incomes are low, seemingly inexpensive medical procedures can have catastrophic financial effects. *DCP3* offers an approach that explicitly includes financial protection as well as the distribution across income groups of financial and health outcomes resulting from policies (for example, public finance) to increase intervention uptake (Verguet, Laxminarayan, and Jamison 2015).

The task in all of the *DCP* volumes has been to combine the available science about interventions implemented in very specific locales and under very specific disorders with informed judgment to reach reasonable conclusions about the impact of intervention mixes in diverse environments. The broad aim of *DCP3* is to delineate essential intervention packages (such as the package for cardiovascular, respiratory, and related disorders in this volume) and their related delivery platforms. This information will assist decision makers in allocating often tightly constrained budgets so that health system objectives are maximally achieved.

DCP3's nine volumes are being published in 2015–18 in an environment in which serious discussion continues about quantifying the Sustainable Development Goal (SDG) for health (United Nations 2015). *DCP3*'s analyses are well-placed to assist in choosing the means to attain the health SDG and assessing the related costs for scaled-up action.

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many arguably preventable disorders is likely to remain high in the coming decades, and that health care systems in LMICs will need to identify viable approaches to treat them. Furthermore, implementing treatment strategies for the aforementioned diseases prevents downstream, highly morbid complications such as heart failure, blindness, or end-stage kidney disease as well as premature mortality among those with preexisting disorders.

In this review, we discuss the overarching burden of CVRDs, including reasons why LMICs face disproportionately high premature mortality. We summarize the

Box 1.2

Key Messages Regarding Cardiovascular, Respiratory, and Related Disorders

1. ***Adults living in low- and middle-income countries (LMICs) face high risk for death, disability, and impoverishment from cardiovascular, respiratory, and related disorders (CVRDs).*** The world is experiencing an increase in the number of deaths from CVRDs at least partly because of population growth and aging (Roth and others 2015). Nearly 80 percent of these deaths occur in LMICs. Furthermore, 39 percent of the CVRD deaths in LMICs occur prematurely—at younger than age 70 years—compared to 22 percent in high-income countries (HICs). In 2015, the United Nations General Assembly agreed to an array of development goals, including a target to reduce premature mortality from NCDs by one-third by 2030 (United Nations 2015). The world is not on track to achieve that goal because premature deaths from CVRDs are declining only very slowly.

   Therefore, stronger actions are needed to combat CVRDs, especially in LMICs. Residents of LMICs have not benefited from the astonishing advances in preventing and treating cardiovascular disease—by far the most common cause of death among CVRDs—seen in HICs. In a woman with cardiovascular disease, the annual risk of death attributable to cardiovascular disease is twofold higher if she lives in a LMIC than if she lives in a HIC (Yusuf and others 2014). Should she require hospitalization for a stroke or myocardial infarction, she bears a one-in-two chance that out-of-pocket payments for her health care will push her family into poverty (Huffman and others 2011).

2. ***Effective prevention strategies are underutilized.*** High- and upper-middle income countries have reduced age-standardized mortality resulting from cardiovascular disease by more than 25 percent since 2000 (WHO 2012), largely by using policy interventions to reduce risk-factor levels, strengthening the health system at the primary care level, and improving acute care with attention to early initiation of treatment. Policies aimed at reducing population-wide risk factors, such as high taxation of tobacco, reduction of salt in processed foods, or bans on trans fatty acids (trans fats), are effective but have not been widely adopted in LMICs. Targets related to individual-level risk factors (for example, reducing obesity and improving physical activity) are harder to achieve; however, when achieved sustainably, these targets improve health in multiple domains.

3. ***Primary care centers require strengthening to treat the current and growing burden of CVRDs.*** Medications crucial for individual-level treatment (such as diuretics for hypertension, and metformin or insulin for diabetes) also have long positive track records for efficacy; however, to improve their uptake, innovation is needed with respect to their affordability and delivery in high-volume, resource-poor health systems. Most of the disease-specific interventions recommended in this volume should be delivered in primary care centers because (a) CVRD management requires long-term follow-up and (b) many interventions use medications that can be prescribed and titrated best in primary care centers. Specific needs to shore up this care platform include training primary or non-physician health care providers in the management and follow-up of CVRDs, ensuring availability of inexpensive, generic, or combination drugs in clinics, and creating culturally viable strategies to improve patient adherence. These approaches are being evaluated worldwide and include shifting and sharing tasks with nonphysician health providers and traditional healers (such as village doctors in China and Ayush practitioners in India) and new health platforms to improve access (such as mobile health [mHealth] and telemedicine).

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Box 1.2 (continued)

4. ***Cost-effective prevention policies and treatments for CVRDs are possible to implement in LMICs.*** Because of lower estimated costs, population-level policies to prevent and control CVRDs are generally more affordable than treatments. However, many cost-effective treatment interventions exist that can be delivered at primary care or referral-level hospitals. Evidence for cost-effective CVRD treatment approaches has increased since *Disease Control Priorities in Developing Countries,* second edition, was published in 2006. Yet evidence gaps remain; the need still exists to generalize many findings from middle- and high-income countries to estimate the potential cost-effectiveness of highly effective individual-level treatments (such as secondary prevention) for which coverage is low and technologies are not available in many low-income countries.
5. ***Universal health care that includes care for CVRDs provides benefits beyond individual health to financial protection of families.*** The household financial burden is particularly relevant in economic analyses related to the disorders covered in this volume, many of which are costly even if cost-effective and often are not part of publicly financed health services. On a value-for-health basis, CVRD interventions—particularly ones that incur ongoing, long-term costs (inhalers for asthma)—are expensive. However, many of the afflicted adults are wage earners, and investing in primary prevention can avert significant disability and acute care costs; the potential to improve economic productivity and avert poverty is clear and large.

effectiveness and cost-effectiveness evidence and propose 36 essential interventions (see tables 1.1 and 1.2) that are feasible for LMICs to pursue that can either reduce the incidence of new disease or delay complications among persons who have developed CVRDs. We also present estimates of the cost of this package in typical low- and lower-middle-income country settings and discuss various aspects of package implementation.

HIGH RISK FOR DEATH, DISABILITY, AND IMPOVERISHMENT

The world's population is aging. Persons older than age 65 years now constitute 10 percent of the world's population and are expected to constitute more than 15 percent by 2030, whereas for most of the twentieth century, 5 percent or fewer persons reached age 65 years (WHO 2011b). Combined with population growth, population aging has led to an overall increase in the number of persons dying from CVRDs, because, although the propensity for these diseases may start *in utero*, their substantive effects are seen in adulthood. From 2000 to 2012, the absolute number of deaths from CVRDs increased 16 percent globally (figure 1.1), although the age-standardized mortality rate for most disorders is declining (WHO 2012).

However, with implementation of population-level risk-reduction measures and advances in acute and chronic care, age-specific mortality has declined to the extent that it counterbalances the absolute increase in number of deaths from population growth and aging (Roth and others 2015; WHO 2012). Thus, age-standardized mortality rates for cardiovascular diseases (CVDs) and respiratory diseases are declining, whereas rates for diabetes and kidney diseases (including kidney disease that is due to diabetes) are unchanged or increasing (Roth and others 2015). In comparison with HICs, LMICs have experienced smaller declines; therefore, inequalities in outcomes are worsening (see annex 1A). For CVD—by far the most common cause of death among the CVRDs—the decline has ranged from 5 percent in low-income countries to 19 percent in upper-middle-income countries versus 28 percent in HICs (figure 1.2). Absolute rates of morbidity and premature mortality, captured in the summary metric of disability-adjusted life-years (DALYs), are increasing rapidly in the poorest regions. From 2000 through 2015, DALYs from CVD and diabetes increased 33 and 72 percent, respectively, in South Asia and 26 and 56 percent, respectively, in Sub-Saharan Africa (GBD 2015 DALYs and HALE Collaborators 2016).

On an individual level, where a person with CVD lives predicts his or her risk for death (Yusuf and others 2014) as strongly as if he or she were overweight (Manson and others 1995) or had hypertension (van den Hoogen and others 2000) (figure 1.3). Residence in a LMIC also predicts higher likelihood of a serious

Table 1.1 Essential Package of Interventions: Interventions Targeted Toward the Prevention or Management of Shared Risk Factors for Cardiovascular and Respiratory Disease

				Personal health services, by delivery platform			
Condition	**Fiscal interventions**	**Intersectoral interventions**	**Public health interventions**	**Community based**	**Primary health center**	**First-level hospital**	**Referral and specialized hospitals**
All conditions	1. Large excise taxes on tobacco products[a] 2. Product taxes on sugar-sweetened beverages	3. Improvements to the built environment to encourage physical activity[b] 4. School-based programs to improve nutrition and encourage physical activity **5. Regulations on advertising and labeling tobacco products** **6. Actions to reduce salt content in manufactured food products** **7. Ban on trans fatty acids**	8. Nutritional supplementation for women of reproductive age[c] 9. Use of mass media concerning harms of specific unhealthy foods and tobacco products	10. Use of community health workers to screen for CVRD using non-lab-based tools for overall CVD risk, improving adherence, and referral to primary health centers for continued medical management	11. Opportunistic screening for hypertension for all adults[d] **12. Screening for diabetes in all high-risk adults,[e] including pregnant women** 13. Combination therapy[f] for persons with multiple risk factors to reduce risk of CVD	14. Tobacco cessation counseling and use of nicotine replacement therapy in certain circumstances	—

Note: Red type denotes urgent care; blue type denotes continuing care; black type denotes routine care. — = none; CVRD = cardiovascular and respiratory disease; CVD = cardiovascular disease; ACEi = angiotensin-converting-enzyme inhibitors.

a. For fiscal and intersectoral policies that address CVRD attributable to indoor and outdoor sources of air pollution, see chapter 1 of *DCP3* volume 7.

b. Data are from high-income countries only.

c. Aimed at preventing gestational diabetes and low birthweight.

d. Treatment with generic drugs is recommended, guided by the severity of hypertension or the presence of additional risk factors.

e. High risk is typically defined as individuals who are older, have high blood pressure, or are overweight or obese (as measured for example by waist circumference).

f. Where available, fixed dose combination therapy is preferred.

Table 1.2 Essential Package of Interventions: Disease-Specific Interventions

			Personal health services, by delivery platform		
Disease condition	**Fiscal, intersectoral, and public health interventions**	**Community based**	**Primary health center**	**First-level hospital**	**Referral and specialized hospitals**
Ischemic heart disease, stroke, and peripheral artery disease[a]	—	—	**15. Long-term management with aspirin, beta-blockers,[a] ACEi, and statins (as indicated) to reduce risk of further events** **16. Use of aspirin in all cases of suspected myocardial infarction**	17. Use of unfractionated heparin, aspirin, and generic thrombolytics in acute coronary events 18. Management for acute critical limb ischemia with unfractionated heparin and revascularization if available, with amputation as a last resort	19. Use of percutaneous coronary intervention for acute myocardial infarction where resources permit
Heart failure	—	—	**20. Medical management with diuretics, beta-blockers,[b] ACEi,[b] and mineralocorticoid antagonists[b,c]**	21. Medical management of acute heart failure	—
	22. Mixed vertical-horizontal insecticide spray programs to prevent Chagas disease	—	**23. Treatment of acute pharyngitis (children) to prevent rheumatic fever[d]** **24. Secondary prophylaxis with penicillin for rheumatic fever or established rheumatic heart disease**	—	—
Diabetes	—	25. Diabetes self-management education	**26. Prevention of long-term complications of diabetes through blood pressure, lipid, and glucose management as well as consistent foot care** 27. Screening and treatment for albuminuria	—	28. Retinopathy screening via telemedicine, followed by treatment using laser photocoagulation

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Table 1.2 Essential Package of Interventions: Disease-Specific Interventions (continued)

		Personal health services, by delivery platform			
Disease condition	**Fiscal, intersectoral, and public health interventions**	**Community based**	**Primary health center**	**First-level hospital**	**Referral and specialized hospitals**
Kidney disease	29. If transplantation available, creation of deceased donor programs[c]	—	30. Treatment of hypertension in kidney disease, with use of ACEi or ARBs in albuminuric kidney disease[c]	—	—
Respiratory disease	—	31. Self-management for obstructive lung disease to promote early recognition and treatment of exacerbations 32. Exercise-based pulmonary rehabilitation for patients with obstructive lung disease	33. Annual flu vaccination and five-yearly pneumococcal vaccine for patients with underlying lung disease **34. Low-dose inhaled corticosteroids and bronchodilators for asthma and for selected patients with COPD[e]**	35. Management of acute exacerbations of asthma and COPD using systemic steroids, inhaled beta-agonists, and, if indicated, oral antibiotics and oxygen therapy	36. Management of acute ventilatory failure due to acute exacerbations of asthma and COPD; in COPD, use of bilevel positive airway pressure preferred

Note: Red type denotes urgent care; blue type denotes continuing care; black type denotes routine care. — = none; ACEi = angiotensin-converting enzyme inhibitors; ARB = angiotensin receptor blocker; COPD = chronic obstructive pulmonary disease.

a. Not applicable to peripheral artery disease.

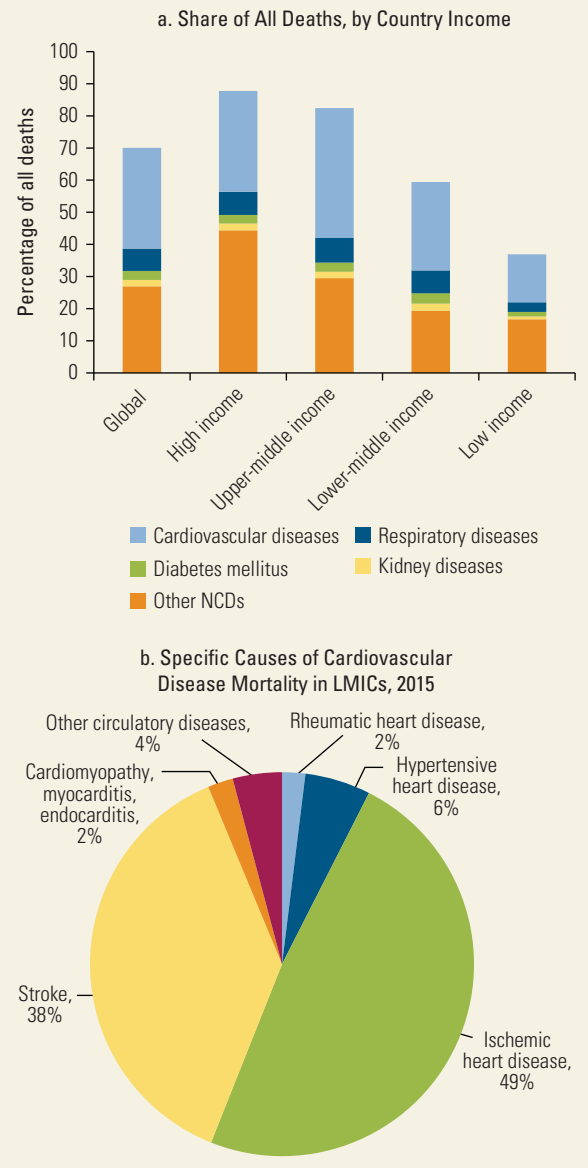
b. Applicable to heart failure with reduced ejection fraction.

c. Data from high-income countries only.

d. Use available treatment algorithms to determine appropriate antibiotic use.

e. Inhaled corticosteroids are indicated in patients with COPD who have severe disease or frequent exacerbations.

Figure 1.1 Share of All Deaths Caused by Cardiovascular, Respiratory, and Related Disorders, and Other Noncommunicable Diseases, by Country Income, 2015



Source: WHO 2016.
Note: NCDs = noncommunicable diseases.

Figure 1.2 Trends in Age-Standardized Mortality Rates from Cardiovascular Disease for Both Genders, by Country Income Group, 2000–15

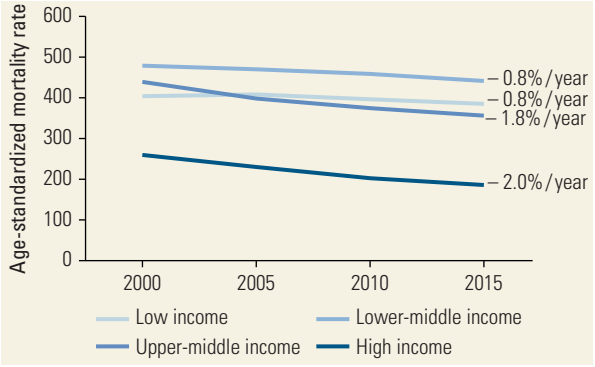
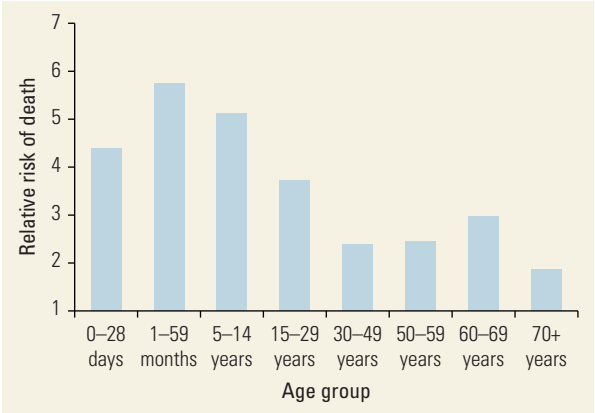


Figure 1.3 Relative Risk for Mortality from Cardiovascular and Respiratory Disease in LMICs versus HICs, by Age Group, 2015



Note: LMIC = low- and middle-income country; HIC = high-income country.

event—for example, myocardial infarction (Yusuf and others 2004) or stroke (Sposato and Saposnik 2012)—at a younger age than in HICs. Acute hospitalizations are expensive and dramatically increase the likelihood of families' falling into poverty (Jaspers and others 2015). More than half of the persons hospitalized for stroke, myocardial infarction, or peripheral artery disease in China, India, or Tanzania experienced catastrophic health spending in the process of receiving care (Huffman and others 2011). Even without acute complications, paying for routine use of generic medications such as atenolol in the Philippines would impoverish more than 5 percent of the population—and more than 20 percent of the population if brand-name atenolol were used (Niens and others 2010).

Why have LMICs not benefited from advances in CVRD prevention and care? The reasons are many and vary by region, but here we highlight the following: (a) the lack of population-wide strategies to tackle behavioral risk factors, (b) missed opportunities to identify and treat disease in early stages, and (c) inability to provide quality care for advanced complications.

Lack of Population-Wide Strategies to Tackle Behavioral Risk Factors

The attention focused on poor diet, obesity, physical inactivity, and tobacco use through population-wide and

individual-level strategies has contributed at least partly to the substantial decline in CVRD mortality in HICs. In contrast, LMICs are experiencing a growing burden of these major behavioral risk factors for the development and progression of CVRDs. For example, most HICs have enacted strict restrictions on public smoking and on advertisements of tobacco products, and they have levied heavy taxes on tobacco consumption. When more than 170 countries signed onto the WHO Framework Convention on Tobacco Control in 2005, optimism grew for a tobacco-free world (Britton 2015). Since that time, the WHO has set a target of reducing the prevalence of smoking by 30 percent by 2025. However, most LMICs are unlikely to meet that goal; the overall number of smokers is growing, and many of the strong evidence-based recommendations of the framework (including taxation, advertising bans, pictorial warnings, and smoking cessation assistance), which are described in the WHO MPOWER package, have not been universally implemented (Bilano and others 2015). Of all tobacco interventions, taxation is the single most effective method of averting tobacco-attributable CVRDs (Jha and Peto 2014). As shown in an extended cost-effectiveness analysis based in China (Verguet, Gauvreau, and others 2015), taxation also provides financial risk protection for low-income families living in LMICs, answering concerns about the potential for a regressive tax on the poor. Yet, tobacco taxes represent less than 40 percent of the average price of cigarettes in LICs, compared with more than 60 percent in HICs, such that cigarettes are relatively more affordable in LMICs and will become even more affordable over time in the absence of drastic price increases (WHO 2010b).

Poor diet, obesity, and physical inactivity are three interlinked risk factors that, when addressed early in life, can lead to lifelong protection from CVRDs in many cases. Based on current trends, the contribution of these risk factors to death and disability is likely to grow in LMICs and diminish in HICs. All countries have experienced a decline in occupation-related physical activity, but leisure-time physical activity is increasing in HICs (Hallal and others 2012). Over the past three decades, deaths attributable to physical inactivity declined 15 percent in HICs but rose 25 percent in LMICs (Institute for Health Metrics and Evaluation [IHME] 2013). In HICs, many stakeholders are working to encourage physical activity: city governments are creating pedestrian plazas, health care organizations are incorporating physical activity assessments in clinic visits, and employers are offering at-work exercise classes (Heath and others 2012). The rapid and haphazard growth of urban metropolises in LMICs, in contrast, impedes the implementation of cost-effective opportunities for physical activity, such as the preservation of safe, traffic-free space for walking or recreation (Laine and others 2014).

Missed Opportunities to Treat CVRDs in Early Stages

One of the first missed opportunities occurs when a lack of effective care exists for sufferers of an acute event such as myocardial infarction or stroke. Timely emergency response with common, relatively inexpensive medications can save a life until diagnosis and treatment are available. Although optimal treatment for a myocardial infarction requires immediate transport to a health care center, an electrocardiogram, and blood work for proper diagnosis, such response is not always possible in remote locations. Nonetheless, if basic medications such as aspirin and beta-blockers are available and practitioners are empowered to use them appropriately, they can be delivered in a timely and cost-effective fashion at the level of primary care health centers prior to transfer to hospitals (Gaziano 2005).

A second missed opportunity is the failure to provide effective management of hypertension and diabetes; such management can prevent complications such as ischemic heart disease, stroke, peripheral artery disease, retinopathy, and chronic kidney disease. The early use of inhaled corticosteroids decreases frequency of serious attacks, even for those with mild persistent asthma (Pauwels and others 2003). Medications required to treat these disorders overlap across many CVRDs. For example, statins can reduce the risk of first-time and recurrent strokes or myocardial infarctions on average by 21 percent (Collins and others 2016). Aggressive lowering of blood pressure affords a similar degree of protection for heart failure, acute coronary events, and strokes (Wright and others 2015).

The use of these therapies, however, remains dismally low. In a multi-country cross-sectional study of hypertension awareness and control, 49 percent of patients in HICs were aware of their hypertension, compared to 31 percent in LICs; 47 percent of those with hypertension in HICs were treated, compared to 32 percent in LICs (Chow and others 2013). The use of effective therapy in lower-income countries was even lower for those at greatest risk. Since the 2003 Doha Declaration on the Trade-Related Aspects of Intellectual Property Rights Agreement and Public Health, generic cardiovascular medications constitute more than 70 percent of the market in many LMICs (Kaplan, Wirtz, and Stephens 2013). Yet affordability remains a key issue, with large swings in cost even within the same class of drugs (Ait-Khaled and others 2000). Although the WHO Model List of Essential Medicines attempts to focus resources on selected effective and cost-effective medications, conflicting

incentives for physicians lead to highly variable prescribing patterns that can increase costs without clear health benefits. One prominent example is the heavier provider reliance on insulin analogs over the cheaper nonanalog form in Brazil, Mexico, and República Bolivariana de Venezuela (Cohen and Carter 2010).

Even if sequelae develop, optimizing their treatment can further delay progression along the disease spectrum to heart failure, limb amputation, blindness, or end-stage kidney disease. Here we note an even larger gap in care provision between HICs and LMICs: fewer than 10 percent of patients in LICs and fewer than 25 percent in lower-middle-income countries take beta-blockers, angiotensin-converting enzyme (ACE) inhibitors, or statins after a myocardial infarction or stroke (Yusuf and others 2011).

Inability to Care for Advanced Complications

Finally, once end-organ damage develops, facilities for caring for advanced conditions are scarce and, when available, have few incentives to ensure high-quality care. The need for specialists or specialized equipment means that some of the advanced conditions covered in this volume (such as heart failure, structural heart disease, and end-stage kidney disease) are expensive to treat. Many middle-income countries and some LICs do have facilities but are not able to take on the large number of persons requiring treatment as a result of either resource scarcity, patient-level financial constraints, or both. In the case of end-stage kidney disease, hemodialysis facilities exist in a majority of countries in the world, but fewer than one-fourth of persons expected to reach end-stage kidney disease annually are able to access therapy (Anand, Bitton, and Gaziano 2013; Liyanage and others 2015). Even for persons who are able to pay for the costly therapy, little to no oversight of the quality of care delivered exists. For example, in a survey of six hemodialysis centers in Lagos, Nigeria, none met accepted standards for microbial decontamination (Braimoh and others 2014). An analysis of patients with rheumatic or congenital heart disease reported that two-thirds of surgical candidates in Uganda did not have access to treatment, and 18 percent died while on the waiting list for surgery (Grimaldi and others 2014). Among those who underwent open-heart surgery, postoperative mortality and loss to follow-up rates were high (19 percent and 22 percent, respectively).

Thus, even as the burden of risk factors for CVRDs increases in LMICs, strategies and facilities to care for persons with these diseases are too rarely available. Evidence also indicates that without oversight, scarce resources are sometimes unnecessarily expended on expensive treatments while cost-effective alternatives go underused (Sakuma, Glassman, and Vaca 2017).

COSTS AND COST-EFFECTIVENESS OF PREVENTION AND TREATMENT INTERVENTIONS FOR CVRDS

We reviewed the costs and cost-effectiveness of various CVRD clinical interventions and policies with the goal of creating a suggested package of interventions that LMICs could adopt to address CVRDs (Gaziano and others 2017). We performed a review of the published literature on the costs of providing preventive care and treatment for cardiovascular and metabolic diseases in LMICs (Brouwer and others 2015), as well as the cost-effectiveness of CVRD interventions in LMICs. We extracted cost and cost-effectiveness data from English-language literature published after 2000 through a bibliometric search, adjusted all reported results to the same currency and year, and ranked the cost and cost-effectiveness outcomes (Gaziano and others 2017). Where necessary to assess priority interventions when evidence from LMICs was lacking, we refer to evidence from HICs. Box 1.3 summarizes use of economic evaluation in *DCP3*.

Overall affordability of individual interventions is an important consideration for country decision making. We found that interventions to prevent and treat conditions at early stages were much less expensive than interventions to treat diseases at advanced stages. Prevention interventions at the population and community levels were the cheapest (less than US$1 per capita in 2012 U.S. dollars), while treatment of end-stage kidney disease was among the most expensive (Gaziano and others 2017). However, affordability is only one measure for policy makers to consider. Preventive treatments or health promotion activities may not have the same efficacy on an individual basis as, for example, appropriate treatment of acute myocardial infarction. Between both population and individual measures, and preventive and treatment measures, policy makers should scrutinize which have the best evidence for being both effective and cost-effective.

Some fairly recent systematic reviews have taken stock of the evidence of cost-effectiveness of interventions to tackle CVD in LMICs specifically (Shroufi and others 2013; Suhrcke, Boluarte, and Niessen 2012). These reviews showed that, while the cost-effectiveness evidence on CVD interventions in LMICs remains modest in comparison to the evidence in HICs, it has been growing. The reviews also noted that a

Box 1.3

Economic Evaluation of Investments in Cardiovascular, Respiratory, and Related Disorder Control

Economic evaluations aim to inform decision making by quantifying the trade-offs between resource inputs required for alternative investments and the resulting outcomes. Four approaches to economic evaluation in health are the following:

- Assessing how much of a *specific health outcome*, such as myocardial infarctions averted, can be attained for a given level of resource input;
- Assessing how much of an *aggregate measure of health*, such as deaths or disability adjusted life years [DALYs], can be attained from a given level of resource inputs applied to alternative interventions. This approach—cost-effectiveness analysis (CEA)—enables comparisons of interventions addressing many different health outcomes (for example, heart disease treatment versus tobacco tax);
- Assessing how much health and financial risk protection can be attained for a given level of public sector finance of a given intervention. This approach, extended CEAs or extended cost-effectiveness analyses (ECEAs), enables assessment not only of efficiency in improving the health of a population but also of efficiency in achieving the other major goal of a health system—protecting the population from financial risk;
- Assessing the *economic benefits*, measured in monetary terms, from investment in a health intervention and weighing that benefit against its cost (benefit-cost analysis [BCA)]. BCA enables comparison of the attractiveness of health investments relative to those in other sectors.

CEAs predominate among economic evaluations in surgery (and for health interventions more generally). Recent overviews of CEA findings for cardiovascular, respiratory, and related disorders (CVRDs) underpin this chapter's conclusion that many CVRD policies and interventions are highly cost-effective even in resource-constrained environments (also see PAHO/*DCP3* companion volume (Alkire, Vincent, and Meara 2015; Chao and others 2014; Legetic and others 2016; Prinja and others 2015; Shroufi and others 2013; Suhrcke, Boluarte, and Niessen 2012). Chapter 19 of *DCP3* Volume 5 also looks at the cost-effectiveness of CVRD interventions (Gaziano and others 2017).

The *Lancet* Commission on Investing in Health applied BCA to broad investments in health and found benefit-cost ratios often in excess of 10 (Jamison and others 2013). Copenhagen Consensus for 2012 used BCAs to rank selected CVRD interventions among the top 15 in a list of 30 attractive priorities for investment in development across all sectors (Kydland and others 2013).

ECEAs remain a relatively new evaluation approach. In chapter 20 of this volume, Watkins and coauthors apply ECEA to several CVRD interventions in different settings and find substantial financial protection benefits (Watkins, Nugent, and Verguet 2017).

substantially larger number of publications assess pharmaceutical interventions, compared with population-level interventions.

Among the most cost-effective ways to reduce CVRD mortality are prevention-oriented *population* policies. The leading types of population policies involve tobacco control, including public smoking bans that are cost-saving/highly cost-effective; for example, taxation that is cost-saving (Vietnam) and highly cost-effective (US$140 per DALY) (Mexico); public smoking bans that cost US$2.4 to US$136 per life-year saved (India); advertising bans that cost US$2,800 per DALY averted (Mexico); and mass media campaigns that range from cost saving to US$3,200 per DALY averted (Gaziano and others 2017). Evidence is growing for the cost-effectiveness of sugar-sweetened beverage (SSB) taxes but is still inconclusive as to the health effects (Colchero and others 2016; Nakhimovsky

and others 2016). The strongest evidence to date comes from Mexico, where an SSB tax reduced consumption of sugary beverages and increased water consumption, especially among the poor (Colchero and others 2016). Longer-term data on changes in obesity, diabetes, and other CVRDs have not yet been reported. Population-level salt reduction strategies range from cost saving (Argentina) to up to US$15,000 per life-year gained (Gaziano and others 2017). Salt reformulation by the food industry appears to be the most cost-effective approach, and salt reduction campaigns to promote health are the least cost-effective (Gaziano and others 2017).

Many important disease prevention or health promotion programs have not been assessed for cost-effectiveness, especially as they might apply to LMICs. Increasing physical activity can, in principle, reduce mortality and improve population health. Governments in many countries have recognized this opportunity, but the evidence on what works best to promote physical activity, let alone what is the best value for the money, remains scarce and largely concentrated on HICs (Ding and others 2016). A study from China shows that combining physical activity with a nutrition program is more effective than either intervention alone (Meng and others 2013), while a review by Laine and others (2014) found that the most efficient interventions to increase physical activity were community rail-trails (US$0.006 per metabolic equivalent hours [MET-h]), pedometers (US$0.014 per MET-h), and school health education programs (US$0.056 per MET-h). How generalizable these findings are to LMIC contexts is unclear.

Screening and pharmacological treatment of hypertension to prevent stroke and ischemic heart disease have been shown to range from cost saving (China) to cost-effective at US$700–US$5,000 per DALY averted or quality-adjusted life year (QALY) gained in South Africa and Argentina (Gaziano and others 2017). Cost-effectiveness of strategies using lipid-lowering therapies have had slightly higher ratios, ranging from as low as US$1,200 per QALY in most large LMICs when part of a multidrug regimen to as much as US$22,000 per DALY in the Philippines (Gaziano and others 2017). The range in cost-effectiveness is wider because the number of generic statins is more limited than the number of blood pressure medications. With more statins coming off patent, the price of statins has dropped, and lipid-lowering therapy is becoming more cost-effective.

Opportunistic screening for prediabetes and diabetes in a high-risk population is more cost-effective than screening for diabetes alone, since prevention of diabetes among those with prediabetes is highly cost-effective or cost saving (Ali and others 2017). Once diagnosed, structured diabetes self-management education programs are cost-effective (Diaz de Leon-Castaneda and others 2012), but self-monitoring of blood glucose among persons not on insulin or an oral hypoglycemic is not (Ali and others 2017). One randomized controlled trial from a HIC supports comprehensive management (for example, attention to blood glucose, blood pressure, and lipids) as being cost-effective (Gaede and others 2008). Similarly, another large randomized trial conducted in India and Pakistan supports comprehensive management delivered through care coordinators enabled with an electronic decision support system (Ali and others 2016). Evidence from both HIC and LMIC settings supports screening for complications of diabetes once diagnosed; screening for foot ulcers is among the most cost-effective (Habib and others 2010). A study in India (Rachapelle and others 2013) suggests that screening for retinopathy via telemedicine ranges from US$1,200 to US$2,400 per QALY gained.

Management of acute ischemic heart disease and stroke can be divided into the prehospital phase and the hospital phase. Prehospital phase management requires an established emergency transport system with trained staff and equipment. When available, prehospital thrombolysis was shown to be cost saving. The use of electrocardiogram machines in primary health centers to triage patients appropriately was shown to be cost-effective in India at US$12 per QALY gained (Gaziano and others 2017). The use of aspirin and beta-blockers is about US$10–US$20 per DALY averted. Streptokinase costs about US$700 per QALY gained, and the use of more fibrin-specific thrombolytics (such as tissue plasminogen activators) costs about US$15,000 per QALY. More advanced treatment includes the use of percutaneous coronary interventions (PCIs), including stents. In China, the availability of PCIs or streptokinase for acute myocardial infarction costs between US$9,000 and US$25,000 per QALY gained. Management of persons undergoing PCI with antiplatelet agents such as prasugrel and clopidogrel is also cost-effective in advanced centers where PCI is conducted. Data on cost-effectiveness of acute ischemic stroke management with a thrombolytic agent are sparse in LMICs, but one study recommends home-based rehabilitation (Sritipsukho and others 2010).

Management of heart failure with oral agents such as ACE inhibitors, beta-blockers, and aldosterone antagonists is cost saving or highly cost-effective (Gaziano and others 2017). Advanced therapy with implantable defibrillators and resynchronization therapy could be cost-effective in advanced centers in middle-income countries, with cost-effectiveness ratios of US$17,000–US$35,000 per QALY gained. The use of low-dose inhaled corticosteroids for mild asthma is an attractive

intervention, as it addresses a large disease burden and is cost-effective in lower-middle-income countries (Gaziano and others 2017).

Acknowledging that cost- and cost-effectiveness data rarely translate directly across settings and that each country would need to individually assess its disease burdens and priorities (box 1.3), our review of cost-effectiveness has identified multiple cost-effective and even cost-saving interventions for CVRDs in LMICs, particularly for population-level interventions. Many highly effective clinical interventions—for example, treatment of hypertension or hyperlipidemia—are also cost-effective in some LMICs, whereas others requiring greater technology and specialized care are only cost-effective in MICs.

PATHWAYS TO ADDRESSING CVRDS IN LMICS

After the 2011 UN General Assembly high-level meeting on NCDs highlighted the growing and detrimental impact of NCDs on the health and wealth of nations, the WHO produced a Global Action Plan for the Prevention and Control of NCDs (WHO 2013). Of the eight voluntary targets set to help countries reduce NCD mortality, six focus on prevention and highlight interventions that improve diet and reduce smoking, obesity, and physical inactivity, helping individuals to live longer, healthier lives. To assist countries in meeting those targets, we offer here a set of policies and interventions that form an essential package of prevention actions, primarily delivered at the population level (table 1.1). Further, acknowledging the reality that LMICs continue to struggle with a spectrum of early to advanced cases of these diseases, we propose a set of disease-specific individual-level services appropriate for low-resource settings (table 1.2). These policies and interventions were selected from those deemed most effective and cost-effective by *DCP3* Volume 5 chapter author teams, each using a literature review combined with expert judgment to prioritize among those with the strongest evidence. Interventions included in the essential package were shown to be cost-effective in at least one LMIC setting, or had strong evidence to suggest LMIC cost-effectiveness. This essential package goes beyond the WHO NCD "best buys" (WHO 2011a), but it has a high degree of overlap with priority interventions in the recent revision of appendix 3 of the WHO Global Action Plan (WHO 2013).

Individually and collectively, the 36 actions contained in the essential package can address a large portion of the health burden of these diseases, are proven to be effective, and are expected to be feasible to implement in low-resource settings. Cost-effectiveness is suggested, either by studies from low-income settings or reasonable extrapolation of existing estimates from well-resourced settings. The essential package of recommended interventions is organized by delivery level (or platform).

While all of the interventions in the essential package meet these criteria, not every country can or should implement all of them, and some countries will take years to build a health system that can implement even some of them. As countries expand and scale up their health benefits, the highest-priority interventions are controlling tobacco consumption (especially through tobacco taxation); improving dietary intake; and (when a health system has the capacity to support it) preventing or treating hypertension and promoting health. In addition, LICs with high disease burden (such as Sub-Saharan African countries) may want to consider starting with a suite of cost-effective interventions for endemic CVRDs such as rheumatic heart disease, chronic kidney disease, chronic obstructive pulmonary disease, and heart failure resulting from nonischemic etiologies. The menu chosen must be appropriate for a country's disease burden and feasible given its health system capacity.

Effective Prevention Strategies for Most CVRDs

Effective prevention strategies are available but underutilized. Table 1.1 offers a set of high-priority disease prevention policies that, when implemented effectively, reduce the multiple risk factors of CVRDs. Implementing these actions creates an environment that encourages healthy behavior and reduces involuntary exposure to CVRD risk. Multiple agencies, both public and private, are responsible for establishing this environment.

Fiscal policies are among the most effective and affordable actions that governments can take to create a healthy environment. Tobacco taxation is the best example of a fiscal policy to reduce CVRD risk, with strong evidence from multiple countries (Shibuya and others 2003). Other fiscal policies are being tested in models and in initial LMIC experiences and show promise for improving diet. Recently, taxation on SSBs is gaining steam as a potential deterrent of obesity (Colchero and others 2016; Falbe and others 2016). Another fiscal policy to reduce CVRD risk is subsidizing fruits and vegetables to increase their consumption. When Cecchini and colleagues (Cecchini and others 2010) modeled the subsidy's effects on preventing NCDs (in combination with taxing high-fat food) using a framework jointly developed by the Organisation for Economic Co-Operation and Development and the WHO, they found it to be cost saving in all six LMICs under consideration. This approach

lacks broad real-world evidence and therefore was not included in the current iteration of the essential package, but it could be strongly considered if a country is focusing intensively on dietary risk factors for CVRDs.

Policies that are not fiscal (such as regulations to reduce salt or tobacco consumption via labeling or bans on advertisements) can also encourage healthy consumer choices. In the United Kingdom, foods labeled as high in salt saw a marked decline in consumption when coupled with an aggressive public education campaign (Webster and others 2011). In the case of partially hydrogenated oils—the processed form of trans fatty acids (trans fats)—the strength of the data demonstrating improvements in "hard health outcomes" (for example, cardiovascular mortality) warrants bans or mandatory elimination of trans fats from the food supply chain (Restrepo and Rieger 2016).

Health promotion activities aimed at improving risk factors on a population level may have similar effect sizes to fiscal policies but generally require more planning or resources to implement. Mass media health campaigns to improve diet are effective when they offer specific actionable health messages such as increasing fruit and vegetable intake (Afshin and others 2017). Once a country commits to one aspect of the approach, other strategies can be layered on with less additional cost. Cities in Brazil and Colombia committed to providing pedestrian plazas and safe areas for physical activity, allowing them also to offer community exercise classes (Bull and others 2017). Similarly, school-based programs to promote physical activity (but not necessarily weight management) are cost-effective (Malik and Hu 2017); if implemented, however, these programs could include components addressing nutrition as well as physical activity.

Across many of the CVRD health endpoints, establishing absolute risk is a critical first step—both for matching the intensity of prevention effort to the level of risk and for efficient targeting of health system resources. Having community health workers (CHWs) use noninvasive methods to screen for many CVRDs is generally feasible (Gaziano, Abrahams-Gessel, Surka, and others 2015). The most recent data demonstrate that well-trained CHWs can deliver lifestyle modification advice (Jafar and others 2010), can identify high-risk individuals with similar effectiveness as primary care physicians (Falbe and others 2016), can be cost-effective in helping patients adhere to hypertension regimens (Cecchini and others 2010), and can be trained to use mHealth tools effectively (Ajay and others 2016; Gaziano, Abrahams-Gessel, Denman, and others 2015; Gaziano, Abrahams-Gessel, Surka, and others 2015). However, exactly what role these CHWs should play remains unclear: screening, follow-up, medication prescription, or a component of all of these. Integrating CHWs into the existing health care infrastructure also is a challenge, as their effectiveness depends on their ability to triage the diagnosed cases to appropriate levels of care and to ensure the delivery of medication.

Opportunistic screening for diabetes and hypertension using more sensitive techniques can be done in clinics, especially for higher-risk populations such as pregnant women, obese adults, and persons with multiple risk factors. Generic therapy for preventing secondary diseases is on the WHO's Model List of Essential Medicines and could be made reliably available in primary health settings. Therapy in combination (for example, fixed-dose combinations) or with individual drugs targeting multiple risk factors is especially attractive for high-volume health systems with limited resources for personalization and titration (Gaziano and Pagidipati 2013; Lonn and Yusuf 2009). Data support the use of fixed-dose combinations in secondary prevention, but we await an assessment of their effectiveness in primary prevention. With the widespread availability of drug and disease management algorithms, follow-up and titration of medications may again be possible via CHWs, accompanied by broader prescribing rights, but otherwise should be managed by primary providers (including CHWs, who could be given prescription rights for selected CVRD drugs), rather than specialized physicians. Very few of the essential preventive interventions need to be delivered at first-level hospitals or in more specialized settings, except management of drug therapy for persons with multiple complication, or for persons who need special consideration (such as those with drug intolerance).

CENTRAL ROLE FOR PRIMARY CARE CENTERS

Stronger and better-equipped primary care centers are needed to manage the current and growing burden of CVRDs. Health systems in LMICs do *not* need to be replicas of health systems in HICs. Perhaps more than any other set of diseases, CVRDs require screening, long-term follow-up, and reliable medication delivery (table 1.2). The approach in a majority of HICs (that is, individualized interval screening performed by primary care physicians followed by highly specialized, referral-based care) is unlikely to be viable in most LMICs for a multitude of reasons. Financial and human resource constraints certainly come into play; in addition, the cultural approach to health may be different. For example, LMIC populations may be more amenable to peer

counseling or community-based health promotion activities. Therefore, a majority of the medical management interventions (table 1.1) recommended in the essential package can be delivered at the community or primary health care level.

Primary health care clinics could be responsible primarily for delivering and titrating medications. The WHO Health Systems Framework provides a comprehensive approach to their strengthening (WHO 2010a). In addition to ensuring availability of key medications, governments can enable these centers to deliver care effectively by developing national guidelines and targets for specific conditions (table 1.3), which could, in turn, encourage reliance on the available generic medications and standardize follow-up intervals. Structured guidelines for referral to specialized systems could improve efficiency at both the primary and specialized care level. Further, if primary health care centers are the first point of contact in an acute situation (for example, chest pain in a patient likely to be experiencing myocardial infarction), available basic therapy (for example, rapid administration of aspirin), though limited, could be lifesaving. Primary care centers could be empowered to deliver such therapy prior to facilitating transfer to a first-level hospital.

Acute myocardial infarction and stroke are two conditions for which timely intervention is essential. Diagnosis and thrombolytic management of myocardial infarction require a simple electrocardiogram machine; ischemic stroke also benefits from thrombolytic therapy but requires use of computed tomography and on-site radiology to differentiate from hemorrhagic stroke. If built from the ground up to serve only stroke, such approach is unaffordable. However, many first-level hospitals in middle-income countries may have access to these facilities and require the implementation of a stroke algorithm to help prioritize their timely use in patients presenting within the appropriate time frame.

When specialized centers are used for conditions that are rare or costly to treat, two potential strategies merit consideration: (1) choosing and scaling up one effective treatment from the roster of potential therapies, or (2) creating high-volume centers that specialize in specific diseases. For example, end-stage kidney disease can be treated with relatively equivalent efficacy using either hemodialysis or peritoneal dialysis. After a careful analysis taking into account cost, cultural opinion, and ethics, Thailand has chosen to pay for and scale up the peritoneal form of dialysis (Teerawattananon, Mugford, and Tangcharoensathien 2007); we await long-term outcomes from this strategy, but preliminary data indicate an increase in the availability of treatment with patient survival similar to that in HICs relying mostly on hemodialysis, albeit at quite high cost (Praditpornsilpa and others 2011; Tantivess and others 2013). In children with congenital heart disease that is amenable to a highly technical but relatively effective surgical procedure (such as ventricular septal defect), creating centers especially designed to serve these patients may be a viable approach to treatment (Reddy and others 2015). Similarly, we know that high-volume kidney transplant centers can achieve good outcomes (Axelrod and others 2004; Medina-Pestana 2006).

The essential package does include a few examples of effective specialized care that is potentially immediately feasible and affordable in low-income settings but that is not widespread. Other effective tertiary care services are considered neither feasible nor affordable in low- and most middle-income settings. Advanced treatments such as implantable cardioverter defibrillators or

Table 1.3 Recommendations for Health Systems Improvements That Enable Implementation of the Recommended Interventions

Policy	Platform
Improve access to the following essential medications: aspirin, beta-blockers, diuretics, ACEi, or ARBs, statins, mineralocorticoid agents, nonanalog insulin, bronchodilators, and inhaled corticosteroids	Policy, public health
Develop a category of trained (nonphysician) health worker	Policy, intersectoral
Offer public emergency medical transport services	Policy, intersectoral
Create standardized care pathways for first-level hospitals to manage acute episodes for myocardial infarction, stroke, critical limb ischemia, heart failure, acute kidney injury, chronic obstructive pulmonary disease, or asthma exacerbation	Policy, public health
Issue national targets for secondary prevention to enable primary health centers to manage CVRD effectively	Policy, public health

Note: ACEi = angiotensin-converting enzyme inhibitors; ARB = angiotensin receptor blocker; CVRD = cardiovascular and respiratory disease.

cardiac synchronization therapy are potentially cost-effective in some places (Brazil, for example) but expensive (Ribeiro and others 2010). As costs drop and skilled providers are trained, additional capacity should become available in specialized facilities to diagnose and manage more complex chronic respiratory diseases that are not amenable to treatment using the simple algorithm. Equipment such as continuous positive airway pressure, nebulizers, Doppler ultrasound, and other tools may all be desired depending on the respiratory disease burden.

Costs of Implementing the Package

We estimated the potential cost of implementing the essential package of interventions in stylized low-income and lower-middle-income country settings, reflecting typical costs, demographic and epidemiological characteristics, and coverage gaps in CVRD care (table 1.4). Supplementary annex 1A contains more detail on costing methods and results. We estimated the annual incremental cost of the essential package to be US$21 in a typical low-income country (3.8 percent of current gross national income [GNI] per capita) and US$24 in a typical lower-middle-income country (1.3 percent of current GNI per capita).

Most (60 percent) of the additional investments would need to be in primary health centers that offer preventive services and manage chronic disease. Low-income countries that are particularly resource constrained could focus on achieving full implementation of the bolded interventions in tables 1.1 and 1.2, which we have deemed likely to provide the best value for money in these settings. This high-priority subpackage would only cost an additional US$11 per capita, or 20 percent of current income. This costing exercise suggests that all countries—regardless of resource levels—can begin to put in place at least a few highly effective CVRD interventions at a reasonable cost as they move toward universal health coverage (UHC).

MEASURING THE BENEFITS FROM UNIVERSAL HEALTH CARE FOR CVRDS

In considering whether to expend strained resources on CVRDs, countries can take into account not only the benefits to individual health but also the benefits to outcomes relevant to societal well-being, such as poverty aversion, financial risk protection, and equity. Extended cost-effectiveness analyses (ECEA), developed as part of the Disease Control Priorities effort, attempt to capture some of these outcomes and provide evidence that CVRD care, in particular, offers substantial financial risk protection. Three ECEAs relevant to CVRDs—assessing tobacco taxation in China (Verguet, Gauvreau, and others 2015), salt reduction in processed foods in South Africa (Watkins and others 2016), and treatment of hypertension in Ethiopia (Verguet, Olson, and others 2015)—not only support the cost-effectiveness of these policies but also demonstrate that they could avert thousands of cases of poverty annually.

Treatment of hypertension in Ethiopia illustrates two specific features of universal public finance for CVRD care in LMICs: (1) treatment of CVRDs may be more expensive than interventions in other domains (such as maternal and child health), but (2) because these health policies and interventions protect wage-earning adults from disability or death, universal coverage could reduce financial risk to a greater degree. Further, poor families spend a much larger portion of their household income on hospitalizations or medications for CVRDs than wealthier families, so they could benefit more (Kankeu and others 2013).

For cases of advanced disease, when universal coverage for treatment is not yet affordable or sustainable (that is, complex congenital heart defects, advanced heart failure, or end-stage kidney disease), countries could consider expanding palliative care services. In addition to easing the

Table 1.4 Potential Costs of the Essential Package in a Stylized Typical Low- and Lower-Middle-Income Country

Estimate	LI country	LMI country
Total cost per capita	$22	$39
as a % of current GNI per capita	4.0%	2.1%
Incremental cost per capita	$21	$24
as a % of current GNI per capita	3.8%	1.3%

Note: LI = low-income; LMI = lower-middle-income; GNI = gross national income. GNI estimates taken from the World Bank and deflated to 2012 US dollars. See annex 1A for details of methods, data sources, and assumptions.

emotional and physical burden of disease, palliative care may offer a form of financial risk protection, allowing families to care for their loved ones without exhausting their financial resources on ultimately unsustainable treatments.

CONCLUSIONS

We offer a range of effective and cost-effective policies and interventions to reduce the high and mounting global health burden from the constellation of CVRD. We reviewed the evidence for CVRD interventions to assemble an essential package of the most effective policies and services that could be implemented in LMICs. Modeled studies suggest that countries can expect a high return on investment from prevention and control of CVRD, especially from implementing population prevention policies that cost relatively little (Nugent, Kelly, and Narula 2012). Countries have effective and cost-effective choices available to them. By relying heavily on population-level policies and on services that can be delivered at the community and primary health levels—and by using an effective referral system for the few specialized interventions that meet the essential package criteria—countries may obtain significant health gains at reasonable cost.

Many important issues remain uncertain, especially given the scarcity of LMIC economic evidence. Research in areas likely to produce high public benefit—such as further evaluation of the health gains from taxes on SSBs, agricultural and trade policies to improve fruit and vegetable intake, intersectoral policies to increase physical activity, use of cheaper or faster surveillance techniques, and methods of ensuring a reliable supply of generic medications, including of fixed-dose combination therapy—could be a specific priority in LMICs. New technologies, medications, and delivery platforms on the horizon have the potential to disrupt and shift management paradigms. These issues warrant development of strong priority-setting institutions in LMICs to develop a research agenda and to evaluate new technologies as well as changing disease epidemiology and health system constraints.

Nonetheless, the health benefits of individual medical interventions are clear, and HICs have achieved huge reductions in mortality by making medical treatment widely available. These gains must be extended to LMICs in order for global goals to be achieved. A strong global framework is now in place. Since the 2011 UN high-level meeting on NCDs, a Global Plan of Action for NCD Prevention and Control has been put in place, and the 2015 SDGs have recognized NCDs as a serious threat to development. The *DCP3* essential package provides a pathway to achieving substantial reduction in death, disability, and impoverishment from CVRD in LMICs using evidence-based cost-effective interventions.

ACKNOWLEDGMENTS

The *DCP3* volume 5 author group consists of the following: Alma Adler, Ashkan Afshin, Vamadevan S. Ajay, Mohammed K. Ali, Eric Bateman, Janet Bettger, Robert O. Bonow, Elizabeth Brouwer, Gene Bukhman, Fiona Bull, Peter Burney, Simon Capewell, Juliana Chan, Eeshwar K. Chandrasekar, Jie Chen, Michael H. Criqui, John Dirks, Sagar B. Dugani, Michael Engelgau, Meguid El Nahas, Caroline H. D. Fall, Valery Feigin, F. Gerald R. Fowkes, Amanda Glassman, Shifalika Goenka, Rajeev Gupta, Babar Hasan, Fred Hersch, Frank Hu, Mark D. Huffman, Samer Jabbour, Deborah Jarvis, Panniyammakal Jeemon, Rohina Joshi, Jemima H. Kamano, Andre Pascal Kengne, Preeti Kudesia, R. Krishna Kumar, Kalyanaraman Kumaran, Estelle V. Lambert, Edward S. Lee, Chaoyun Li, Rong Luo, Matthew Magee, Vasanti S. Malik, J. Antonio Marin-Neto, Guy Marks, Bongani Mayosi, Helen McGuire, Renata Micha, J. Jaime Miranda, Pablo Aschner Montoya, Andrew E. Moran, Dariush Mozaffarian, Saraladevi Naicker, Nadraj G. Naidoo, K. M. Venkat Narayan, Irina Nikolic, Martin O'Donnell, Churchill Onen, Clive Osmond, Anushka Patel, Rogelio Perez-Padilla, Neil Poulter, Michael Pratt, Miriam Rabkin, Vikram Rajan, Anis Rassi, Anis Rassi Jr., Ishita Rawal, Giuseppe Remuzzi, Miguel Riella, Greg A. Roth, Ambuj Roy, Adolfo Rubinstein, Yuna Sakuma, Uchechukwu K. A. Sampson, Karen R. Siegel, Karen Sliwa, Marc Suhrcke, Nikhil Tandon, Bernadette Thomas, Claudia Vaca, Rajesh Vedanthan, Stéphane Verguet, Michael Webb, Mary Beth Weber, Laurie Whitsel, Gary Wong, Lijing L. Yan, Clyde W. Yancy, Ping Zhang, Dong Zhao, and Yishan Zhu.

The authors would like to acknowledge Jinyuan Qi for her assistance in preparing the essential package cost estimates, Dean T. Jamison for thoughtful review and guidance, Kristen Danforth for assistance with literature reviews and document preparation, and the World Bank Publisher's office for excellent production support.

ANNEX

The annex to this chapter is as follows. It is available at http://www.dcp-3.org/CVRD.

- Annex 1A. Costing the Essential Package for Cardiovascular, Respiratory, and Related Disorders Notes

NOTE

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  (a) lower-middle-income = US$1,046 to US$4,125
  (b) upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

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