Implementing the National Heart, Lung, and Blood Institute's Strategic Vision in the Division of Cardiovascular Sciences

David C. Goff Jr, Denis B. Buxton, Gail D. Pearson, Gina S. Wei, Teri E. Gosselin,
Ebyan A. Addou, Catherine M. Stoney, Patrice Desvigne-Nickens, Pothur R. Srinivas,
Zorina S. Galis, Charlotte Pratt, Brian K. Kit, Christine Maric-Bilkan, Holly L. Nicastro,
Renee P. Wong, Vandana Sachdev, Jue Chen, Lawrence Fine;
for the writing group of Division of Cardiovascular Sciences' Strategic Vision Implementation Plan.

Abstract: As we commemorate the 70th anniversary of the National Heart, Lung, and Blood Institute and celebrate important milestones that have been achieved by the division of cardiovascular sciences, it is imperative that division of cardiovascular sciences and the Extramural Research community at-large continue to address critical public health challenges that persist within the area of cardiovascular diseases. The National Heart, Lung, and Blood Institute Strategic Vision, developed with extensive input from the extramural research community and published in 2016, included overarching goals and strategic objectives that serve to provide a general blueprint for sustaining the legacy of the institute by leveraging opportunities in emerging scientific areas (eg, regenerative medicine, omics technology, data science, precision medicine, and mobile health), finding new ways to address enduring challenges (eg, social determinants of health, health inequities, prevention, and health promotion), and training the next generation of heart, lung, blood, and sleep researchers. Division of cardiovascular sciences has developed a strategic vision implementation plan to provide a cardiovascular framing for the pursuit of the institutes overarching goals and strategic objectives garnered from the input of the broader National Heart, Lung, and Blood Institute community. This plan highlights 6 scientific focus areas that demonstrate a cross-cutting and multifaceted approach to addressing cardiovascular sciences, including (1) addressing social determinants of cardiovascular health and health inequities, (2) enhancing resilience, (3) promoting cardiovascular health and preventing cardiovascular diseases across the lifespan, (4) eliminating hypertension-related cardiovascular diseases, (5) reducing the burden of heart failure, and (6) preventing vascular dementia. These priorities will guide our efforts in institute-driven activities in the coming years but will not exclude development of other novel ideas or the support of investigator-initiated grant awards. The Division of Cardiovascular Sciences strategic vision implementation plan is a living document that will evolve with iterative dialogue with the National Heart, Lung, and Blood Institute community and adapt as the dynamic scientific landscape changes to seize emerging opportunities. (*Circ Res*. 2019;124:491-497. DOI: 10.1161/CIRCRESAHA.118.314338.)

Key Words: cholesterol ■ health equity ■ heart failure ■ hypertension

It is an exciting time for the Division of Cardiovascular Sciences (DCVS) to develop its implementation plan for the National Heart, Lung, and Blood Institutes (NHLBI) strategic vision.[1] In line with the mission of the National Institutes of Health (NIH), the mission of DCVS is turning discovery into cardiovascular health (CVH). Ongoing successes in pursuit of that mission are reflected in the decline in mortality from coronary heart disease and stroke in the United States has seen in recent decades.[2] Yet challenges persist, including evidence that coronary heart disease mortality rates for young adults might be leveling off,[3] and the continuing burden of cardiovascular diseases (CVD) such as hypertension, heart failure, and vascular dementia, particularly among the elderly and other disadvantaged groups.[2,4] At the same time, innovations in fields such as computational biology, regenerative medicine, omics technology, mobile health, telemedicine, clinical informatics, and data science offer exciting opportunities in biomedical, behavioral, and social medicine. To leverage

Nonstandard Abbreviations and Acronyms	
ABCD	Adolescent Brain and Cognitive Development
ACCORD	Action to Control Cardiovascular Risk in Diabetes
AD	Alzheimer disease
ARIC	Atherosclerosis Risk in Communities
CARDIA	Coronary Artery Risk Development in Young Adults
CHEAR/HHEAR	Children's Health Exposure Analysis Resource/Human Health Exposure Analysis Resource
CVD	Cardiovascular disease
CVH	Cardiovascular health
DASH	Dietary Approaches to Stop Hypertension
dbGaP	Database of Genotypes and Phenotypes
DCVS	Division of Cardiovascular Sciences
ECHO	Environmental Influences on Child Health Outcomes
HCHS/SOL	Hispanic Community Health Study/Study of Latinos
JHS	Jackson Heart Study
MESA	Multi-Ethnic Study of Atherosclerosis
NHLBI	National Heart, Lung, and Blood Institute
NIH	National Institutes of Health
SHS	Strong Heart Study
SPRINT	Systolic Blood PRessure Intervention Trial
TOPMed	Trans-Omics for Precision Medicine
VCID	vascular contributions to cognitive impairment and dementia
WHI	Women's Health Initiative

these opportunities and address these challenges, DCVS initiated a process in 2017 for developing a strategic vision implementation plan based on the community input provided in the strategic vision published in 2016.[1] This process included a landscape analysis of existing institute priorities, including support for investigator-initiated research, training, and career development, as well as other strategic investments, for example, cardiothoracic surgery, congenital heart disease, emergency medicine, HIV-related comorbidities, obesity, and women's health. Using these inputs and iterative feedback from NHLBI's Board of External Experts and Advisory Council, DCVS staff identified 6 scientific focus areas, all of which reflect significant opportunities across the translational spectrum for breakthroughs in knowledge and health over the next decade and interdigitate with many NHLBI strategic vision critical challenges and compelling questions informed by the broader NHLBI stakeholder community[1]:

1. Addressing social determinants of CVH and health inequites.
2. Enhancing resilience.
3. Promoting CVH and preventing CVD across the lifespan.
4. Eliminating hypertension-related CVD.
5. Reducing the burden of heart failure.
6. Preventing vascular dementia.

These focus areas represent a mix of related cross-cutting topics and targeted diseases/conditions that involve complex biological, behavioral, social, and environmental interactions, thus requiring multifaceted approaches across the translational spectrum to address them effectively to create a more positive future. These areas complement the existing focus areas for strategic investments. DCVS anticipates that NHLBI's ongoing leadership and investment in the TOPMed program (Trans-Omics for Precision Medicine), the NHLBI data (storage, toolspace, access, and analytics for big data empowerment), and the NIH data commons pilot will generate rich resources and data science platforms to enable research in new and existing focus areas.

Portfolio analyses of our funded research projects support the development of plans for workshops and potential initiatives. DCVS hosts workshops to convene external experts to identify opportunities to advance discovery to improve CVH, and sometimes, these efforts contribute to the development of Institute activities, investigator applications, or funding announcements for new research initiatives. Workshop summaries are posted on the NHLBI website (https://www.nhlbi.nih.gov/events) for the public. Our efforts to implement the strategic vision are already influencing workshop topics as shown for recent and upcoming workshops between September 2017 and December 2018 in the Table. As this process evolves, steps will include expanding portfolio analyses beyond NHLBI, exploring collaborations with other NIH Institutes/Centers/Offices (eg, All of Us Research Program, National Institute of Environmental Health Sciences, National Institute on Aging, and National Institute of Neurological Disorders and Stroke) and beyond (eg, professional societies and other research funding agencies) to leverage knowledge and resources, and proposing workshops to gather input from the external community. Current progress of the working groups is summarized below. Although not discussed in detail below, support for workforce development was a common theme across the working groups.

Addressing Social Determinants of CVH and Health Inequities

According to the World Health Organization, the social determinants of health are defined as the conditions in which people are born, grow, live, work, and age.[5] The social determinants of health are often viewed as fundamental influences on an individuals health[6] and include factors such as socioeconomic status, education, neighborhoods, the physical environment, employment, social networks, and health care access.[7] In the United States, CVD disproportionately affects racial and ethnic minorities[8] and individuals of low socioeconomic status,[9] including those in rural communities.[10] DCVS has been at the forefront of supporting population-based research that has identified the important contributions of social determinants to inequities in cardiovascular disease among different segments of the US population—through cohort studies such as ARIC study (Atherosclerosis Risk in Communities), CARDIA study (Coronary Artery Risk Development in Young Adults), HCHS/SOL (Hispanic Community Health Study/Study of Latinos), JHS (Jackson Heart Study), MESA (Multi-Ethnic Study of Atherosclerosis), and the SHS (Strong Heart Study). Efforts to address the social determinants of health have included studies to identify relevant exposures, understand their biologic effects, and modify exposures like the built environment, air pollution, and other social environmental factors that are inequitably distributed.[11] Development of an evidence base for intervening on the social determinants of CVH and

Table. NHLBI DCVS Workshops Held or Planned Between September 2017 and December 2018

Workshop Topic	Links
Challenges and opportunities for the prevention and treatment of cardiovascular disease among young adults, 9/2017	https://www.nhlbi.nih.gov/events/2017/challenges-and-opportunities-prevention-and-treatment-cardiovascular-disease-among
Research priorities in heart failure with preserved ejection fraction, 9/2017	https://www.nhlbi.nih.gov/events/2017/research-priorities-heart-failure-preserved-ejection-fraction-hfpef
Understanding the combined effects of environmental chemical and nonchemical stressors: atherosclerosis as a model, 4/2018	https://www.niehs.nih.gov/news/events/pasmtg/2018/stressors/index.cfm
Preventing vascular dementia, 5/2018	https://www.nhlbi.nih.gov/events/2018/nhlbi-working-group-vascular-contributions-cognitive-impairment-and-dementia-executive
Predicting, preventing and treating preeclampsia, 5/2018	https://www.nhlbi.nih.gov/events/2018/nhlbi-nichd-predicting-preventing-and-treating-preeclampsia-workshop
Social determinants of health: contributions of early life adversity to cardiovascular disparities in adulthood, 5/2018	https://www.nhlbi.nih.gov/events/2018/social-determinants-health-contributions-early-life-adversity-cardiovascular
Diversity training support at NHLBI, 5/2018	Web link pending
Promoting cardiovascular health in early childhood (0–5 y) and transitions in childhood through adolescence, 6/2018	https://www.nhlbi.nih.gov/events/2018/promoting-cardiovascular-health-early-childhood-0-5-years-and-transitions-childhood
Precision medicine for the advancement of knowledge on heart, lung, blood, and sleep health and disease: exploring opportunities and addressing challenges using the All of Us Research Program, 7/2018	https://www.nhlbi.nih.gov/events/2018/precision-medicine-advancement-knowledge-heart-lung-blood-and-sleep-health-and-disease
Enhancing resilience for cardiovascular health and wellness, 7/2018	Web link pending
Unlocking the secrets of mitochondria in the cardiovascular system: path to a cure in heart failure, 8/2018	https://www.nhlbi.nih.gov/events/2018/nhlbi-working-group-unlocking-secrets-mitochondria-cardiovascular-system-path-cure
Defining the NHLBI's research priorities in the ethical, legal, and social implications (ELSI) of genomics 9/2018	Web link pending
The role of short-term training in HLBS workforce development, 10/2018	Web link pending
Cardiovascular consequences of post-traumatic stress disorder, 11/2018	Web link pending
Hypertension: barriers to translation, 12/2018	Web link pending

health inequity is an important endeavor for DCVS to support whereas continuing to support research to identify new relevant exposures and their biologic mechanisms. Evidence-based strategies that focus on effective and sustainable interventions that close the gap on health inequities in CVH must be implemented.[9] Current efforts include partnering with the NHLBI Center for Translation Research and Implementation Science on a funding opportunity to support a community-based initiative titled disparities elimination through coordinated interventions to prevent and control heart and lung disease risk.[12] Future efforts could include supporting development of a toolbox with common data elements to standardize data collection of social determinants across studies and supporting research to evaluate interventions, including natural experiments, addressing social determinants. These efforts would be consistent with NIH and NHLBI efforts to promote the development and adoption of common data elements in research to facilitate data harmonization, linkage, and analysis across studies.[13,14]

Enhancing Resilience

Resilience has been defined in a variety of ways and experts from our recently convened working group recommended adopting the following simple working definition: Resilience is the ability to resist and recover from a stressor. Assets and resources within the individual, their life and environment facilitate this capacity for adaptation and bouncing back in the face of adversity.[15] Although much of the scientific research landscape has focused on the treatment and modification of symptoms,[16] enhancing resilience may be key to achieving optimal CVH.[17] Leveraging existing precision medicine efforts such as NIH's All of Us Research Program, NHLBI's TOPMed, and the National Center for Biotechnology Informations database of Genotypes and Phenotypes[18] are critical to efforts to incorporate research on resilience into the Division's grant portfolio by enabling a systems biology approach to understanding response and adaptation to environmental and behavioral exposures, including medications. Recommendations from our recent working group suggests future directions should include efforts in understanding resilience across the spectrum from basic science to population sciences, stimulation of big data approaches to detection of stressors and resilience enhancing factors in resources such as TOPMed, development of standardized metrics of resilience, and trials of resilience enhancing interventions.

Promoting CVH and Preventing CVD Across the Lifespan

Despite improvements in life expectancy throughout the 20th Century, continued improvement in the overall health of the US population is threatened by the increasing incidence and prevalence rates of obesity, type 2 diabetes mellitus, and hypertension,

trends that might be expected to shorten the average life expectancy.[19] As CVH deteriorates across the lifespan, CVD risk factors accumulate.[20] Multiple studies have supported approaches that focus on primordial prevention of CVD.[21] In this paradigm, the period of achieving optimal CVH begins in utero to early childhood and modifications made during this period may have life-long effects.[21] In 2010, the American Heart Association Goals and Metric Committee of the Strategic Planning Task Force established the 2020 impact goal to improve the CVH of all American by 20%.[22] The American Heart Association's 2020 impact goal uses 7 metrics as a means for keeping track of CVH in US populations[23] including current cigarette smoking, body mass index, physical activity, a healthy diet score, total cholesterol, blood pressure, and fasting glucose. Because CVH deteriorates so rapidly during childhood and early adulthood, bold new strategies are needed to improve the nations overall CVH. Success will likely require a combination of interventions encompassing clinical, public health, and health policy initiatives.[24] Opportunities abound to leverage other NIH efforts, including for example the ABCD study (Adolescent Brain Cognitive Development),[25] the ECHO program (Environmental influences on Child Health Outcomes),[26] and the CHEAR/HHEAR (Children's Health Exposure Analysis Resource/Human Health Exposure Analysis Resource).[27] Future efforts could include support for basic, mechanistic, and epidemiological research on biomarkers of CVH, refinement and standardization of metrics, the biologic role of stressors at different development periods on CVH, and effective age-appropriate interventions, including dietary and behavioral interventions for preserving, promoting, and restoring CVH across the lifespan.

Eliminating Hypertension-Related CVD

High blood pressure is a major risk factor for the development of CVD, including heart failure, cerebral vascular disease, and coronary heart disease,[28] and elevated blood pressure is the leading risk factor for mortality and disability worldwide, causing ≈9.4 million deaths per year.[29] Attempts to mitigate high blood pressure among the general population have traditionally centered on medications that treat individuals diagnosed as having high blood pressure.[30] Lifestyle modifications such as exercise, reduction in salt intake, maintenance of healthy weight, and eating a diet that is rich in fruits and vegetables and low in fat and cholesterol can also decrease blood pressure in individuals diagnosed with hypertension and prevent hypertension in individuals who do not have the disease.[30] Despite these advancements in the treatment, differences continue to exist in the incidence and prevalence of hypertension,[31] as hypertension incidence and prevalence is particularly high in Black compared with Whites.[32] Ground breaking hypertension clinical trials supported by the NHLBI such as the blood pressure reduction in black barbershops[33] and the SPRINT trial (Systolic Blood Pressure Intervention)[34] have demonstrated the need for re-examining hypertension detection, treatment, and control methods. In addition, the DASH trial (Dietary Approaches to Stop Hypertension) as well as the subsequent DASH-Sodium trial and OMNI heart trial (Optimal MacroNutrient Intake Trial to Prevent Heart Disease)[35] demonstrated that consuming a diet rich in fruits, vegetables, and low-fat dairy products, and reduced in saturated fat and cholesterol lowers both systolic and diastolic blood pressure.[36,37] Although support of research on the prevention of hypertension continues to be a priority for DCVS, research on better methods to manage high blood pressure and its impact on cardiovascular events is also important.[28] Future efforts could include support for research on translating basic science discoveries regarding blood pressure regulation into precision treatment strategies, understanding the biologic mechanisms that influence blood pressure trajectories across the lifespan, how early pharmacological treatment should begin to maximize prevention of vascular and target organ damage, the biologic basis of subgroup differences in incidence of hypertension and response to treatment, and effective implementation strategies for lifestyle and pharmacological interventions to prevent and treat hypertension.

Reducing the Burden of Heart Failure

In the United States, ≈6.5 million adults are living with heart failure with total costs of care for patients with heart failure estimated to be $31 billion and expected to increase to $70 billion by 2030 as the prevalence of this disease increases.[2,38] Although advances in the treatment and prevention of heart failure have resulted in lower incidence rates, the prevalence of heart failure in the US is expected to increase by 46% by 2030.[39] Acute decompensated heart failure continues to be the primary cause of hospitalization among the elderly.[40] NHLBI initiatives such as the heart failure network have provided valuable insights into the efficacy of heart failure treatment protocols and have demonstrated the need for continued research to improve and advance prevention and treatment of heart failure.[40] Future efforts could include support of research to understand the role of the mitochondria in heart failure and support of resources to enable research on other mechanisms of heart failure at the cellular and molecular level. Improved phenotyping of the complex set of conditions included under the umbrella of heart failure is also needed. This latter effort is especially pertinent to heart failure with preserved ejection fraction, for which therapeutic options are limited. Improved phenotyping could facilitate development of animal models and therapeutic strategies that are more precisely aligned with the underlying causes of the various heart failure phenotypes. Future efforts might also include innovative methods for partnering with heart failure patients to facilitate clinical research efforts, including trials. Opportunities exist to leverage other programs, including the All of Us Research Program and TOPMed, to advance heart failure prevention, phenotyping, and precision medicine.

Preventing Vascular Dementia

Dementia is a critical public health issue and is estimated to affect >47 million people globally.[41] Dementia is an umbrella term that encompasses multiple disorders, often with mixed pathology and multifactorial cause. Vascular dementia, more recently known as vascular contributions to cognitive impairment and dementia (VCID), is defined as the aging neurovascular unit failing to cope with biological insults because of vascular disease, Alzheimer biology, metabolic disease, and immune affront, resulting in cognitive decline. After Alzheimer Disease (AD), vascular dementia

is the second most common dementia diagnosis, accounting for ≈20% of cases[42]; furthermore, vascular pathology often co-exists with AD.[43] Although dementia research is classified as being focused on AD and AD-related dementia, in clinical presentation, it is common to have both classic AD pathology and nonAD pathology, including vascular pathology together.[43] As life expectancies continue to increase, the burden of dementia will continue to take a toll on health care systems and populations on a global basis,[44] with costs associated with dementia in the US expected to soon surpass cancer and heart disease.[42] Although the burden of dementia is expected to increase, there is evidence that the incidence may be decreasing, possibly due in part to more aggressive treatment of vascular risks, raising the likelihood, and promise of preventing dementia by treating vascular risk factors and diseases. In addressing the challenges faced in the prevention of VCID, a multi-pronged approach to supporting research is needed and might include: lifestyle changes, such as healthy diet, physical activity, and healthy weight,[42] more effective treatment of CVD risk factors and disorders, a recalibration of measuring the prevalence and epidemiology of all dementia subtypes,[45] better use of large data sets to collect and mine clinical data related to VCID,[46] and reducing differences in VCID among racial and ethnic groups.[47] Multiple opportunities exist to leverage efforts supported by the National Institute on Aging and the National Institute of Neurological Disorders and Stroke. Unique contributions supported by the NHLBI could include research on basic mechanisms of VCID, such as through continued support of research on vascular biology in the brain and the extension of animal models developed to study vascular disease into this research space. Other opportunities could include leveraging existing and future epidemiological studies and clinical trials to examine cognitive outcomes, including mild cognitive impairment and dementia, as has already been accomplished in studies leveraging multiple cohorts, including ARIC, CARDIA, Framingham Heart Study, JHS, MESA, and the WHI (Women's Health Initiative), and several trials, including the ACCORD trial (Action to Control Cardiovascular Risk in Diabetes), SPRINT, and WHI.

Conclusions

The priorities described above, as informed by input from stakeholder-engagement in the strategic vision and subsequent workshops as well as dialogue with NHLBI advisory council will be used to augment our portfolio with strategically-focused institute activities or institute-solicited research programs that represent our best efforts to accelerate discovery and translation and to advance workforce development to nurture future generations of researchers. The dynamic process of implementation is ongoing in each of the areas discussed above; hence, we cannot provide detailed action plans at this time. We anticipate that reports from related workshops will provide additional information. We anticipate future reports will synthesize the output from relevant workshops and provide more detailed implementation plans. This document should be viewed as the first step in communicating this implementation plan to the community. Although not discussed above, workforce development

is a theme that cuts across all scientific priorities, and an issue strongly endorsed by our investigator community. Furthermore, these priorities will inform funding recommendations for mechanisms where a payline is not specified.[48] These priorities will not restrict development of other novel ideas for workshops and initiatives, nor restrict the investigator-initiated grant portfolio or select pay of other meritorious grant applications in DCVS' purview. DCVS will continue to capitalize on emerging opportunities, including re-evaluation of our focus areas to refresh these areas over time as appropriate. The DCVS strategic vision implementation plan is a living document that will evolve with iterative dialogue with the NHLBI community and adapt as the dynamic scientific landscape changes to seize emerging opportunities. DCVS envisions that ten years hence, NHLBI will have fostered significant advancement of the state of cardiovascular science, the promotion of CVH, and the prevention of CVD by leveraging emerging opportunities in an informed, nimble, and collaborative fashion. We encourage the investigator community to pursue scientific advances related to the topics addressed above as well as the numerous other topics that hold promise for achieving our shared mission of turning discovery into CVH.

Appendix: NHLBI and NIH Staff Who Contributed to the DCVS Strategic Vision Implementation Plan

Ebyan Addou, MPH; Bishow Adhikari, PhD; Sean Altekruse, DVM, MPH, PhD; Sonia Arteaga, PhD; Larissa Aviles Santa, MD, MPH; Tim Baldwin, PhD; Ravi Balijepalli, PhD; Rebecca Beer, PhD; Carol Blaisdell, MD, (NIH, ECHO); Josephine Boyington, PhD, MPH; Catherine Burke, MA; Kristin Burns, MD; Rebecca Campo, PhD; Drew Carlson, PhD; Marc Charette, PhD; Jue Chen, PhD; Shu Hui Chen, PhD; Sean Coady, MA; Lawton Cooper, MD; Narasimhan Danthi, PhD; Patrice Desvigne-Nickens, MD; Gaya Dowling, PhD, (NIDA); Ray Ebert, PhD; Paula Einhorn, MD; Lawrence Fine, MD, MPH, DrPH; Jerry Fleg, MD; Zorina Galis, PhD; Yunling Gao, PhD; Nancy Geller, PhD; Matthew Gillam, MD, (NIH ECHO); Kathy Green, BS; Maya Harris, BS; Ahmed Hasan, MD; Lucy Hsu, MPH; Alice Hurtado de Mendoza, M.B.A.; Pamela James; Erin Iturriaga, RN, BS; Cashell Jaquish, PhD; Shari Ludlam, MPH; Katherine Kavounis, MPH; Fassil Ketema, BS, MSc; Jonathan Kaltman, MD; Dong-Yun Kim, PhD; Andrei Kindzelski, MD, PhD; Ruth Kirby, RN; Brian Kit, MD; John Kunz, MS; Eric Leifer, PhD; Huiqing Li, MD, PhD; Lijuan Liu, PhD; Martha Lundberg, PhD; James Luo, PhD; Christine Maric-Bilkan, PhD (NIDDK); Marissa Miller, DVM, MPH; Cheryl Nelson, MSPH; Holly Nicastro, PhD; Margaret Ochocinska, PhD; Michelle Olive, PhD; Jean Olson, MD, MPH; Anne O'Malley, BA; Stavroula Osganian, MD, ScD, MPH (NIDDK); Young Oh, PhD; Melissa Green Parker, PhD; Charlotte Pratt, PhD; Mona Puggal, MPH; Kevin Purkiser; Nicole Redmond, MD, PhD, MPH; Diane Reid, MD; Jared Reis, PhD; Yves Rosenberg, MD; Vandana Sachdev, MD; Charlene Schramm, PhD; Lisa Schwartz-Longacre, PhD; Jane Scott, ScD, MSN; Scarlet Shi, PhD; Phyliss Sholinsky, MSPH; Lorraine Silsbee, MHS; Joni Snyder, RN, BSN, MA; George Sopko, MD, MPH; Pothur Srinivas, PhD, MPH; Dennis Stanley; Catherine Stoney, PhD; Wendy Taddei-Peters, PhD; Perdita Taylor-Zapata, MD, (NICHD); Emily Tinsley, BS, MSc; Olga Tjurmina, PhD; Eser Tolunay, PhD; Michael Twery, PhD; Myron Waclawiw, PhD; Jenelle Walker, PhD; Barbara Wells, PhD, RDH; Michael Wolz, MS; Renee Wong, PhD; Jacqueline Wright, DrPH; Colin Wu, PhD; Ye Yan, PhD (NINDS); Song Yang, PhD

Disclosures

None.

References

1. National Heart L, and Blood Institute. Charting the Future Together. The NHLBI Strategic Vision. https://www.nhlbi.nih.gov/about/strategic-vision. Accessed June 1, 2018.

2. Benjamin EJ, Virani SS, Callaway CW, et al; American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics-2018 update: a report from the American Heart Association. *Circulation*. 2018;137:e67–e492. doi: 10.1161/CIR.0000000000000558

3. Sidney S, Quesenberry CP, Jr, Jaffe MG, Sorel M, Go AS, Rana JS. Heterogeneity in national U.S. mortality trends within heart disease subgroups, 2000-2015. *BMC Cardiovasc Disord*. 2017;17:192. doi: 10.1186/s12872-017-0630-2

4. Roth GA, Dwyer-Lindgren L, Bertozzi-Villa A, Stubbs RW, Morozoff C, Naghavi M, Mokdad AH, Murray CJL. Trends and patterns of geographic variation in cardiovascular mortality among US counties, 1980-2014. *JAMA*. 2017;317:1976–1992. doi: 10.1001/jama.2017.4150

5. Viner RM, Ozer EM, Denny S, Marmot M, Resnick M, Fatusi A, Currie C. Adolescence and the social determinants of health. *Lancet*. 2012;379:1641–1652. doi: 10.1016/S0140-6736(12)60149-4

6. Havranek EP, Mujahid MS, Barr DA, Blair IV, Cohen MS, Cruz-Flores S, Davey-Smith G, Dennison-Himmelfarb CR, Lauer MS, Lockwood DW, Rosal M, Yancy CW; American Heart Association Council on Quality of Care and Outcomes Research, Council on Epidemiology and Prevention, Council on Cardiovascular and Stroke Nursing, Council on Lifestyle and Cardiometabolic Health, and Stroke Council. Social determinants of risk and outcomes for cardiovascular disease: a scientific statement from the American Heart Association. *Circulation*. 2015;132:873–898. doi: 10.1161/CIR.0000000000000228

7. Artiga S, Hinton E. Beyond Health Care: The Role of Social Determinants in Promoting Health and Health Equity. 2018. https://www.kff.org/disparities-policy/issue-brief/beyond-health-care-the-role-of-social-determinants-in-promoting-health-and-health-equity/. Accessed February 1, 2019.

8. Pool LR, Ning H, Lloyd-Jones DM, Allen NB. Trends in racial/ethnic disparities in cardiovascular health among US adults from 1999–2012. *J Am Heart Assoc*. 2017;6(9):e006027. doi: 10.1161/JAHA.117.006027

9. Schultz WM, Kelli HM, Lisko JC, Varghese T, Shen J, Sandesara P, Quyyumi AA, Taylor HA, Gulati M, Harold JG, Mieres JH, Ferdinand KC, Mensah GA, Sperling LS. Socioeconomic status and cardiovascular outcomes: challenges and interventions. *Circulation*. 2018;137:2166–2178. doi: 10.1161/CIRCULATIONAHA.117.029652

10. Murray CJ, Kulkarni SC, Michaud C, Tomijima N, Bulzacchelli MT, Iandiorio TJ, Ezzati M. Eight Americas: investigating mortality disparities across races, counties, and race-counties in the United States. *PLoS Med*. 2006;3:e260. doi: 10.1371/journal.pmed.0030260

11. Bhatnagar A. Environmental determinants of cardiovascular disease. *Circ Res*. 2017;121:162–180. doi: 10.1161/CIRCRESAHA.117.306458

12. National Heart Lung and Blood Institute. Notice of Intent to Publish a Funding Opportunity Announcement for Disparities Elimination through Coordinated Interventions to Prevent and Control Heart and Lung Disease Risk (DECIPHeR). https://grants.nih.gov/grants/guide/notice-files/NOT-HL-18-632.html. Accessed February 1, 2019.

13. National Institutes of Health. Common Data Element (CDE) Resource Portal. https://www.nlm.nih.gov/cde/. Accessed December 14, 2018.

14. National Heart Lung and Blood Institute. New Epidemiology Cohort Studies in Heart, Lung, Blood, and Sleep Diseases and Disorders (U01 - Clinical Trial Not Allowed). https://grants.nih.gov/grants/guide/pa-files/PAR-18-577.html. Accessed February 1, 2019.

15. Windle G, Bennett KM, Noyes J. A methodological review of resilience measurement scales. *Health Qual Life Outcomes*. 2011;9:8. doi: 10.1186/1477-7525-9-8

16. Friend SH, Schadt EE. Translational genomics. Clues from the resilient. *Science*. 2014;344(6187):970–972. doi: 10.1126/science.1255648

17. Fuster V. The power of resilience. *J Am Coll Cardiol*. 2014;64:840–842. doi: 10.1016/j.jacc.2014.07.013

18. Mailman MD, Feolo M, Jin Y, et al. The NCBI dbGaP database of genotypes and phenotypes. *Nat Genet*. 2007;39:1181–1186. doi: 10.1038/ng1007-1181

19. Thornburg KL. The programming of cardiovascular disease. *J Dev Orig Health Dis*. 2015;6:366–376. doi: 10.1017/S2040174415001300

20. Allen NB, Ning H, Lloyd Jones D, Zhao L, Siddique J. Abstract P196: cardiovascular health across the lifespan: the development and validation of a synthetic cardiovascular cohort. *Circulation*. 2017;135(suppl 1):AP196.

21. Gillman MW. Primordial prevention of cardiovascular disease. *Circulation*. 2015;131:599–601. doi: 10.1161/CIRCULATIONAHA.115.014849

22. Yeboah J. Road to the American Heart Association 2020 impact goals: the metric for monitoring progress. *Circ Cardiovasc Imaging*. 2018;11:e007385. doi: 10.1161/CIRCIMAGING.117.007385

23. Lloyd-Jones DM, Hong Y, Labarthe D, et al; American Heart Association Strategic Planning Task Force and Statistics Committee. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic impact goal through 2020 and beyond. *Circulation*. 2010;121:586–613. doi: 10.1161/CIRCULATIONAHA.109.192703

24. Karmali KN, Lloyd-Jones DM. Achieving and maintaining cardiovascular health across the lifespan. *Curr Epidemiol Rep*. 2014;1(2):75–81.

25. National Institutes of Health. Adolescent Brain Cognitive Development Study. https://abcdstudy.org/index.html. Accessed July 19, 2018.

26. National Institutes of Health. Environmental Influences on Child Health Outcomes http://echochildren.org/. Accessed July 18, 2018.

27. National Institutes of Environmental Health Sciences. Children's Health Exposure Analysis Resource (CHEAR). https://www.niehs.nih.gov/research/supported/exposure/chear/index.cfm. Accessed February 1, 2019.

28. Hardy ST, Loehr LR, Butler KR, Chakladar S, Chang PP, Folsom AR, Heiss G, MacLehose RF, Matsushita K, Avery CL. Reducing the blood pressure-related burden of cardiovascular disease: impact of achievable improvements in blood pressure prevention and control. *J Am Heart Assoc*. 2015;4:e002276. doi: 10.1161/JAHA.115.002276

29. Ettehad D, Emdin CA, Kiran A, Anderson SG, Callender T, Emberson J, Chalmers J, Rodgers A, Rahimi K. Blood pressure lowering for prevention of cardiovascular disease and death: a systematic review and meta-analysis. *Lancet*. 2016;387:957–967. doi: 10.1016/S0140-6736(15)01225-8

30. Appel LJ. Lifestyle modification as a means to prevent and treat high blood pressure. *J Am Soc Nephrol*. 2003;14:S99–S102. https://doi.org/10.1097/01.ASN.0000070141.69483.5A.

31. Dorans KS, Mills KT, Liu Y, He J. Trends in prevalence and control of hypertension according to the 2017 American College of Cardiology/American Heart Association (ACC/AHA) guideline. *J Am Heart Assoc*. 2018;7(11):e008888. doi: 10.1161/JAHA.118.008888

32. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2018;71:e127–e248. doi: 10.1016/j.jacc.2017.11.006

33. Victor RG, Lynch K, Li N, Blyler C, Muhammad E, Handler J, Brettler J, Rashid M, Hsu B, Foxx-Drew D, Moy N, Reid AE, Elashoff RM. A cluster-randomized trial of blood-pressure reduction in black barbershops. *N Engl J Med*. 2018;378:1291–1301. doi: 10.1056/NEJMoa1717250

34. Egan BM, Li J, Wagner CS. Systolic Blood Pressure Intervention Trial (SPRINT) and Target Systolic Blood Pressure in Future Hypertension Guidelines. *Hypertension*. 2016;68:318–323. doi: 10.1161/HYPERTENSIONAHA.116.07575

35. Appel LJ, Sacks FM, Carey VJ, Obarzanek E, Swain JF, Miller ER, 3rd, Conlin PR, Erlinger TP, Rosner BA, Laranjo NM, Charleston J, McCarron P, Bishop LM; OmniHeart Collaborative Research Group. Effects of protein, monounsaturated fat, and carbohydrate intake on blood pressure and serum lipids: results of the OmniHeart randomized trial. *JAMA*. 2005;294:2455–2464. doi: 10.1001/jama.294.19.2455

36. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin PH, Karanja N. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. *N Engl J Med*. 1997;336:1117–1124. doi: 10.1056/NEJM199704173361601

37. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, Conlin PR, Miller ER, 3rd, Simons-Morton DG, Karanja N, Lin PH; DASH-Sodium Collaborative Research Group. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med*. 2001;344:3–10. doi: 10.1056/NEJM200101043440101

38. Dunlay SM, Roger VL. Understanding the epidemic of heart failure: past, present, and future. *Curr Heart Fail Rep*. 2014;11:404–415. doi: 10.1007/s11897-014-0220-x

39. Savarese G, Lund LH. Global public health burden of heart failure. *Card Fail Rev*. 2017;3:7–11. doi: 10.15420/cfr.2016:25:2

40. Joyce E, Givertz MM. Turning failure into success: trials of the heart failure clinical research network. *Curr Cardiol Rep*. 2016;18:121. doi: 10.1007/s11886-016-0801-2

41. Corriveau RA, Koroshetz WJ, Gladman JT, et al. Alzheimer's disease-related dementias summit 2016: national research priorities. *Neurology*. 2017;89:2381–2391. doi: 10.1212/WNL.0000000000004717

42. Dichgans M, Leys D. Vascular cognitive impairment. *Circ Res*. 2017;120:573–591. doi: 10.1161/CIRCRESAHA.116.308426

43. Kapasi A, DeCarli C, Schneider JA. Impact of multiple pathologies on the threshold for clinically overt dementia. *Acta Neuropathol*. 2017;134:171–186. doi: 10.1007/s00401-017-1717-7

44. Hurd MD, Martorell P, Delavande A, Mullen KJ, Langa KM. Monetary costs of dementia in the United States. *N Engl J Med*. 2013;368:1326–1334. doi: 10.1056/NEJMsa1204629

45. Goodman RA, Lochner KA, Thambisetty M, Wingo TS, Posner SF, Ling SM. Prevalence of dementia subtypes in United States medicare fee-for-service beneficiaries, 2011-2013. *Alzheimers Dement*. 2017;13:28–37. doi: 10.1016/j.jalz.2016.04.002

46. Doubal FN, Ali M, Batty GD, et al. Big data and data repurposing - using existing data to answer new questions in vascular dementia research. *BMC Neurol*. 2017;17:72. doi: 10.1186/s12883-017-0841-2

47. Froehlich TE, Bogardus ST, Jr, Inouye SK. Dementia and race: are there differences between African Americans and Caucasians? *J Am Geriatr Soc*. 2001;49:477–484. https://doi.org/10.1046/j.1532-5415.2001.49096.x.

48. National Heart, Lung, and Blood Institute. FY 2018 Funding and Operating Guidelines. https://www.nhlbi.nih.gov/node-general/fy-2018-funding-and-operating-guidelines. Accessed June 1, 2018.