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THE NATIONAL ACADEMIES INFOCUS

Fall 2017

Containing a CRISIS

**A Strategy to
Reduce the
National Opioid
Epidemic**

also in this issue

A Grid at Risk

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volume 16 number 2

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THE NATIONAL ACADEMIES

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For those who are actively seeking advice on steps they can take to maintain brain health and hold off mental decline, the National Academies recently released a report that identifies three interventions that might help.

Although the scientific evidence has not yet matured to the level that would support an assertive public health campaign aimed at the widespread adoption of any of these interventions, additional research could help us better understand and gain confidence in their effectiveness. The interventions that show encouraging scientific evidence, albeit inconclusive, for preventing cognitive decline and dementia are cognitive training, blood pressure management for people with hypertension, and increased physical activity.

“There is good cause for hope that in the next several years much more will be known about how to prevent cognitive decline and dementia, as more clinical trial results become available and more evidence emerges,” said Alan I. Leshner, chair of the study’s committee and CEO emeritus of the American Association for the Advancement of Science. “Even though clinical trials have not conclusively supported the three interventions discussed in our report, the evidence is strong enough to suggest the public should at least have access to these research results to help inform their decisions about how they can invest their time and resources to maintain brain health with aging.”

Cognitive training, which includes a broad set of activities aimed at enhancing reasoning and problem-solving, memory, and speed of processing, has shown low to moderate strength of evidence in randomized controlled trials — considered the gold standard of evidence — to delay or



Some Encouraging Evidence for Preventing Cognitive Decline and Dementia

slow age-related cognitive decline. Good evidence shows that cognitive training can improve performance on a trained task, at least in the short term. However, debate has centered on evidence for long-term benefits and whether training in one domain, such as processing speed, yields benefits in others, such as in memory and reasoning, and if this can translate to maintaining independence in instrumental activities of daily living like driving and remembering to take medications. Evidence from one trial suggests that cognitive training delivered over time and in an interactive context can improve long-term cognitive function as well as help maintain independence in daily activities for adults with normal cognition.

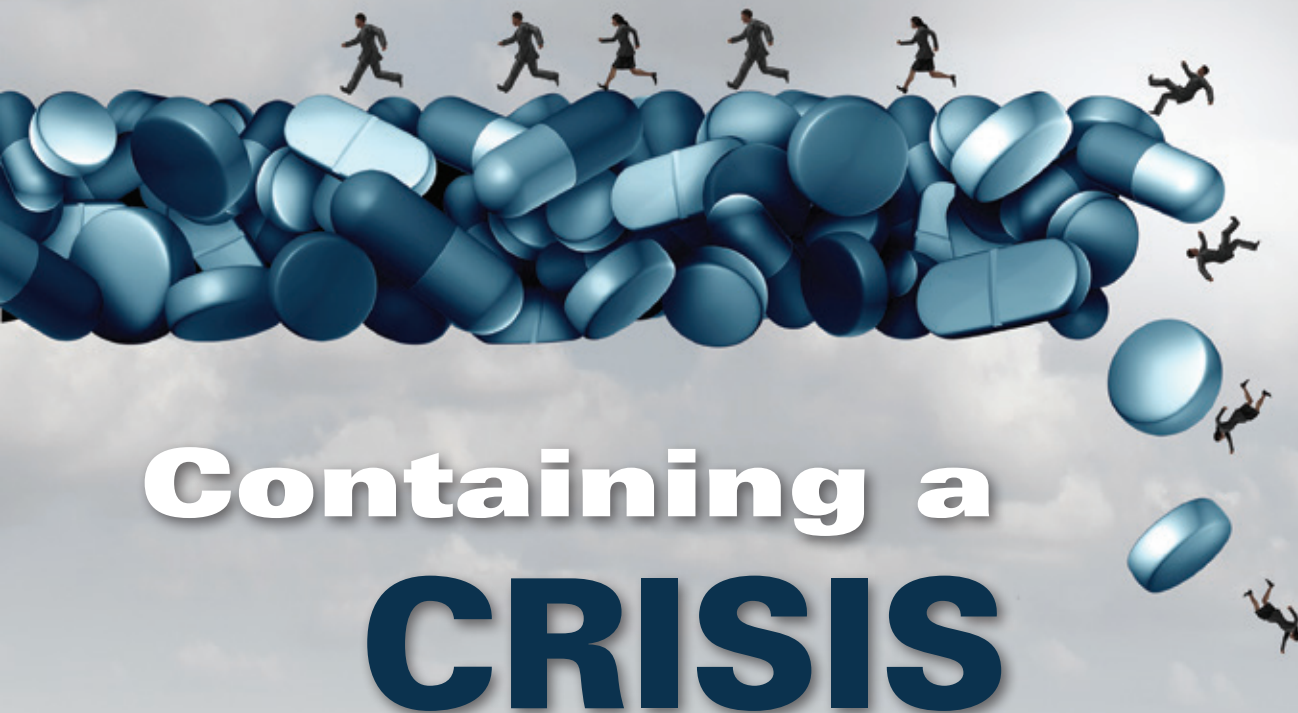
Blood pressure management for people with hypertension, particularly during midlife — generally ages 35 to 65 — is supported by encouraging but inconclusive evidence for preventing, delaying, and slowing clinical Alzheimer’s-type dementia. This evidence, together with the strong evidence for the role of blood pressure management in preventing stroke and cardiovascular disease and the relative benefit/risk ratio of antihypertensive medications and lifestyle interventions, is sufficient to justify communication with the public regarding the potential of blood pressure management.

Physical activity has been well-documented to have many health benefits, and some of these benefits — such as stroke prevention — are causally related to brain health. One systematic review found that the pattern of randomized controlled trial results across different types of physical activity interventions provides an indication of the effectiveness of increased physical

activity in delaying or slowing age-related cognitive decline, although these results were not consistently positive. However, several other considerations led the committee to conclude that the evidence is sufficient to justify communicating these findings to the public.

None of the interventions evaluated met the criteria for being supported by high-strength evidence, based on the quality of the trials and the lack of consistently positive results across independent studies. This limitation suggests the need for additional research as well as methodological improvements in future research. The National Institutes of Health and other interested organizations should support further research to strengthen the evidence base on cognitive training, blood pressure management, and increased physical activity, the committee said. Examples of research priorities for these three classes of interventions include evaluating the comparative effectiveness of different forms of cognitive training interventions; determining whether there are optimal blood pressure targets and approaches across different age ranges; and comparing the effects of different forms of physical activity. — *Jennifer Walsh*

Preventing Cognitive Decline and Dementia: A Way Forward (2017, 180 pp., ISBN 978-0-309-45959-4) is available from the National Academies Press, tel. 1-800-624-6242; \$75.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24782>. Additional resources are available at <www.nationalacademies.org/dementia>. The study was sponsored by the National Institute on Aging.



Containing a **CRISIS**

**A NEW REPORT
PRESENTS A
Strategy
TO REDUCE THE
National
Opioid
Epidemic**

The nation's opioid crisis lies at the intersection of two substantial public health challenges — containing the rising toll of societal harms that result from the misuse of opioid medications and reducing the burden of suffering for those who live with pain. A new National Academies report, requested by the U.S. Food and Drug Administration, says it is possible to stem the escalating prevalence of opioid use disorder and other opioid-related harms without foreclosing access to opioids for patients in pain whose providers have prescribed these drugs responsibly. It warns, however, that years of sustained and coordinated efforts will be required.

Opioids are a class of drugs that include prescription pain relievers, such as oxycodone, as well as the illegal drug heroin. Drug overdose is now the leading cause of unintentional injury deaths in the United States, and most of these deaths involve an opioid. U.S. Department of Health and Human Services data from 2015 indicate that each day an average of 90 Americans die from an overdose involving an opioid, and trends suggest that premature deaths associated with the use of opioids are likely to climb. At least 2 million Americans have

A fundamental shift in the nation's approach to prescribing practices and improving awareness of the risks and benefits of opioids is needed.

an opioid use disorder involving prescribed opioids and nearly 600,000 have an opioid use disorder involving heroin.

“The broad reach of the epidemic has blurred the formerly distinct social boundary between prescribed opioids and illegally manufactured ones, such as heroin,” said Richard J. Bonnie, Harrison Foundation Professor of Medicine and Law and director of the Institute of Law, Psychiatry, and Public Policy at the University of Virginia and chair of the committee that carried out the study and wrote the report. “This report provides an action plan directed particularly at health professions and the government agencies responsible for regulating opioids. This plan aims to help the millions of people who suffer from chronic

pain, while reducing unnecessary opioid prescribing. We also wanted to convey a clear message about the magnitude of the challenge. This epidemic took nearly two decades to develop, and it will take years to unravel.”

A fundamental shift in the nation's approach to prescribing practices and improving awareness of the risks and benefits of opioids is needed, the committee determined. To this end, it recommended measures to enhance education for both health professionals and the general public. These include developing an evidence-based national approach to pain education encompassing drug and non-drug treatments, creating educational materials on opioid prescribing for all health professionals who provide care to people with pain, requiring and providing basic training in the treatment of opioid use disorder for health care providers, and instructing prescribers and pharmacists to recognize and counsel patients who are at risk for opioid use disorder or overdose. In addition, the committee was struck by the relative lack of attention to educating the general public about the risks and benefits of prescription opioids and called for an evaluation of the impact and cost of an education program that raises awareness among patients with pain and the general public.

Restrictions on lawful access to prescription opioids could have unintended effects, the committee stressed, and any policy designed to curtail legal access to them will inevitably drive some people toward the illegal market. Therefore, any strategy for reducing lawful access to opioids should be coupled with an investment in treatment for the millions who have opioid use disorder. The committee recommended that





states, with assistance from relevant federal agencies, provide universal access to evidence-based treatment in a variety of settings, including hospitals, criminal justice settings, and substance-use treatment programs.

Preventing overdose deaths and other opioid-related harms should be substantially and immediately elevated as a public health priority. (Since the report's release, the White House declared the opioid epidemic a national emergency.) The committee recommended that states take steps to improve access to the life-saving medication naloxone, which treats opioid overdose, as well as safe injection equipment to reduce transmission of infectious diseases, such as HIV and hepatitis C.

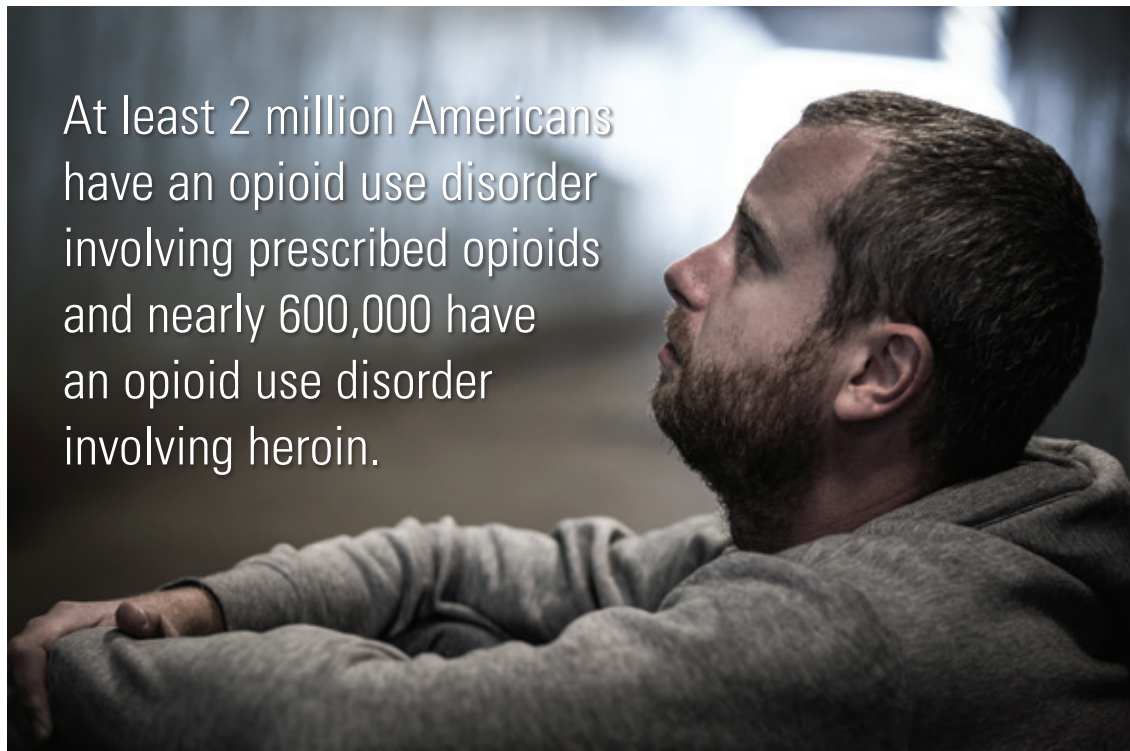
Another part of the strategy is to weigh the societal, not just the individual, impacts of opioids in regulatory decision-making.

The FDA traditionally has taken a product-specific approach to drug approval decisions by focusing on the data generated and submitted by a drug's manufacturer and balancing the benefits against the known risks to the individual patient, such as side effects. While this approach works well in most cases, it is necessary to view regulatory oversight of opioid medications differently from that of other drugs, because these medications can have a number of consequences not only at the individual level but also at the household and societal levels. Therefore, the FDA should incorporate public health considerations into opioid-related regulatory decisions, including during the clinical development, approval, and post-approval stages.

Several other strategies the committee recommended are:

- The FDA should complete a review of the safety and effectiveness of all approved opioids.

At least 2 million Americans have an opioid use disorder involving prescribed opioids and nearly 600,000 have an opioid use disorder involving heroin.



Special Publication for Clinicians

In September, the National Academy of Medicine released a new special publication — *First, Do No Harm: Marshaling Clinician Leadership to Counter the Opioid Epidemic* — at the request of the National Governors Association to assist governors as they work with clinicians to counter the opioid crisis. Authored by leading national authorities on substance use disorders, the 30-page paper serves as an action guide for clinicians if they are prescribing an opioid or managing a patient who presents with a likely opioid use disorder. To successfully marshal progress, the publication calls for clinicians to prioritize non-opioid strategies when managing chronic pain, follow five axioms of responsible opioid prescribing, and promote policies that stimulate and support available scientific evidence.

www.nam.edu/FirstDoNoHarm

- States should convene a public-private partnership to implement drug take-back programs that allow drugs to be returned to any pharmacy on any day, rather than relying on occasional take-back events.
- Public and private payers, which include insurance companies, should develop reimbursement models that support evidence-based and cost-effective comprehensive pain management that involves both drug and non-drug treatments for pain.
- HHS, in concert with state organizations, should conduct or sponsor research on how data from prescription drug monitoring programs can be better leveraged to track opioid prescribing and dispensing information.
- The National Institutes of Health, the Substance Abuse and Mental Health Services Administration, the U.S. Department of Veterans Affairs, and industry should invest in research that examines the nature of pain and opioid use disorder, as well as develop new non-addictive treatments for pain.

— Jennifer Walsh

Pain Management and the Opioid Epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use

(2017, 482 pp., ISBN 978-0-309-45954-9) is available from the National Academies Press, tel. 1-800-624-6242; \$77.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24781>. Additional resources are available at <www.nationalacademies.org/OpioidStudy>. The study was sponsored by the U.S. Food and Drug Administration.



The U.S. Role in

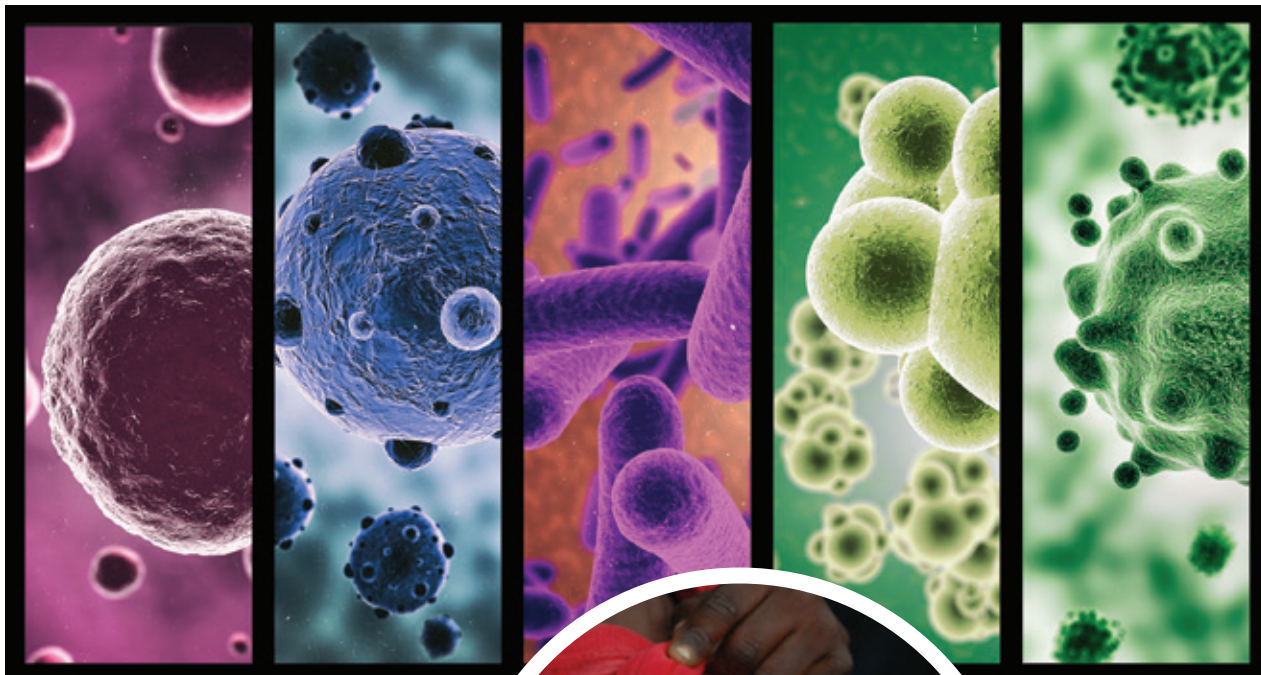
Global Health

From infectious disease pandemics such as the Ebola outbreak in 2014 to the silent killers of chronic noncommunicable diseases such as heart disease and diabetes, many health problems transcend national boundaries. Two recent reports from the National Academies examined the United States' role in global health and how we can better prepare for and respond to the next pandemic.

One report examined national priorities in light of current and emerging global health threats and concluded that the U.S. should maintain its leadership position in global health efforts as matter of national interest and as a public benefit that also enhances America's international standing. The growth in international travel and trade over the last several decades heightens the urgency of continued investments in global health. Moreover, the resulting increased interconnectedness of the world and interdependency of countries, economies, and cultures have brought not only improved access to goods and services but also a variety of health threats.

While additional investment is required, more money alone is not the answer, said the committee that wrote the report. It identified four priority areas for action:

- **Achieve global health security.**
- **Maintain a sustained response to the continuous threats of communicable diseases.**
- **Save and improve the lives of women and children.**
- **Promote cardiovascular health and prevent cancer.**



“By investing in global health over the next 20 years, there is a chance to save the lives of millions of children and adults,” said committee co-chair Valentin Fuster, physician-in-chief at Mount Sinai Hospital and director of Mount Sinai Heart. “The health and well-being of other countries both directly and indirectly affect the health, safety, and economic security of Americans.”

One of the key recommendations of the report is to improve international emergency response coordination, noting that the U.S. alone committed \$5.4 billion in response to the 2014 Ebola outbreak.



Similarly, another report by the National Academies examined how to improve the speed and effectiveness of clinical trial research to create drugs and vaccines while an epidemic is occurring, especially in settings with limited health care and research infrastructure.

Using key lessons learned from the Ebola epidemic, the study committee that wrote the report said that successful clinical trials for the next pandemic disease will rely on building capacity, community engagement, and collaboration among international stakeholders before and

during an outbreak. More specifically, mobilization of a rapid and robust clinical research program for the next infectious disease epidemic will depend on strengthening capacity in low-income countries for response and research, engaging people living in affected communities, and conducting safety trials before an epidemic hits. In addition, clinical trials could be more rapidly planned, approved, and implemented during an outbreak if promising products are studied through Phase 1 or Phase 2 safety trials in advance of an outbreak and if emergency response planning included clinical research considerations and clinical researchers in the discussions from the beginning.

The research and development of therapeutics and vaccines is a long, complex, and expensive process and cannot be compressed into the course of a rapidly progressing outbreak, the committee said. The development of a drug “from bench to bedside” is estimated, on average, to take at least 10 years and cost \$2.6 billion, with less than 12 percent likelihood of eventual

licensing. Thus, making progress on the research and development of products — such as therapeutics and vaccines — before an epidemic breaks is the only way to ensure that promising candidates are ready for trials once an outbreak occurs.

The Ebola clinical trial teams overcame immense logistical obstacles encountered while trying to design and implement trials in West Africa in the midst of a rapidly spreading epidemic of a highly dangerous contagious disease, the committee said. However, none of the therapeutic trials ended with conclusive results on product efficacy, although limited evidence from the trial for the ZMapp treatment did trend toward a possible benefit. Given the resources, time, and effort put into these trials, they were not as successful as they could have been. The results of the vaccine trials were more fruitful. Two Ebola vaccine candidates have data that suggest they may be safe and produce an immune response, and one is most likely protective, but further data are needed.

— *Jennifer Walsh & Dana Korsen*

Global Health and the Future Role of the United States

(2017, 384 pp., ISBN 978-0-309-45763-7) is available from the National Academies Press, tel. 1-800-624-6242; \$78.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24737>. Additional resources are available at <www.nationalacademies.org/USglobalhealth>. Jendayi Frazer, adjunct senior fellow for Africa studies at the Council on Foreign Relations, and Valentin Fuster, physician-in-chief at Mount Sinai Hospital and director of Mount Sinai Heart, co-chaired the study, which was sponsored by the U.S. Centers for Disease Control and Prevention, U.S. Food and Drug Administration, National Institutes of Health, President’s Emergency Plan for AIDS Relief, U.S. Agency for International Development, Rockefeller Foundation, Medtronic, Merck Foundation, and BD (Becton, Dickinson and Company).

Integrating Clinical Research Into Epidemic Response:

The Ebola Experience (2017, 342 pp., ISBN 978-0-309-45776-7) is available from the National Academies Press, tel. 1-800-624-6242; \$79.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24739>. Additional resources are available at <www.nationalacademies.org/EpidemicClinicalTrials>. The study committee was co-chaired by Gerald T. Keusch, professor of medicine and global health at Boston University Schools of Medicine and Public Health, and Keith McAdam, emeritus professor of clinical and tropical medicine at the London School of Hygiene and Tropical Medicine. The study was sponsored by the U.S. Department of Health and Human Services’ Office of the Assistant Secretary for Preparedness and Response, National Institutes of Health, and U.S. Food and Drug Administration.

Disaster Resilience of the Biomedical Research Community

PROTECTING THE NATION'S INVESTMENT

Each year, the federal government and other research sponsors invest about \$27 billion in life sciences research at U.S. academic research institutions. This hub of employment, productivity, and scientific progress drives local and national economic development and generates knowledge that affects society in myriad ways.

Recent disasters, from hurricanes to cyberattacks, and their consequences have shown that the investments of the federal government and of the many other entities that sponsor academic research are not uniformly secure, says a recent National Academies report. Failure to plan for those that lead to the greatest damage, such as in Hurricanes Katrina and Sandy, is often rooted in flaws that are systemic to an institution or to common practices in general across institutions — for example, storing generators and other utilities on low floors, housing research animals in basements, and establishing emergency procedures that do not account for employees' inability to reach the site and implement them.

The report recommends 10 steps that academic research institutions, researchers, and research sponsors should take to bolster the resilience of academic biomedical research. For example, research universities should implement mandatory disaster resilience education for research students,



staff, and faculty and integrate it within the broader safety, ethics, and compliance training programs already in place. And the National Institutes of Health should convene a consortium of stakeholders to discuss efforts that research sponsors can take to enhance the disaster resilience of the biomedical research enterprise.

Resilience planning should be an institution-wide process with full endorsement from senior leadership, institutional authority to establish priorities, and the necessary financial support, the report says. This planning should be aligned with the planning taking place at the local, state, and national levels through the National Preparedness System. In addition, the goals of these efforts should be to protect human life, research animals, and property and the environment, and to maintain the integrity and continuity of research. Each institution should designate a “chief resilience officer for the research enterprise” — a qualified senior individual with oversight of disaster resilience efforts designed specifically for



that institution. This person should lead a planning committee that works with the institution to assess the unique characteristics of its research enterprise, determine resilience goals and objectives, and develop and implement plans.

Principal investigators are an integral part of resilience efforts and should work with their academic research institutions to safeguard and preserve critical research data, supplies, and reagents, though protection of these materials and data is the responsibility of both the investigator and the institution. Institutions should increase incentives for off-site storage and the duplication of critical samples and data. In addition, institutions should develop performance-based standards for facilities and critical infrastructure. For example, they can ensure that disaster-resistant construction is an explicit design requirement for all new research buildings.

In order to preserve the lives and prevent the suffering of research animals, institutions should consider designating facilities

that house these animals as essential facilities and strive to incorporate fail-safe design criteria. Possible actions include developing evacuation and shelter-in-place procedures, as well as procedures in case research animals escape.

Each academic research institution should think about how to best invest its financial resources in the pre- and post-disaster environments to sustain and grow its research enterprise and develop an institutional financial investment strategy, the report says. Institutions could identify new sources or reallocate traditional sources of capital funds to enhance disaster resilience, for instance.

“Disasters that damage research laboratories and the institutions that house them can have enormous impacts — on the safety and well-being of humans and research animals, on career trajectories, and on scientific progress,” said Georges Benjamin, chair of the committee that wrote the report, and executive director of the American Public Health Association. “Continuing scientific advancement and the promise of future discoveries will require a commitment to resilience and an unparalleled partnership across the emergency management and academic research sectors.” — *Dana Korsen*

Strengthening the Disaster Resilience of the Academic Biomedical Research Community: Protecting the Nation's Investment

(2017, 448 pp., ISBN 978-0-309-46246-4) is available from the National Academies Press, tel. 1-800-624-6242; \$87.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24827>. The study was sponsored by the Alfred P. Sloan Foundation, Doris Duke Charitable Foundation, Howard Hughes Medical Institute, and National Institutes of Health.



Integrity

whether the scientific research enterprise is broken or seriously off-track.

The National Academies decided it was time to examine the research enterprise and whether additional steps are needed to protect the integrity of scientific research — revisiting a subject that the institution last explored in-depth in the 1992 report *Responsible Science: Ensuring the Integrity of the Research Process*.

The research environment is not broken, the Academies concluded in a new report, but there are significant challenges to creating the conditions needed to sustain the highest standards of integrity. One problem is that attention to research integrity often focuses exclusively on the behavior of individual researchers and not on their institutions or the broader research environment, both of which can either foster or discourage good practices. All stakeholders in the research enterprise — institutions, publishers, funders, scientific societies, federal agencies, and individual scientists — need to examine their practices and policies and improve those that weaken the integrity of research, the report says.

Because research institutions play a central role in fostering research integrity, they should maintain the highest standards, going beyond simple compliance with federal regulations and applying these standards to all research regardless of the source of funding. Institutions' key responsibilities include creating and sustaining a culture that encourages adherence to best practices and monitoring the

A number of developments in recent years — high-visibility cases of scientific misconduct, evidence that half or more of published results in some fields are not reproducible, and growth in the number of retracted journal articles — have raised questions about

IN SCIENTIFIC RESEARCH

integrity of their research environments. Senior leaders at each institution — the president, other senior executives, and faculty leaders — should guide these tasks. Institutions must also have the capacity to effectively investigate and address allegations of research misconduct.

A critical point of failure in many cases of misconduct where investigations were delayed or sidetracked has been inadequate responses to whistleblowers, the report notes. Research institutions and federal agencies should ensure that good faith whistleblowers — those who raise red flags about problematic research — are protected and their concerns addressed in a fair, thorough, and timely manner.

Currently, standards for transparency in many fields and disciplines do not adequately support reproducibility, which not only substantiates research findings but also enables other researchers to build on previous work. The report recommends that research sponsors and publishers ensure that the information needed for a person knowledgeable about the field to reproduce the reported results is made available at the time of publication or as soon as possible after that.

While the report endorses the definition of scientific misconduct proposed in the 1992 report — “fabrication, falsification, or plagiarism in proposing, performing, or reporting research” — it suggests changing how other behaviors are labeled to reflect their harmful effects. Many practices that have until now been described as “questionable”

research practices — for example, misleading use of statistics that falls short of falsification, and failure to retain research data — should be recognized as “detrimental” research practices.

To bring a unified focus to addressing challenges in fostering research integrity across all disciplines and sectors, the report urges the establishment of a nonprofit, independent Research Integrity Advisory Board. This group could facilitate the exchange of information on approaches for creating environments of the highest integrity and to handling allegations of misconduct and investigations. It could provide advice, support, encouragement, and where helpful advocacy. The board would have no direct role in investigations, regulation, or accreditation; rather, it would serve as a neutral resource that helps the research enterprise respond to integrity-related issues. — *Sara Frueh*

Fostering Integrity in Research (2017, 284 pp., ISBN 978-0-309-39125-2) is available from the National Academies Press, tel. 1-800-624-6242; \$55.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/21896>. The study committee was chaired by Robert Nerem, Institute Professor and Parker H. Petit Professor Emeritus, Institute for Bioengineering and Bioscience, Georgia Institute of Technology, Atlanta. The study was sponsored by the U.S. Geological Survey of the U.S. Department of the Interior, Office of Research Integrity of the U.S. Department of Health and Human Services, Office of the Inspector General of the National Science Foundation, Office of Science of the U.S. Department of Energy, U.S. Department of Veterans Affairs, U.S. Environmental Protection Agency, Burroughs Wellcome Fund, Society for Neuroscience, and the National Academy of Sciences Arthur L. Day Fund and the W.K. Kellogg Foundation Fund.



VALUABLE ASSETS

The Social, Behavioral, and Economic Sciences

Nearly every major challenge the United States confronts — from alleviating unemployment to protecting the nation from terrorism — requires understanding the causes and consequences of people's behavior. The diverse disciplines of the social, behavioral, and economic (SBE) sciences — such as anthropology, linguistics, and psychology — produce fundamental knowledge and tools that provide a greater understanding of why people and societies respond the way they do, what they find important, and what they believe and value — which is critical for a country's well-being.

In response to a request from the National Science Foundation (NSF), the National Academies of Sciences, Engineering, and Medicine appointed an expert committee to help determine whether the federal government should fund research in the SBE sciences at NSF. Specifically, the committee was asked to examine whether SBE research furthers the mission of NSF and those of other federal agencies and advances business and industry in the United States.

The committee concluded that the SBE sciences make significant contributions to the NSF's mission to advance health, prosperity, and public welfare, national defense, and scientific progress. In addition, the understanding, tools, and methods provided by the SBE sciences — including research supported by the NSF — provide an essential foundation that helps other government agencies achieve their missions. For example, NSF-supported research has provided valuable information about the patterns of behavior of hackers and the vulnerabilities of the nation's cyber networks. These analyses served as the basis for the development of tools and applications that contribute to military capability as well as to efforts to combat terrorism, which are central to the missions of the U.S. Department of Defense, intelligence agencies, and the U.S. Department of Homeland Security.

The SBE sciences also have provided advances applicable to business and industry and enhanced the U.S. economy, the report says. For example, social science methods such as polling and forecasting

are routinely used to inform consequential business decisions related to marketing, customer relations, and product development. In addition, the original version of the Google search engine resulted from a formula developed with NSF funding in the late 1990s. Researchers recognized that the decision to link pages to each other required conscious effort and the need to reflect human judgment about the significance of the link's destination, which led researchers to treat the collection of links as a network.

For future planning, NSF should undertake a systematic and transparent strategic planning process that defines SBE research priorities, the required resources, and how success in addressing SBE priorities will be evaluated over time. The report also includes recommendations for NSF to support training to prepare the next generation of scientists to be more data-intensive, interdisciplinary, and team-oriented, as well as communicate the results and value of the SBE research it supports and how NSF grants advance its mission. — *Dana Korsen*

The Value of Social, Behavioral, and Economic Sciences to National Priorities: A Report for the National Science Foundation (2017, 52 pp., ISBN 978-0-309-45992-1) is available from the National Academies Press, tel. 1-800-624-6242; \$50.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24790>. Alan I. Leshner, CEO emeritus of the American Association for the Advancement of Science, was chair of the study's committee. The study was sponsored by the National Science Foundation.

Polar Icebreakers



Setting Sail to Protect U.S. Interests in the Arctic and Antarctic

The U.S. has strategic national interests in the polar regions that require reliable, year-round access, attainable only through the use of icebreakers. In the Arctic, icebreakers help support economic interests, search-and-rescue needs, national defense and security readiness, environmental protection, maritime mobility, and scientific research. In the Antarctic, the U.S. maintains three year-round research facilities and verifies compliance with international treaty obligations, both of which require

icebreaking ability during any season.

The U.S. Coast Guard (USCG) currently has three multi-mission polar icebreakers in its inventory: the Polar Star, Polar Sea, and Healy. However, the Polar Sea was removed from service in 2011 after a major engine casualty during the preceding year and is being used for parts. And only the Polar Star — built in 1976 and nearing the end of its useful life in the next three to seven years — is capable of independently performing the annual breakout and resupply of McMurdo Station in the Antarctic.

“For more than 30 years, studies have underscored the need for U.S. icebreakers

to maintain polar presence, sovereignty, leadership, and research capacity, but the nation has failed to make the recommended investments, leaving the U.S. ill-equipped to protect its interests, while other nations have mobilized to expand their access to ice-covered regions,” said Richard D. West, retired rear admiral of the U.S. Department of the Navy and chair of a National Academies committee that made recommendations for ways to increase the United States’ icebreaking capability in the polar regions. “Given the strong warming and related environmental changes occurring in both the Arctic and Antarctic, the deficiencies in U.S. icebreaking capacity have become more critical.”

The committee’s report calls for the construction of four polar icebreakers with heavy icebreaking capability to allow the U.S. Coast Guard to meet its statutory mission needs at a lower cost, providing three ships for a continuous presence in the Arctic and one ship to service the Antarctic. The committee recommended an acquisition strategy that includes block buy contracting with a fixed-price incentive fee contract to ensure the best value for investment of public funds. By taking advantage of the approach outlined in the report and based on the acquisition of four ships of common design, the average cost per heavy icebreaker is estimated to be \$791 million. Four heavy icebreakers of common design will reduce operating and maintenance costs over the life of the vessels, improve continuity of service, increase USCG’s icebreaking capability, and improve operational effectiveness.

To continue to support research needs in a more cost-effective way, the USCG should

ensure that the new icebreakers are “science-ready,” and one should have full science capability to be used as a replacement for the Healy, as it is approaching the end of its life. Science-ready design includes several

“Given the strong warming and related environmental changes occurring in both the Arctic and Antarctic, the deficiencies in U.S. icebreaking capacity have become more critical.”

critical elements that cannot be retrofitted cost-effectively into an existing ship, such as flexible accommodation spaces and weight and stability latitudes to allow installation of scientific equipment. A fully science-capable ship would include features such as oceanographic overboarding equipment and instrumentation and facilities comparable to other modern oceanographic research vessels. Given the pivotal role of polar oceans in global circulation and Earth-system processes, and their importance to national security, maintaining U.S. polar oceanographic research capability is vital for the nation. — *Dana Korsen*

Acquisition and Operation of Polar Icebreakers: Fulfilling the Nation’s Needs (2017, ISBN 978-0-309-46293-8) is available from the National Academies Press at <www.nap.edu/catalog/24834>. The study was sponsored by the U.S. Coast Guard.

THE BATTLE AGAINST



The Greater Yellowstone Area (GYA) — which includes Yellowstone National Park, Grand Teton National Park, and the land surrounding them — is a region where wilderness meets ranches and farms, and where wild animals often cross paths with domestic ones. That contact has been the source of a problem that ranchers have struggled with for decades — brucellosis, an infectious disease that affects cattle, bison, and elk. The disease causes animals to abort late in the gestational period, decreases milk production, and leads to infertility in infected animals.

Most of the nation's cattle are now free of brucellosis, thanks to a decades-long eradication program. But the Greater Yellowstone Area is an exception: Between 1998 and 2016, 22 cattle herds and five privately owned bison herds in Idaho, Montana, and Wyoming were affected by the disease. The difficulty in eradicating the

disease springs from its prevalence in wild elk and bison herds in the region.


The National Academies' first study of brucellosis in the late 1990s produced recommendations for controlling transmission from bison and elk to cattle. But a re-emergence of the disease prompted the U.S. Department of Agriculture to ask the Academies to take another look.

One of the most significant changes in the understanding of brucellosis in recent years is that the disease in the Yellowstone area can be traced to transmission primarily from elk, not bison, says the Academies' new report. The prevalence of brucellosis in elk has been increasing from what were historically low levels. In addition, there is no effective brucellosis vaccine for elk, unlike for cattle and bison.

Federal and state agencies should prioritize their efforts on preventing brucellosis transmission by elk, the report says. Managing brucellosis in a complex

Brucellosis

Protecting Livestock From a Decades-Old Infectious Threat




ecosystem like that of the Greater Yellowstone Area will require that stakeholders and experts cooperate across disciplines to understand the costs and benefits of actions taken to control the disease's spread. Leadership at the highest levels of federal and state agencies should be involved in coordinating discussions and making decisions. In the past, the National Park Service, U.S.

could be done by allowing more hunting or targeting hunting toward elk populations at high risk of having brucellosis. Using contraception in high-risk female elk is another approach that could significantly reduce the elk population. Still another option is testing animals and removing those that are infected from the herd; this approach has been successful in halting the spread of brucellosis in domestic species and could be used in wild elk as well.

Another potential remedy would be to close supplemental feedgrounds for elk, which are used to reduce loss of elk in winter due to food shortage. Evidence suggests that gradually closing feedgrounds could reduce the prevalence of the disease in the broader elk population and benefit the herds' overall health in the long term. State and federal land managers should take a strategic, stepwise, science-based approach to analyzing how closing feedgrounds would affect elk health, risk of transmission to cattle, and brucellosis prevalence.

In general, the report says, making timely, data-driven decisions for reducing the risk of brucellosis will require that federal and state agencies adopt an active adaptive management approach — a method that involves testing hypotheses and using the results to inform subsequent decisions.

— Sara Frueh & Riya Anandwala



Department of Agriculture, members of local tribal groups, and the three affected states worked together to manage the risk of transmission from wild bison to domestic cattle and bison. A similar joint effort is needed to reduce transmission of brucellosis from elk to livestock.

No single management approach on its own can prevent transmission, the report says, but there are options that can lower the risks. For example, reducing the density or size of the GYA elk population — currently about 125,000 animals — would likely reduce the risk of transmission. This

Revisiting Brucellosis in the Greater Yellowstone Area (2017, 209 pp., ISBN 978-0-309-45831-3) is available only on the Internet at <www.nap.edu/catalog/24750>. The study was sponsored by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service.



ABOUT TO EXPLODE?

Improving Our Prediction of Volcanic Eruptions

Although we have a broad understanding of volcanoes, our ability to predict the timing, duration, type, size, and consequences of volcanic eruptions is limited. Volcano monitoring is critical for forecasting eruptions and mitigating the potential fallout, but few volcanoes are adequately observed, and many are not monitored at all, according to a new report by the National Academies of Sciences, Engineering, and Medicine.

Fewer than half of the 169 potentially active volcanoes in the U.S. have any seismometers — an instrument that detects small earthquakes, a signal of underground magma movement. And only three have

continuous gas measurements, which are crucial because the composition and quantity of dissolved gases in magma are what drive eruptions. The committee that conducted the study and wrote the report recommended using enhanced monitoring combined with advances in experimental and mathematical models of volcanic processes to improve our understanding and forecasting of eruptions.

“There have been great improvements in conceptual models of volcanic phenomena, compared with those used a few decades ago, but the volcano science community is not yet adequately prepared for the



next large eruption,” said Michael Manga, professor in the department of earth and planetary science at the University of California, Berkeley, and chair of the committee. “There are fundamental challenges that need to be addressed and require a sustained effort from across disciplines.”

The report outlines research priorities in areas such as the processes that move and store magma beneath volcanoes; how eruptions begin, evolve, and end; how a volcano erupts; forecasting eruptions; the response of landscapes, oceans, and the atmosphere to volcanic eruptions; and the response of volcanoes to changes on Earth’s surface.

Based on these research priorities, the committee identified three overarching grand challenges for advancing volcano science:

Forecasting the size, duration, and hazard of eruptions by integrating observations with models

Current forecasts are based on recognizing patterns in monitoring data. An approach based on models of physical and chemical processes, informed by monitoring data, as is done in weather forecasting, could improve the accuracy of eruption forecasts.

Quantifying the life cycles of volcanoes and overcoming our current biased understanding

Current understanding of a volcano’s life cycle is skewed because only a small number of volcanoes are studied. Extended monitoring from the ground, sea, and space can overcome some of these observational biases, the report says. The committee

“The volcano science community is not yet adequately prepared for the next large eruption.”

noted that emerging technologies such as inexpensive sensors, drones, and new micro-analytical geochemical methods are promising tools to provide new insights into volcanic activity.

Building a coordinated volcano science community

Strengthening multidisciplinary research, domestic and international research and monitoring partnerships, and training networks can help the research community maximize scientific advances that result from the study of eruptions around the world, the committee said.

These grand challenges may be large in scope and require great effort, but achieving them would yield new understanding of how volcanoes work and their consequences, and greatly improve our ability to plan appropriately for an impending eruption and adequately warn communities that would be affected. — *Riya Anandwala*

Volcanic Eruptions and Their Repose, Unrest, Precursors, and Timing

(2017, 134 pp., ISBN 978-0-309-45412-4) is available from the National Academies Press, tel. 1-800-624-6242; \$54.00 plus \$6.50 for single copies; also on the Internet at <www.nap.edu/catalog/24650>. The study was sponsored by the National Science Foundation, NASA, the U.S. Geological Survey, and the National Academies of Sciences, Engineering, and Medicine.





A Grid at

Risk

Securing the



Nation's Electricity System

The safety, productivity, comfort, and convenience of Americans depends on the reliable supply of electricity. But the electrical grid — a complex system of physical infrastructure and computer networks that transmits electricity from power plants to homes and businesses — is at risk from natural disasters and a potential target for malicious acts. A recent congressionally mandated report by the National Academies of Sciences, Engineering, and Medicine says that the U.S. Department of Energy and the U.S. Department of Homeland Security should work closely with utility operators and other stakeholders to improve the cyber and physical security and resilience of the nation's electricity system.

Diverse threats could cause extensive damage, loss of life, and prolonged, large-area outages costing billions of dollars, the report finds. The committee that conducted the study and wrote the report focused on how to reduce the potential for blackouts that extend over several service areas or states and last three days or longer. Events that can lead to this type of outage include hurricanes, earthquakes, solar storms, cyber



or physical attacks, and major operational errors. Although the possibility of such long-duration outages cannot be totally eliminated, the report identifies many steps that can be taken to make the power system less vulnerable and more resilient.

“Outages of this scale leave millions of customers without power, resulting in economic damages estimated in the billions of dollars, posing serious threats to health and public safety, and also potentially compromising national security,” said M. Granger Morgan, professor of engineering at Carnegie Mellon University and chair of the committee. “Outages caused by natural disasters are more common than one might think. While the U.S. has not been subject to a large physical assault or cyberattack, both pose serious and growing risks.”

To ensure that critical electric infrastructure is robust and that society is able to cope when the grid fails, the committee recommended increased investment in physical resources through public and private funds. For example, DOE, DHS, and other relevant agencies should oversee the development of more reliable inventories of backup power needs and capabilities, like the U.S. Army Corps of Engineers’ mobile generator fleet and recovery equipment like high-voltage transformers that can be rapidly deployed in an emergency. Investments should also

go toward expanding efforts to improve the ability to maintain and restore critical services, such as power for hospitals, first responders, water supplies, and communications systems.

The report includes several overarching recommendations to adopt a more integrated perspective across the numerous, diverse institutions responsible for the resilience of electricity system. The committee called for improvements in the process of systematically envisioning and assessing plausible large-area, long-duration grid disruptions, which should also focus on how such events could impact the U.S. dependence on vital public infrastructures and services provided by the grid.

The report also includes specific recommendations for federal, state, and regulatory agencies, detailing actions that different groups can undertake to improve grid resilience. For example, DOE should support a number of research, development, demonstration, and convening activities to improve the resilience of grid operations and recovery. The owners and operators of electrical infrastructure should work closely with DOE in systematically reviewing previous outages and demonstrating technologies, operational arrangements, and exercises that increase the resilience of the grid. — *Riya Anandwala*

Enhancing the Resilience of the Nation's Electricity System (2017, 170 pp., ISBN 978-0-309-46307-2) is available from the National Academies Press, tel. 1-800-624-6242; \$75.00 plus \$6.50 for single copies; also on the Internet at <www.nap.edu/catalog/24836>. The study was sponsored by the U.S. Department of Energy.

Energy Agency Makes Progress Toward Its Mission



The Advanced Research Projects Agency — Energy (ARPA-E) was created by Congress in 2008 with the mission to identify and speed transformational advances in energy technologies, funding high-risk research with potentially high returns for the nation. To help it pursue this ambitious aim, ARPA-E was given greater flexibility and autonomy than other DOE offices and programs.

The law that created ARPA-E required that it be evaluated six years into its operations, and tasked the National Academies with this assessment. To gauge the agency's progress, the Academies' study committee — made up of economists, engineers, researchers, program evaluators, and other experts — collected data on the program, conducted interviews with current and former ARPA-E

ARPA-E is in many cases
successfully enhancing the
economic and energy security
of the United States by
funding activities and areas
that the private sector would
be unlikely to fund.

personnel and DOE officials, and examined case studies of research and development that was funded by the agency.

In its report, the committee cautioned that ARPA-E cannot reasonably be expected to have completely fulfilled its goals given so few years of operation and the size of its budget. Developing new energy technologies usually takes decades, and decades also must usually pass before there is evidence that innovations are truly transformative.

Nevertheless, the report says, the agency is making progress toward achieving its mission and goals. While the full market impacts of ARPA-E-funded technologies will not be seen for years, some intermediate outcomes are evident now. One-quarter of the supported project teams or technologies have received follow-on funding for continued work; roughly half of supported projects have published the results of their research in peer-reviewed journals; and about 13 percent have obtained patents. All of these are positive indicators for technologies on a trajectory toward commercial products.

ARPA-E is in many cases successfully enhancing the economic and energy security

of the United States by funding activities and areas that the private sector would be unlikely to fund, the report says. The agency is also conducting studies to open up new technological directions and evaluate the technical merit of possible paths.

The agency's program directors have been empowered to take risks in selecting projects and to actively manage ongoing projects, which includes altering project milestones, budgets, and timelines, the report says. As it moves forward, ARPA-E should strive to preserve this management style and risk-taking culture, the report says. It stresses that there is no need to "reform" the agency, and that any attempts to do so — for example, by applying pressure for ARPA-E to show short-term successes rather than focusing on its long-term goals — could backfire and harm the agency's chances of meeting its mission.

The committee's assessment also concludes that ARPA-E is serving as a positive agent of change in DOE and the federal government, and notes that the agency's best practices are being adopted in other DOE offices. The secretary of energy should ensure that offices and programs within DOE continue to explore and adopt elements of ARPA-E's practices that can improve the department's operations. — *Sara Frueh*

An Assessment of ARPA-E (2017, 280 pp., ISBN 978-0-309-45945-7) is available from the National Academies Press, tel. 1-800-624-6242; \$64.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24778>. The study was chaired by Pradeep K. Khosla, chancellor, University of California, San Diego, and sponsored by the U.S. Department of Energy and the Alfred P. Sloan Foundation.



Strengthening the Nation's Skilled Technical Workforce

U.S. employers report having difficulty finding workers to fill skilled technical jobs. These jobs, which require a high level of technical knowledge but do not require a four-year degree for entry, can be found in most occupational groups, from health care to construction to manufacturing. Medical laboratory technicians, installation and repair technicians, and computer support specialists are examples of the many positions that fall into this category.

At the same time, however, many students and workers are unaware that these well-paying jobs are available, or they shy away from training for them because of a lack of basic math or science skills. Often, they do not have the information, guidance, and support needed to complete needed training or certification programs.

While it's unclear how well labor markets for skilled technical jobs are functioning on a national level, the U.S. is experiencing imbalances in supply and demand for these jobs in certain locations, occupations, and industry sectors, the report says. Gaps are particularly evident in health care and manufacturing — industries that increasingly require proficiency in science, technology, engineering, and mathematics (STEM) skills. Overall, according to a new National Academies report, the United States is not adequately developing and sustaining a workforce with the skills needed to compete in the 21st century.

“Skilled technical jobs are an increasingly essential part of our economy, and we need to give more priority to training people for these careers,” said committee chair and former U.S. Senator Jeff Bingaman. “In the international economy, we are competing with countries that are doing a better job than we are of training people in these skills.”

The report calls on state and federal policymakers to support and enhance strategies that help students successfully train for the skilled technical workforce. In addition, it says that public policies should ensure that stakeholders — including students, workers, employers, and educational organizations — have the right incentives to improve the quality of technical education and training, encourage experimentation and collaboration, and improve the collection and use of information about the market for skilled technical jobs.

To this end, the report calls on the U.S. Department of Education to collect and disseminate information on best practices at community colleges that facilitate timely



completion of skilled technical training programs and enhance the employment of graduates. And the U.S. Department of Labor should encourage employers to partner with an array of other stakeholders — industry and trade associations, labor unions, other civic organizations, educators, workers, and policymakers — to develop workforce skills.





Colleges and other educational organizations will need to create more flexible programs, offer supportive services to students, and offer programs that teach skills

In addition, federal and state agencies should remove barriers that can keep skilled technical workers from moving to where jobs are — for example, by dropping licensing and certification requirements

that are unrelated to public safety. Agencies should also collect and disseminate more information on the labor market's changing requirements for skilled technical workers, in order to help reduce imbalances in the labor market.

Action also is needed to raise awareness of the value of these jobs and the demand for them, the report says. It urges industry, trade,



sought by industry. The report recommends that the secretaries of education and labor offer incentives to these organizations — for instance, by using funding formulas tied to metrics focused on increasing enrollment and completion for programs in high demand among local employers.

Educating students to enter skilled technical careers is not enough, however. Actions are also needed to support lifelong learning for workers, the report says. For example, the Department of Education should consider ways to reform the financial aid system, which currently limits aid to undergraduate students in for-credit programs, leaving out students who are taking continuing education classes in certificate programs.

academic and civic associations, and labor unions, in cooperation with the U.S. departments of Labor and Education, to organize a communication campaign with that goal. — *Sara Frueh*

Building America's Skilled Technical Workforce

(2017, 258 pp., ISBN 978-0-309-44006-6) is available from the National Academies Press, tel. 1-800-624-6242; \$65.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/23472>. The study was sponsored by the National Science Foundation, the U.S. Department of Health and Human Services, the U.S. Department of Labor, grants from the Spencer Foundation, and additional support from the National Academy of Sciences W.K. Kellogg Foundation Fund. The study was also funded in part by a grant from JPMorgan Chase & Co.

Global Engineering Summit in Washington

Inspires Next Sparks



Students and educators from nearly 150 universities around the world gathered with engineers and policy-makers in Washington, D.C., in July for the third Global Grand Challenges Summit (GGCS), organized jointly by the U.S. National Academy of Engineering, the U.K. Royal Academy of Engineering, and the Chinese Academy of Engineering. Based on NAE's Grand Challenges for Engineering, the series of summits was established to spark collaboration and innovative thinking to address critically important global challenges and opportunities through engineering, and to inspire the next generation of change makers. Previous summits were held in London and Beijing.



“This summit and the Grand Challenges for Engineering are driven by a straightforward idea — what does engineering need to contribute in this century for continuation of life on the planet, making our world more sustainable, secure, healthy, and joyful,” said NAE President C. D. Mote, Jr., as he welcomed attendees to the summit. “The grand challenges idea is now nine years old, and its uptake is continuing to expand around the world. It is a movement, not a project, and while the idea is bigger than any of us, at the same time, we can all be part of it.”

GLOBAL GRAND CHALLENGES SUMMIT

engineering for the future

Generation, Collaboration



The summit kicked off with a keynote address from Rajiv Shah, president of the Rockefeller Foundation and former administrator of the U.S. Agency for International Development, who discussed his experience witnessing the importance of science, technology, and innovation for solving complex problems, such as the global fight to end extreme poverty and suffering.

Over the course of the packed schedule on George Washington University's campus, Ali Velshi, MSNBC host and NBC business correspondent, moderated discussions with speakers such as Jeffrey Dean, senior fellow at Google, about how advances in artificial intelligence and machine learning can be

used to tackle grand challenges, and Sally Davies, chief medical officer for the United Kingdom, about the challenge of antimicrobial resistance. During a session on climate change, Ding Yihui, senior adviser at the China Meteorological Administration, talked about the increasing risks of global climate change and about sustainable governance. In another session on reverse-engineering the brain — one of the grand challenges — Christof Koch, president and chief scientific officer at the Allen Institute for Brain Science, discussed the circuit elements that make up a brain.

A session on engineering education and public engagement began with a discussion about the Global STEM Challenges Program at Edison High School in Alexandria, Virginia, in which a diverse



“What does engineering need to contribute in this century for continuation of life on the planet, making our world more sustainable, secure, healthy, and joyful?”

group of 90 students work independently and in groups within teams focused on specific goals — such as building a portable, affordable microscope — that could solve real-world issues. Francis Reyes, who will be a sophomore this fall, explained the positive experience she has had in the program. “In STEM, I actually got to build a greenhouse! I didn’t know how to use tools [before], and now I do,” she said. “It’s hands-on. In most classes you’re taught to learn it and you’re not applying it to anything, so it doesn’t stick.”

The session was rounded out with a panel that included Deanne Bell, founder and CEO of Future Engineers and host of CNBC’s “Make Me a Millionaire Inventor,”

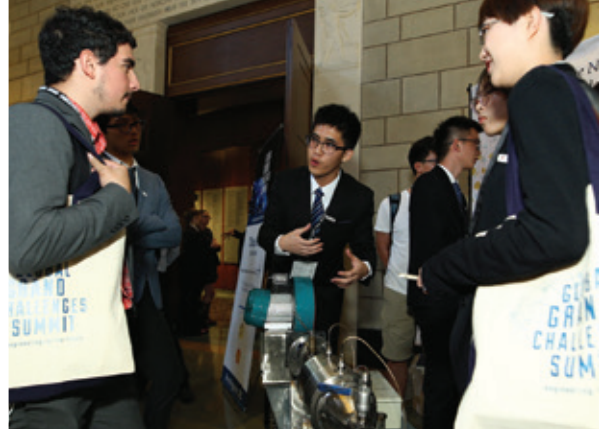
talking about how to empower early-stage hardware designers, inventors, and entrepreneurs — from building prototypes and developing business plans to finding investors. She also discussed the importance of communicating engineering passions publicly and connecting with females at a younger age in order to get them interested in engineering. U.S. Senator Tim Kaine of Virginia provided perspective on how public policy can support innovation.

In addition to the keynote addresses and discussions, five teams of undergraduate students from each of the host countries competed in a Student Day Business Model Competition during the summit, presenting their ideas and business models for addressing one or more of the NAE’s 14 Grand Challenges for Engineering. Three teams were recognized and received \$50,000 for their winning business model ideas. In addition, 10 undergraduate and graduate students took home \$2,000 each for posters they presented related to research on the grand challenges, such as an ultrasonic and vacuum wear-free washing machine and a virtual reality-enhanced intelligent upper-arm exoskeleton for rehabilitation of stroke patients.

The three engineering academies will continue their efforts to inspire this new generation of young problem-solvers during the next Global Grand Challenges Summit, which will be held in London in 2019. — *Dana Korsen*

Visit engineeringchallenges.org/14500/23671.aspx

The Global Grand Challenges Summit was sponsored by the Lockheed Martin Corp., the Boeing Company Charitable Trust, the Northrop Grumman Foundation, and Shell Oil Co.





A Lifeline for the Health Care Workforce

Health care workers across all specialties and care settings are experiencing alarming rates of “burnout,” often characterized by emotional exhaustion, detachment, and a low sense of personal accomplishment on the job. More than 50 percent of U.S. physicians report symptoms of burnout, and recent research has shown that declines in the well-being of health care professionals cut across all ages, career paths, and stages in their careers — from trainees to experienced practitioners. The consequences can be dire, ranging from reduced job performance and high turnover to extreme cases of medical error, patient dissatisfaction, and higher rates of suicide compared with other professions.

In response to this distressing evidence, the National Academy of Medicine launched a wide-ranging “action collaborative” of multiple organizations to promote clinician well-being and resilience. To date, more

than 50 professional and educational organizations have committed to the NAM-led initiative.

“It’s disturbing that so many clinicians are stressed out and overwhelmed, but even more so when we consider the impact on patients and society,” said National Academy of Medicine President Victor J. Dzau, who is chairing the initiative. “Addressing this problem will require individual, organizational, and systems-level reform. The NAM is committed to leading this collaborative effort in finding workable solutions that will ultimately benefit us all.”

Greater well-being produces clinicians who are more engaged, effective, and have improved relationships with their patients. However, rapid changes in the practice of health care over the past several years have resulted in busier schedules, more administrative tasks, and less time with patients and colleagues. Clinicians are being asked to provide high-quality care with less time and resources than ever before.

Supporting clinician well-being requires sustained attention and action at the organizational, state, and national levels. And it requires investment in research and information sharing to advance evidence-based solutions. The NAM-led collaborative will identify priorities for promoting clinician well-being and will stage collective efforts to advance evidence-based, multidisciplinary solutions that will reverse the trends in clinician stress and ultimately improve patient care and outcomes.
— Molly Galvin

To learn more or participate in the collaborative, visit www.nam.edu/ClinicianWellBeing.

NATIONAL ACADEMY OF SCIENCES RECEIVES \$10.5 MILLION TO ESTABLISH **FRED KAVLI ENDOWMENT FUND**

The National Academy of Sciences has received a \$10.5 million gift from the Kavli Foundation to establish the Fred Kavli Endowment Fund, which honors the late physicist, entrepreneur, innovator, business leader, and philanthropist.

To recognize Kavli's generous and unwavering support for science, the auditorium of the historic National Academy of Sciences building has been renamed the Fred Kavli Auditorium. A portrait of Kavli and a commemorative plaque were

unveiled during the Academy's 154th annual meeting.

"Fred Kavli had an insatiable curiosity about the world around him that underscored his appreciation and support of science and basic research," said Rockell Hankin, chairman of the board of the Kavli Foundation and Kavli's friend and associate for 40 years. "This gift aligns strongly with our Foundation's mission because it will give the National Academy of Sciences broad discretion in recognizing



and promoting outstanding science for the betterment of the nation and the world.”

“The National Academy of Sciences is the symbolic home for science in the United States,” added Robert W. Conn, president and chief executive officer of the Kavli Foundation. “It’s entirely fitting that Fred Kavli’s lasting contributions to the advancement of science are honored in a way that will have meaningful impact for the Academy and the entire scientific enterprise.”

The Fred Kavli Endowment Fund will provide unrestricted funding to the NAS, allowing the flexibility to provide timely guidance on cutting-edge issues in science. The funding will help support new programs, policy studies, and events that bring together experts and practitioners from many institutions and disciplines, fostering the Academy’s missions of validating scientific excellence; enhancing the vitality of the scientific enterprise; guiding public policy with science; and communicating the nature, values, and judgments of science to government and the public.

“Fred Kavli was a champion of basic research and the scientific process, and his legacy is felt widely throughout society,” said National Academy of Sciences President Marcia McNutt. “Through this generous gift, the NAS will build on that legacy by providing leadership on emerging issues for which science can inform effective policy and promote understanding of science.”

A Norwegian-born American citizen, Fred Kavli received a degree in engineering from the Norwegian Institute of Technology in 1955. He emigrated to the United States a year later, and in 1958 founded the Kavlico Corporation, which

became one of the world’s largest suppliers of sensors for aeronautics, automotive, and industrial applications. Kavli was the sole owner and sold the company in 2000. He then established the Kavli Foundation, dedicated to advancing science for the benefit of humanity, promoting public understanding of scientific research, and supporting scientists and their work. Former NAS President Ralph Cicerone was among those from whom Fred Kavli sought advice and guidance in creating the Foundation.

The deep connections between the Kavli Foundation and the NAS are built upon mutual goals of promoting science and recognizing scientific excellence. The NAS is among an international group of scientific societies that appoints representatives to committees that recommend winners of the Kavli Prizes — three \$1 million biennial prizes to recognize scientists for their seminal advances in astrophysics, nanoscience, and neuroscience. In addition, the NAS Kavli Frontiers of Science program, funded in part by the Kavli Foundation since 2005, brings together outstanding young scientists from a variety of disciplines to discuss advances and opportunities and build long-term relationships. In 2007, Fred Kavli and the Kavli Foundation provided initial funding to support the Academy’s America’s Energy Future project. And the Foundation and the Academy have worked together to encourage the adoption of convergence research at universities across the country. This research integrates promising developments in the physical and life sciences, mathematics, and engineering in order to find solutions to some of the most complex challenges facing humanity. — *Molly Galvin*



A BLUEPRINT FOR BETTER HEALTH CARE IN AMERICA

Health insurance coverage has dominated national policy debates, but Americans are facing issues in health care that go far beyond insurance. Structural inefficiencies, unprecedented costs, and fragmented care are putting larger burdens on patients, their families, and businesses and communities. An income-related gap in life expectancy is growing, and persistent health inequities remain across socio-economic and racial and ethnic lines, life stages, and geographic locations. Beyond systemic and structural problems, there are also serious public health challenges and threats: a worsening opioid epidemic; emerging infectious diseases; high rates of tobacco use, obesity, and related chronic diseases; and a rapidly aging population that requires more care.

This past March, the National Academy of Medicine released a publication that provides a succinct blueprint to address many of the predicaments facing Americans' health and health care. The paper is part of the NAM's *Vital Directions for Health and Health Care Initiative*, which conducted a comprehensive national health and health care assessment over the course of 18 months. Written by the initiative's bipartisan steering committee, the publication presents a streamlined framework of eight policy directions consisting of four priority actions and four essential infrastructure needs to advance American health, health care, and scientific progress. A companion publication was released in the *Journal of the American Medical Association* as a Special Communication.

"In the midst of controversies and political debates, we can't afford to lose focus

on the ultimate goal of achieving better health for all through an effective health care system — one that not only helps people prevent and treat their ailments but also helps every American reach their best health and well-being,” said Victor J. Dzau, president of the National Academy of Medicine and co-chair of the initiative steering committee. “With so many voices and ideas on how to reform health care, we wanted to cut through all the noise and draw upon expert advice for the most direct path the country should take.”

For its initiative, NAM recruited more than 150 leading experts in health policy, science, and research to examine how to address ongoing, national challenges and to propose the most promising opportunities to improve health and health care in the U.S. The publication summarizes the most important information from the initiative’s collection of 19 expert papers and a national symposium and builds upon lessons learned during previous health care reform experiences.

Achieving an optimal health and health care system for the United States requires commitment to three core goals: better health and well-being, high-value health care, and strong science and technology, the publication says. The complexity and magnitude of the issues at hand calls for vigorous leadership from every quarter, beginning with federal initiatives, but ultimately anchored in strong leadership and capacity at the state and local levels.

The four action priorities are to ensure payments reward high-quality care that is affordable for all, empower people to be fully informed and engaged in their personal health decisions, activate

communities to mobilize resources and promote partnerships for local solutions and health progress, and connect care by implementing integrated services and seamless digital interfaces for care. The four infrastructure needs are to use consistent and meaningful metrics to reduce reporting burdens and sharpen clinical performance and outcomes, modernize workforce skills for the 21st century health care and biomedical science, accelerate the use of real-world data by deriving evidence from everyday experience, and advance research to cures through innovation-ready clinical research processes, efficient regulation, and partnerships. The paper underscores that evidence exists on the potential of the eight policy directions to deliver better health for all Americans at a sustainable cost.

“These priorities offer major opportunities to improve health outcomes and prevent avoidable costs in the U.S. health care system,” said Mark McClellan, co-chair of the initiative steering committee; professor and director of the Duke-Margolis Center for Health Policy, Duke University; and former director of the Center for Medicare and Medicaid Services. “The policy directions represent a substantial departure from the status quo, and are needed now more than ever as health costs and health disparities continue to rise.”

Since the publication’s release, the NAM has been widely disseminating the work of the initiative, engaging key leaders across government agencies and Congress and the broader stakeholder communities. — *Molly Galvin*

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The number of people who participated in the third Global Grand Challenges Summit.

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The number of National Academies reports downloaded free of charge during the past year.

One recent consensus study report, *Human Genome Editing: Science, Ethics, and Governance*, has been downloaded over 13,700 times and reached 137 countries since its release in February 2017. This and many of the Academies' other expert studies are funded in part through private support.

351

The number of distinguished individuals named health policy fellows or scholars through the National Academy of Medicine.

Supported by private funds, the National Academy of Medicine administers four national fellowship and scholar programs. A fifth — the International Health Policy Fellowship — was announced in June of this year with the goal of fostering a pipeline of health policy scholars to solve some of the world's most critical health challenges.

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Steve Miller: Health of the Planet

Known as the “lungs of the planet,” the Amazon rainforest absorbs an enormous amount of the world’s carbon dioxide and produces oxygen. In recent decades, large swaths of the rainforest have been deforested for timber, urbanization, cattle ranching, and plant extracts. Today, roughly one-fifth of the Amazon is gone, and scientists cite this deforestation as a major contributing factor to global climate change. Through the juxtaposition of the X-rays and land-use imagery, Steve Miller reveals the inner structure and beauty of animals at risk and gives a broader perspective on their dwindling habitats. *Through Jan. 31, 2018*

The Arctic Melt: Images of a Disappearing Landscape

Exploring the effects of climate change on the Arctic, Diane Tuft traveled by plane, boat, and helicopter during the summers of 2015 and 2016 to photograph landscapes in Svalbard, Norway, the Arctic Ocean’s sea ice, and the icebergs and ice sheet of Greenland. This exhibition of 11 large-scale photographs features both panoramic views and close-ups to show the power and vastness of the seas, while documenting the fragility of the snowbound landscape as it melts away. *Through Feb. 20, 2018*



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