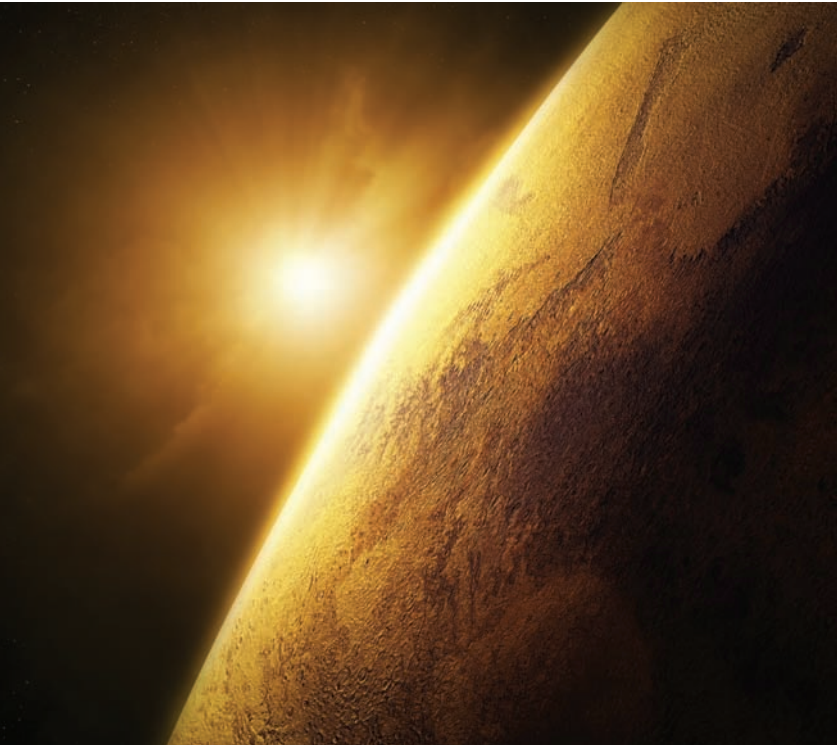


# THE NATIONAL ACADEMIES **IN FOCUS**

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Incarceration Rates in the United States  
The Promise and Perils of a Changing Arctic  
Next Steps in Human Space Exploration



**Fall 2014**  
vol. 14 number 1

# THE NATIONAL ACADEMIES

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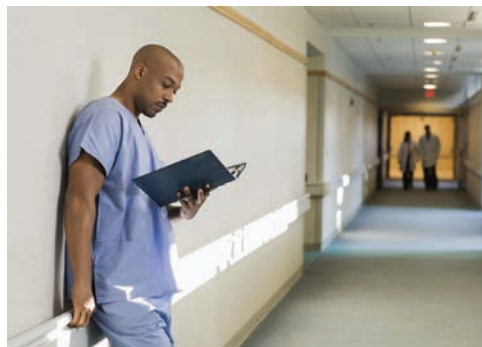
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# The New Arctic

**A RAPIDLY CHANGING CLIMATE  
OPENS DOOR FOR NEW  
OPPORTUNITIES, BUT ALSO  
INVITES NEW RISKS**

**A** recent report from the National Research Council highlights new questions that have emerged or might arise in the wake of rapid changes in the Arctic. Because the climate, biology, and societies of the Arctic are transforming in complex and interconnected ways, the report organizes the research questions into five cross-cutting categories.

What happens in the Arctic doesn't stay in the Arctic. As average global temperatures rise, this region of the planet is experiencing a loss of ice and snow, thawing permafrost, and shifts in ecosystems, changes that have far-reaching implications around the world, from coastal flooding to food production to our daily weather.

The “evolving Arctic” focuses on the transition to the new normal of reduced ice and snow and the cascading impacts it will have on environmental and societal systems in the region. The “hidden Arctic” explores what could be found as snow and ice retreat, as well as what could be lost forever. The “connected Arctic” examines how the changes occurring there affect the rest of the northern hemisphere and beyond. The “managed Arctic” aims to understand the implications of human drivers of change such as urbanization, international relations, and industrial and technological development. Finally, the “undetermined Arctic” addresses the need to be prepared to detect and respond to the unexpected.

## New Opportunities, New Challenges

Earth's changing climate is increasing the accessibility of the Arctic region to industries such as oil and gas development, shipping, and tourism. Unfortunately, this surge in human activity also increases the possibility of an oil spill.

The Arctic poses unique challenges for responding to oil spills, including extreme weather, limited infrastructure to support spill response operations and communications, and vulnerable species and ecosystems. While much is known about oil behavior and the capabilities of response technologies in ice-covered environments, there is a need to validate current and emerging response tools under these real-world conditions.

Another recent National Research Council report recommends conducting carefully controlled field experiments that release oil into Arctic waters as part of a long-term comprehensive research and development program. When an oil spill occurs, decision makers should use a process that compares the advantages and disadvantages of different response options in order to select the combination of tools that offer the greatest reduction in environmental harm. Key response options include biodegradation, chemical dispersants, in situ burning, and mechanical containment and recovery.

## Building Capacity

As areas once ice-bound and inaccessible become available, there is a growing need for infrastructure both to support new research endeavors important for understanding how transitions occurring in the Arctic will affect environments and societies worldwide, and to ensure that

the region's species, ecosystems, and communities are protected against an influx of human activity.

Both of the reports call for cooperation and communication among researchers, local, state, and federal decision makers, and international communities to meet their respective goals, and highlight the importance of meaningful engagement with indigenous groups to ensure that traditional knowledge is incorporated into policy decisions and that research is translated back into practicable information.

— *Lauren Rugani*

■ ***The Arctic in the Anthropocene: Emerging Research Questions.*** Committee on Emerging Research Questions in the Arctic, Polar Research Board, Division on Earth and Life Studies (2014, 224 pp.; ISBN 978-0-309-30183-1; available from National Academies Press, tel. 1-800-624-6242; \$65.00 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog/18726.html](http://www.nap.edu/catalog/18726.html)>). The study was co-chaired by **Henry P. Huntington**, senior officer at the Pew Charitable Trusts in Eagle River, Alaska, and **Stephanie Pfirman**, professor of environmental and applied sciences at Barnard College and Columbia University in New York City. The study was funded by the U.S. Arctic Research Commission, U.S. Department of Energy, NASA, National Oceanic and Atmospheric Administration, National Science Foundation, and Smithsonian Institution.

■ ***Responding to Oil Spills in the U.S. Arctic Marine Environment.*** Committee on Responding to Oil Spills in the U.S. Arctic Marine Environment, Ocean Studies Board and Polar Research Board, Division on Earth and Life Studies; Marine Board, Transportation Research Board (2014, 210 pp.; ISBN 978-0-309-29886-5; available from National Academies Press, tel. 1-800-624-6242; \$58.00 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog/18625.html](http://www.nap.edu/catalog/18625.html)>). The study was chaired by **Martha R. Grabowski**, chair of the business administration department at Le Moyne College in Cazenovia, N.Y. The study was funded by the U.S. Arctic Research Commission, American Petroleum Institute, U.S. Coast Guard, Bureau of Ocean Energy Management, Bureau of Safety and Environmental Enforcement, Marine Mammal Commission, National Oceanic and Atmospheric Administration, Oil Spill Recovery Institute, and the National Academy of Sciences.



# The Promise of Microbial Forensics

## Building a Better Toolbox Against Biological Pathogens

**W**ith the popularity of police procedural TV series such as “CSI” and “NCIS,” many people are familiar with the power of DNA as a tool to identify and convict criminals, exonerate the innocent, and identify missing persons.

Much as human DNA can be used as evidence in criminal trials, genetic information about microorganisms can also be analyzed to identify their possible origins. The tools and methods used to investigate these organisms — and the serious threats they pose — belong to the emerging field known as microbial forensics. Used to examine biological outbreaks ranging from deliberate acts of bioterrorism to the accidental release of a microorganism to the rise of a natural and virulent pathogen, microbial forensics can help officials prevent further cases of exposure by quickly identifying both the dangerous microorganism and its source.

Despite its promise, however, the field is still in the early stages of development. It faces substantial scientific challenges in providing a robust suite of technologies to identify the source of biological threats, says a new report from the National Research Council.

The report emphasizes the importance of creating, testing, and validating methods that are compatible with rare incidents, such as bioterrorism or accidental releases, as well as common outbreaks due to natural causes. This way, detection and response are not delayed by the absence of or unfamiliarity with diagnostic protocols and tools.

One of the largest hurdles in the development of this field is the prospect of long

timeframes. There are particular goals that will likely take years to fully realize due to technologically challenging circumstances. For example, there is a crucial need for the development of high-confidence methods to distinguish among natural, accidental, and deliberate disease outbreaks. In addition, a more comprehensive database of microorganisms and their basic information has yet to be established.

Objectives that can be accomplished in a relatively short period of time include the development of faster, cheaper, and more reliable sequencing technologies, the compilation and validation of protocols used for sampling and sequencing, as well as the expansion of technical training to increase the number of qualified practitioners.

The report also calls for collaboration among international scientific communities to identify, monitor, and characterize global microbial species. This effort would benefit the entire discipline of microbial forensics and help reduce complications that often arise when an investigation crosses international boundaries. — *Christina Anderson & Lauren Rugani*

■ **Science Needs for Microbial Forensics: Developing Initial International Research Priorities.** Committee on Science Needs for Microbial Forensics: Developing an Initial International Roadmap, Board on Life Sciences, Division on Earth and Life Studies, in cooperation with the Croatian Academy of Sciences and Arts, U.K. Royal Society, and International Union of Microbiological Societies (2014, 252 pp.; ISBN 978-0-309-30245-6; available from National Academies Press, tel. 1-800-624-6242; \$56.00 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog/18737.html](http://www.nap.edu/catalog/18737.html)>).

The study committee was chaired by **John D. Clements**, professor and chair of microbiology and immunology at Tulane University School of Medicine, New Orleans. The study was funded by the U.S. Navy, U.S. Department of State, and National Academy of Sciences.



## A PATHWAY TO MARS

The **Red Planet** may be the next giant leap for mankind, but getting there will require numerous challenging steps

Two enduring questions have long dominated the minds of scientists and sci-fi enthusiasts alike: How far into space can humans go? And, what will we find when we get there? For now, given technological challenges and the limited ability of the human body to withstand long-duration space missions, Mars is the furthest realistic destination for human spaceflight.

**T**he long voyage from Earth to Mars will be expensive, challenging, and dangerous. While maintaining a long-term focus on Mars as the “horizon goal” for human spaceflight, NASA should pursue a pathway approach that involves first reaching a series of intermediate destinations such as an asteroid, the moon, or Martian moons, according to a recent National Research Council report.

These intermediate stops will help incrementally build the technical capacity and knowledge required for a successful human visit to Mars. For each combination of destinations, there are trade-offs among affordability, schedule, risk, and frequency of missions, and the development of technologies or capabilities applicable to a future Mars mission. Ten high-priority capabilities need to be developed, the report says, with a particular emphasis on Mars entry, descent, and landing, radiation safety, and in-space propulsion and power.

While the report doesn't recommend which pathway NASA should follow, it says that extended surface operations on the moon would make significant contributions to a strategy ultimately aimed at landing people on Mars, and that it would also provide opportunities for international and commercial cooperation.

## Rationale for Human Spaceflight

Public opinion of the space program has historically been positive, with views becoming more favorable after a significant accomplishment, such as putting a man on the moon in 1969. In the past, the rationales used to justify the cost and risk of human spaceflight have included economic benefits, national security, national stature and international relations, inspiration for science and engineering education, and contributions to scientific knowledge.

In today's budget environment, however, most of the public does not view spending for space exploration as a high priority. In fact, many people admit to not paying much attention to or being well-informed about the topic. Among the general public, and even among scientists in both space-related and unrelated fields, there is no agreement on a single pragmatic reason for continuing a human spaceflight program.

But a shared human destiny and urge to explore, as well as the eventual survival of the human species, provide aspirational rationales for space exploration. When supplemented by the practical benefits associated with the pragmatic rationales, there is an argument for a continued human space program in pursuit of the answers to those enduring questions.

## A National Vision

The success of a human mission to Mars will rely greatly on a steadfast national commitment to the goal, one that doesn't waver across political administrations or economic scenarios. It will also benefit from international collaboration, including potentially with China, which has demonstrated its own methodical and successful progress toward a sustained human space program.

National leaders can use the report's set of proposed principles to decide on a given pathway, measure its progress, navigate off one pathway and onto another, or cease the endeavor altogether.

A pathway to Mars will be measured in decades and hundreds of billions of dollars, and will only succeed with appropriate funding. A flat budget, or one that increases only with inflation, will not work, the report states. The only pathways that would successfully land humans on the surface of Mars require spending to rise above inflation for an extended period.

— *Lauren Rugani*

### ■ *Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration.*

Committee on Human Spaceflight, Aeronautics and Space Engineering Board and Space Studies Board, Division on Engineering and Physical Sciences; and Committee on National Statistics, Division of Behavioral and Social Sciences and Education (2014, 279 pp.; ISBN 978-0-309-30507-5; available from National Academies Press, tel. 1-800-624-6242; \$67.00 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog/18801.html](http://www.nap.edu/catalog/18801.html)>).

The study was co-chaired by **Jonathan Lunine**, director of the Center for Radiophysics and Space Research at Cornell University in Ithaca, N.Y., and **Mitchell E. Daniels Jr.**, former governor of Indiana and president of Purdue University in West Lafayette, Ind. The study was funded by NASA.



# The Future of Autonomous Flight

**W**hile drones have been used for years in military missions and intelligence gathering, the use of unmanned aircraft in the civilian world is on the verge of exploding for applications ranging from dusting crops to making movies to delivering packages. Regulatory approval for widespread commercial use of these aircraft in the United States is still pending, but some countries are already using unmanned aircraft extensively, particularly in agriculture.

Nearly all unmanned aircraft now in use operate under continuous human control, albeit remotely. But systems are also being developed that allow aircraft to adapt to changing conditions and determine how to handle situations without human intervention. In addition to guiding unmanned aircraft, these “increasingly autonomous” systems could be used in piloted aircraft and air traffic management systems to lessen the need for human monitoring and control of certain functions, with the goal of increasing safety and reducing costs.

Unmanned and increasingly autonomous aircraft have the potential to revolutionize civil aviation and could offer many benefits, says a new report from the National Research Council, but a number of barriers need to be overcome before these aircraft can be safely integrated into the U.S. civil aviation system.

One technological stumbling block is building unmanned and autonomous systems so that they are compatible with existing air traffic management systems. Barriers also exist in the realm of regulations and certification; for example, most existing safety standards are designed to ensure the safety of passengers and crew — not a worry on

unmanned aircraft, where the concern is how these aircraft might themselves endanger passengers in other planes and people on the ground. And before truly autonomous craft can safely take to the skies, more work needs to be done to develop and refine machine sensory, perceptual, and cognitive systems.

To surmount these and other hurdles, the report recommends a national research agenda, one to which government, industry, and academia can all make contributions. For example, for autonomous aircraft to operate for extended periods of time without real-time human oversight, their systems will need to perform certain critical functions currently provided by humans, such as detecting and avoiding obstacles and making decisions in emergency situations. Developing these systems successfully will depend on understanding how humans perform those functions now and translating them to the autonomous system, particularly for high-risk situations. Also on the recommended research agenda are the development of models to determine how autonomous designs perform under various conditions, as well as approaches to validate and certify autonomous aircraft before they can enter the aviation system. — *Sara Frueh*

■ **Autonomy Research for Civil Aviation: Toward a New Era of Flight.** Committee on Autonomy Research for Civil Aviation, Aeronautics and Space Engineering Board, Division on Engineering and Physical Sciences (2014, 95 pp.; ISBN 978-0-309-30614-0; available from National Academies Press, tel. 1-800-624-6242; \$45.00 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog/18815.html](http://www.nap.edu/catalog/18815.html)>).

The study committee was co-chaired by **John-Paul Clarke**, associate professor at the Daniel Guggenheim School of Aerospace Engineering, Georgia Institute of Technology, and **John Lauber**, private consultant. The study was funded by NASA.

# Learning From Fukushima

## REPORT EXAMINES LESSONS FOR THE U.S.



**O**n March 11, 2011, at 2:46 p.m. local time, a large earthquake struck off the northeast coast of Japan. Approximately 50 minutes later, a tsunami flooded parts of the Fukushima Daiichi Nuclear Power Plant, sparking a chain of events that resulted in the meltdown of three reactor cores and hydrogen explosions in three reactor buildings. Offsite releases of radioactive materials contaminated land in Fukushima and several neighboring prefectures, which prompted widespread evacuations of local populations, triggered large economic losses, and led to the eventual shutdown of all nuclear power plants in Japan.

The U.S. Congress requested that the National Academy of Sciences assess the causes of the accident and determine what could be learned and applied here in the United States.

The personnel at the Fukushima Daiichi plant responded to the accident with courage and resilience, said the committee that undertook the study, which found that the employees' actions likely reduced its severity and the magnitude of offsite radioactive material releases. However, several factors prevented plant personnel from achieving greater success and contributed to the overall severity of the accident. The overarching lesson learned from the accident,

says the committee's report, is that nuclear plant licensees and their regulators must actively seek out and act on new information about hazards that can affect the safety of nuclear plants.

In response to the accident, nuclear plant operators and regulators in the U.S. and other countries are taking actions to upgrade nuclear plant systems, operating procedures, and training. As the U.S. nuclear industry and its regulator, the U.S. Nuclear Regulatory Commission (USNRC), implement upgrades, the report recommends particular attention to improving specific systems at nuclear plants: DC power for instrumentation and safety system control; tools for estimating real-time plant status during power losses; reactor heat removal and depressurization; containment venting systems and protocols; instrumentation for monitoring critical thermodynamic parameters — for example temperature and pressure — in reactors, containments, and spent-fuel pools; hydrogen monitoring; instrumentation for onsite and offsite radiation and security monitoring; and communications and real-time information systems. The report also recommends the U.S. nuclear industry and the USNRC improve resource availability and operator training and strengthen their capabilities for assessing risks from events that could challenge the design of nuclear plant structures and components. Part of this effort should focus on external events that have the potential to affect large geographic regions and multiple nuclear plants, including earthquakes, tsunamis and other geographically extensive floods, and geomagnetic disturbances. The USNRC should sup-

port these efforts by providing guidance and overseeing rigorous peer review, and eventually use these strengthened risk-assessment capabilities to further incorporate modern risk concepts into its nuclear safety regulations. The industry and its regulator should continuously seek to maintain a strong safety culture.

Four decades of analysis and operating experience have demonstrated that reactor core-damage risks are dominated by “beyond-design-basis events” — such as equipment failures, loss of power, and inability to cool the reactor core — that could impair critical safety functions, the report says. The Fukushima Daiichi, Three Mile Island, and Chernobyl accidents were all initiated by beyond-design-basis events. Current approaches for regulating nuclear plant safety are clearly inadequate for preventing core-melt accidents and mitigating their consequences, the committee found. A more complete application of modern risk-assessment principles in licensing and regulation could help address this inadequacy and enhance the overall safety of all nuclear plants, present and future.

— *Jennifer Walsh*

■ **Lessons Learned From the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants.**

Committee on Lessons Learned From the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants, Nuclear and Radiation Studies Board, Division on Earth and Life Studies (2014, approx. 366 pp.; ISBN 978-0-309-31177-9; available from the National Academies Press, tel. 1-800-624-6242; \$64.95 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog/18294.html](http://www.nap.edu/catalog/18294.html)>).

The study was chaired by **Norman Neureiter**, senior adviser at the Center for Science Diplomacy and acting director of the Center for Science, Technology, and Security Policy of the American Association for the Advancement of Science. The study was sponsored by the U.S. Nuclear Regulatory Commission.



# Improving Treatment Programs for PTSD

strategy to track outcomes of their treatment efforts. Without tracking outcomes, neither DOD nor VA knows whether it is providing effective or adequate PTSD care, for which they spent \$294 million and more than \$3 billion, respectively, in 2012.

“Given that the DOD and VA are responsible for serving millions, we found it surprising that no PTSD outcome measures are used consistently to know if these treatments are working or not,” said Sandro Galea, chair of the committee that wrote the report. “They could be highly effective, but we won’t know unless outcomes are tracked and evaluated.”

The report also recommends that DOD and VA have an adequate workforce of mental health care providers to meet the growing demand for PTSD services. While the departments have substantially increased their mental health staffing, the pace has not kept up with the demand. Such staffing shortages can result in clinicians not having time to provide evidence-based psychotherapies readily. In 2013, only 53 percent of veterans of the Afghanistan and Iraq conflicts who had a primary diagnosis of PTSD and sought care in the VA received the recommended eight sessions within 14 weeks.

— Jennifer Walsh & Sara Frueh

■ **Treatment for Post-Traumatic Stress Disorder in Military and Veteran Populations — Final Assessment.** Committee on the Assessment of Ongoing Efforts in the Treatment of Post-Traumatic Stress Disorder; Institute of Medicine (2014, 300 pp.; ISBN 978-0-309-30173-4; available from the National Academies Press, tel. 1-800-624-6242; \$57.00 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog18724.html](http://www.nap.edu/catalog18724.html)>).

The study was chaired by **Sandro Galea**, professor and chair of the department of epidemiology, Mailman School of Public Health, Columbia University, New York City. The study was sponsored by the U.S. Department of Defense. The report is the second of a two-phase assessment of PTSD services for service members and veterans.

**F**or many service members who were deployed to Afghanistan and Iraq, an internal battle continues in the form of post-traumatic stress disorder (PTSD). From 2003 to 2012, the overall number of veterans who sought care for PTSD at the VA more than doubled — from approximately 190,000 veterans to more than a half million. An estimated 5 percent of all service members in the military health system, and 8 percent of those who have served in Afghanistan and Iraq, have been diagnosed with PTSD.

The U.S. Department of Defense and the U.S. Department of Veterans Affairs have responded to this rising tide with a multitude of programs and services to prevent, screen for, diagnose, and treat current and former service members who have PTSD or who are at risk for it. Although the departments are making strides in a positive direction, their treatment programs appear to be local, ad hoc, incremental, and crisis-driven, with little planning devoted to the development of a long-range approach to obtaining desired outcomes, says a recent report from the Institute of Medicine.

The report calls for both departments to develop a coordinated and comprehensive



## Exploring the **Causes** and **Consequences**

After decades of stability, the United States' incarceration rate more than quadrupled in the past 40 years, increasing the country's penal population to 2.2 million adults, the largest in the world. Currently, nearly 1 out of 100 American adults is in prison or jail, which is 5 to 10 times higher than rates in Western Europe and other democracies.

**T**he rise in state and federal prison populations occurred in main part because of policy decisions such as mandatory sentencing, long sentences for violent and repeat offenses, and intensified criminalization of drug-related activity. Stricter sentencing policies were formed initially during a period of rising crime and social change; however, over the four decades when incarceration rates rose steadily, crime rates fluctuated.

According to a recent National Research Council report, this unprecedented and internationally unique rise in incarceration is not serving the country well. Given the minimal impact of long prison sentences on crime prevention and the negative social consequences and considerable fiscal burden of high incarceration rates, the U.S. should revise current criminal justice policies to significantly reduce imprisonment rates, the report recommends. Specifically, federal and state policymakers should re-examine policies requiring mandatory and long sentences, as well as take steps to

improve prison conditions and to reduce unnecessary hardship and harm to the families and communities of those incarcerated. In addition, policymakers should reconsider drug crime policy, in view of the apparently low effectiveness of a heightened enforcement strategy that resulted in a tenfold increase in the incarceration rate for drug offenses from 1980 to 2010 — twice the rate for other crimes.

The committee that wrote the report evaluated scientific evidence on the effects of high incarceration rates on public safety and U.S. society, as well as their effects on those in prison, their families, and the communities from which prisoners originate and to which they return. It found that the current rate of imprisonment comes at a considerable cost. Allocations for corrections have outpaced budget increases for nearly all other key government services, including education, transportation, and public assistance.

People who live in poor and minority communities have always had substantially higher rates of prison admission and return than other groups. Consequently, the report says, the effects of harsh penal policies in the past 40 years have been concentrated in severely disadvantaged communities and have fallen most heavily on blacks and Hispanics. Of those incarcerated in 2011, about 60 percent were black or Hispanic.

In addition, incarceration correlates with negative social and economic outcomes for former prisoners and their families, as men with a criminal record often experience reduced earnings and employment after prison. From 1980 to 2000, the number of children with incarcerated fathers increased from about 350,000 to 2.1 million — about

3 percent of all U.S. children. Further, housing insecurity and behavioral problems in children are hardships strongly related to fathers' incarceration.

The committee stressed that future policy decisions regarding incarceration should not only be based on empirical evidence but also should be guided by four principles with deep roots in jurisprudence and social policy. The principles state that criminal offenses should be sentenced in



proportion to their seriousness, the period of confinement should be sufficient but not greater than necessary to achieve the goals of sentencing policy, the conditions and consequences of imprisonment should not be so severe or lasting as to violate one's fundamental status as a member of society, and prisons should be instruments of justice and as such their collective effect should be to promote society's aspirations for a fair distribution of rights, resources, and opportunities. — *Dana Korsen*

■ ***The Growth of Incarceration in the United States: Exploring Causes and Consequences.*** Committee on Causes and Consequences of High Rates of Incarceration, Committee on Law and Justice, Division of Behavioral and Social Sciences and Education (2014, 464 pp.; ISBN 978-0-309-29801-8; available from National Academies Press, tel. 1-800-624-6242; \$74.95 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog/18613.html](http://www.nap.edu/catalog/18613.html)>).

The study committee was chaired by **Jeremy Travis**, president, John Jay College of Criminal Justice, New York City. The study was funded by the National Institute of Justice and the John D. and Catherine T. MacArthur Foundation.



## FINANCING GRADUATE MEDICAL EDUCATION

**E**very year, approximately \$15 billion in public funding is invested in “graduate medical education,” which is the residency training that medical school graduates must complete to become licensed to practice. The majority of this financing comes from the Medicare program — an estimated \$9.7 billion in 2012.

Medicare has provided a secure and stable source of funding for residency training for almost 50 years; however, today’s health care system is very different from that of 1965. The burden of chronic disease, the need for greater emphasis on preventive care, and modern information technologies have all shifted health care increasingly to clinics and community settings. Yet — much as it did in 1965 — physician training continues to take place at large training hospitals rather than in the health care settings used by most Americans.

A new report by the Institute of Medicine calls for a significant overhaul of this financing system, which currently requires little accountability, allocates funds regardless of workforce needs or educational outcomes, and offers few opportunities to train physicians in settings other than hospitals.

Teaching hospitals receive the majority of Medicare’s funding for physician training, and the funds are distributed to these hospitals through complicated formulas linked to the volume of Medicare patients treated, even though physicians in training treat patients from all walks of life. These hospitals control how the funds are spent, but few data about the costs, effectiveness, or outcomes of the training programs exist, the report says. The mix of available physician training slots may be driven more by the needs or priorities of individual teaching hospitals rather than U.S. health care needs.

Between 2003 and 2013, for example, there was a disproportionate increase of physicians being trained as specialists despite a greater demand for generalists.

The U.S. Department of Health and Human Services should establish a two-part governance infrastructure to oversee policy and decision making and fund distribution, the report says. Medicare support should be provided through two distinct funds — an operational fund to finance ongoing residency training activities and a transformational fund to finance new training slots where needed, provide technical support, and support much needed research and innovative pilot programs.

To encourage training at a variety of settings, funds should be distributed directly to hospitals, clinics, universities, and other sponsors of the training, and the payment methodology should be based on a single national, per-resident amount. These improvements should be made during 10-year transition period to allow careful planning and avoid intended harm. — *Molly Galvin*

■ **Graduate Medical Education That Meets the Nation’s Health Needs.** Committee on the Governance and Financing of Graduate Medical Education, Board on Health Care Services, Institute of Medicine (2014, 232 pp.; ISBN 978-0-309-30355-2; available from National Academies Press, tel. 1-800-624-6242; \$67.00 plus \$5.00 shipping for single copies; also on the Internet at <[www.nap.edu/catalog/18754.html](http://www.nap.edu/catalog/18754.html)>).

The study was co-chaired by **Donald M. Berwick**, former president and CEO of the Institute for Healthcare Improvement; and **Gail Wilensky**, economist and senior fellow at Project HOPE. The study was funded by the American Board of Internal Medicine Foundation, Aetna Foundation, California Endowment, California HealthCare Foundation, Commonwealth Fund, East Bay Community Foundation, Jewish Healthcare Foundation, Kaiser Permanente Institution for Health Policy, Josiah Macy Jr. Foundation, Missouri Foundation for Health, Robert Wood Johnson Foundation, UnitedHealth Group Foundation, Health Resources and Services Administration, and the U.S. Department of Veterans Affairs.

## Supporting Science, Technology, and Innovation in **AFRICA**



**D**uring August, President Obama hosted a summit for 50 African leaders in Washington, D.C., to enable discussion of shared priorities and commitment to Africa's development. At the same time, the National Academies held a symposium to explore the roles of science, technology, and innovation in Africa's development.

Among the keynote speakers was Grace Naledi Mandisa Pandor, South Africa's minister of science and technology, who spoke about some of the challenges facing Africa and South Africa in particular, such as decreasing funding for universities. "Our institutions that would advance innovation are not receiving the support that they should in order to execute this role," she said. Loss of human capital is



a problem as well, Pandor added, noting that 4 in 10 African scientists live and work in high-income countries. Solutions to these problems could include establishing conditions supportive of R&D investment and partnerships. "The investment of private companies and charities in R&D needs to be supported through favorable tax policy, a strong research base, and a culture promoted by government for international collaboration."

Building science and technology capacity through international partnerships was

a priority mentioned by Wole Soboyejo, president of the African University of Science and Technology in Nigeria. One of the university's partnerships has created a pipeline of scientists ranging from students to senior scientists to run a virtual institute whose R&D projects have led to technologies that improve ceramic water filters and that convert kerosene lanterns into solar lanterns, providing rural areas with a more sustainable energy source.

The president of the Nigerian Academy of Science, Oyewale Tomori, noted the need for improved computer and Internet access to build Africa's scientific capacity, while his counterpart at the Uganda

National Academy of Sciences, Nelson Sewankambo, pointed to the need to build awareness of the value of evidence in effective policymaking. The policy advice space in Africa is not crowded, so there is an opportunity for science academies to do more, especially given the "noise" policymakers hear on many issues.



Private-sector perspectives were offered by representatives from IBM and General Electric, who stressed the importance of investing in local innovation and in building capacity by training people.

The event also included a teleconference with researchers at the Nelson Mandela Institute in Tanzania who are part of USAID's Partnerships for Enhanced Engagement in Research (PEER) Program. The program, whose grants are administered by the U.S. National Academies, supports scientists in developing countries who conduct research on development issues in collaboration with National Science Foundation-supported scientists. Archived videos of the conference sessions can be found at <[vimeo.com/album/3052525](https://vimeo.com/album/3052525)>.

— Sara Frueh



## Publications

*For documents shown as available from the National Academies Press (NAP), write to 500 Fifth St., N.W., Room 360, Washington, D.C. 20001; call tel. 202-334-3313 or 1-800-624-6242; or order on the Internet at <www.nap.edu>. Documents from a specific unit of the National Academies are available from the source as noted.*

### 3D Printing in Space

Aeronautics and Space Engineering Board and National Materials and Manufacturing Board, Division on Engineering and Physical Sciences (2014, approx. 100 pp.; ISBN 978-0-309-31008-6; available from NAP).

### Acute Exposure Guideline Levels for Selected Airborne Chemicals, Vol. 17

Committee on Toxicology, Board on Environmental Studies and Toxicology, Division on Earth and Life Studies (2014, 492 pp.; ISBN 978-0-309-30476-4; available from NAP).

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Committee on Toxicology, Board on Environmental Studies and Toxicology, Division on Earth and Life Studies (2014, 178 pp.; ISBN 978-0-309-31189-2; available from NAP).

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### Can Earth's and Society's Systems Meet the Needs of 10 Billion People? Summary of a Workshop

Board on Environmental Change and Society and Committee on Population, Division of Behavioral and Social Sciences and Education; and Board on Life Sciences, Division on Earth and Life Studies (2014, 112 pp.; ISBN 978-0-309-30634-8; available from NAP).

### Capturing Change in Science, Technology, and Innovation: Improving Indicators to Inform Policy

Committee on National Statistics, Division of Behavioral and Social Sciences and Education; and Board on Science, Technology,

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