LACK OF SLEEP COSTS US HUNDREDS OF BILLIONS OF DOLLARS EVERY YEAR—AND THAT’S JUST THE START. PAGE 12

America’s HEALTH OUTCOMES

Investing in INNOVATION

The future of the ELECTRICITY GRID

SLEEP DEPRIVED
1. The Future of Artificial Intelligence
RAND experts talk about the unintentional biases due to data and design practices affecting AI systems in use today and why caution must be used in designing AI systems for the future.
MORE AT www.rand.org/a161214

2. The Value of Overseas Security Commitments
To what extent does the U.S. derive economic benefits from its overseas security commitments? This interactive visualization tool allows for comparisons among different estimated "gains" and "losses" from selected retrenchment levels and selected tax, spending, and trade multipliers.
MORE AT www.rand.org/t/TL229

3. Healthy Tweets
Does America prioritize health and well-being? To find out, RAND experts sifted through 32 million tweets about a range of health topics: obesity, exercise, safe sex, alcohol use, mental health, and more.
MORE AT www.rand.org/b160126

4. Health History
To celebrate the 40th anniversary of the RAND Health Insurance Experiment (HIE), the largest, most comprehensive, evidence-based health policy study in U.S. history, the HIE research team and other health policy experts discuss the long-lasting impact of HIE on the health policy landscape.
MORE AT www.rand.org/v170113

5. "Drive" My Car
In testimony presented before the Senate Appropriations Committee, Subcommittee on Transportation, Housing and Urban Development, and Related Agencies, information scientist Nidhi Kalra discussed how policymakers can promote safety, mobility, and efficiency in the brave new world of driverless vehicles.
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RAND researchers found a strong link between how much a country spends on social programs, such as old-age benefits, and its health outcomes. That could explain why America spends more on health care than other countries but scores worse on several measures of population health—the so-called American health care paradox.
Blood as a Public Health Good

It’s a familiar story in the new economy: an industry grappling with historic change, caught between high supply costs and falling demand for its products. In this case, though, the health of millions rides on the outcome.

The industry is blood. A recent RAND study warned that America’s system for supplying it to hospitals and health centers might not be sustainable—and may need an infusion of government oversight and investment.

That system extends far beyond the public blood drives of the American Red Cross and other blood centers. It includes testing centers and equipment suppliers, blood brokers, hospitals, clinicians, and—at the end of the intravenous line—patients. In 2013, it produced more than 13 million units of transfused blood for hospital operating rooms, cancer treatment centers, and other medical uses.

But better surgical techniques and hospital procedures have cut down on the demand for blood. Hospital mergers, and growing competition among blood suppliers, have further reduced revenues across the industry. At the same time, the costs of collecting, testing, and delivering blood have stayed level or even increased.

For now, the system continues to provide blood when and where it’s needed. But those challenges could eventually threaten its ability to always have a safe supply of blood available, especially during public health emergencies, RAND researchers concluded. That suggests a role for the federal government, the researchers wrote—especially given the life-and-death importance of a reliable blood supply. For example, it could invest in new disease tests and other technologies that would make the blood supply safer. It also could set guidelines for how much blood the system needs to hold to provide an adequate surge supply, and then subsidize efforts to reach that level.

The goal should be to address any shortages quickly, safely, and efficiently, the researchers wrote—a safety net for the nation’s blood supply.

Another Kind of Battle

The U.S. military needs a clear strategy as it confronts a hidden threat to the health and readiness of its forces: the misuse of powerful prescription drugs.

That threat is not unique to the military, RAND researchers noted in a recent study. Prescription drug misuse has fed a nationwide epidemic of opioid overdoses and deaths in recent years. But there is reason for special concern among service members: In 2010, the most recent year studied, more than a quarter of those in active duty had a prescription for some kind of opioid painkiller.

Yet military directives provide little guidance on how to prevent or treat the misuse of prescription drugs, the researchers found. And interviews with military health care providers revealed some uncertainty about how to identify misuse or respond when prescriptions become problems.

The researchers created a tracking tool to help the military get a better handle on drug misuse within the ranks, and to better predict trends going forward. That will help the military identify when and where prevention or treatment efforts will be most effective.

More immediately, though, the military should provide some basic training—and more support—to help its health care providers get ahead of the problem, the researchers wrote. It also should reconsider its mostly zero-tolerance approach to problem users. One alternative: expanding programs that allow service members to report themselves for treatment without facing harsh consequences, which have been successful in addressing alcohol use disorders.

“The threat to readiness is real,” the researchers concluded, “and matters not just for individual service members but also for the entire teams or units to which those service members belong.”
The Price of Justice

Think about this the next time you watch the evening news: Every homicide in the United States costs taxpayers as much as $44,000 in legal fees and court costs.

The number comes from a recent RAND study that calculated what it takes to prosecute and defend different crimes, from the judge's salary to the paper supplies.

Those court costs represent only a small fraction of the overall harm done by crime, of course. But they provide a fuller picture of the drain on the legal system that each and every crime causes—and a new way to measure the economic benefits of reducing crime.

Researchers worked through national databases of state and local court expenditures, caseloads, and crime rates. Importantly, their estimates reflect the average court costs of every reported crime, not just those that make it all the way through trial.

The results provide the first comprehensive look at how much it costs to adjudicate seven major types of crime. Those include homicides ($22,000 to $44,000), rapes and sexual assaults ($2,000 to $5,000), aggravated assaults ($800 to $2,100), and robberies ($600 to $1,300).

Put another way: Preventing a single theft ($300 to $600) could free up 30 minutes of a judge's time; three hours of work by both prosecutors and public defenders; five hours of court staff time; and $100 of supplies, equipment, and other costs.

"Programs that prevent crime can be expensive, but benefit everyone by freeing up resources in our criminal justice system," said economist Priscillia Hunt, lead author of the study. "We hope this research will contribute to the dialogue on how to allocate scarce dollars, improve the efficiency of the criminal-justice system, and pay for crime-prevention programs."

MORE AT WWW.RAND.ORG/T/EP66592
Today, our researchers are working on the same questions driving Silicon Valley startups and billion-dollar Bay Area corporations. RAND launched a new office this year in the San Francisco Bay Area to serve as a research hub at the intersection of technological change, innovation, and public policy. Nidhi Kalra, a senior information scientist who studies science and technology policy, will lead the office. Her recent work includes groundbreaking studies on autonomous vehicles and a TEDx talk on the science of making good decisions.

**Investing in Innovation**

A new Bay Area office signifies RAND’s commitment to public-policy research at the cutting edge

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**Q Why is RAND opening a Bay Area office?**

**A** The San Francisco Bay Area is really at the center of technology and transformation. That’s also been a focus at RAND since our very first report, *Preliminary Design of an Experimental World-Circling Spaceship*, in 1946, which foretold the creation of satellites more than a decade before *Sputnik*. Today, our researchers are working on important questions related to autonomous vehicles, drones, cybersecurity, education technology, virtual medicine—the same questions driving Silicon Valley startups and billion-dollar Bay Area corporations. At the same time, we’re looking at issues surrounding social inequality, drug policy, water resource management, and transportation, all of which directly relate to the Bay Area.

**How do you see RAND becoming part of the conversation there?**

RAND works to make individuals, families, and communities throughout the world healthier, safer, and more prosperous. Today, that means finding ways to make the most of the innovation coming from the Bay Area. We bring a unique set of tools to these policy questions: big-data analytics, gaming, methods to help people make hard decisions in the face of uncertainty. We want to partner with the region’s technology and innovation communities, to link our research and their expertise to make better policies and improve people’s lives.

**Will RAND’s work in the Bay Area only focus on technological innovation?**

Not at all. In just the past several years, the U.S. Preventive Services Task Force released new guidelines for colorectal cancer screening informed by RAND modeling and estimating efforts; the Centers for Disease Control and Prevention launched an online tool created by RAND researchers to help states decide how best to invest in and implement interventions proven to prevent car injuries and death; and RAND was instrumental in the development of Louisiana’s 50-year coastal risk mitigation and restoration plan, which was adopted unanimously by the state legislature. Researchers behind that effort are now helping other vulnerable regions reduce future flood risks and achieve greater resilience to confront future disasters. Technological innovation will be an important part of the work this office does, but it won’t be the limit.

**What is an example of a project this office might do?**

We recently took a look at whether test-driving autonomous vehicles could really prove their safety. Nobody had asked that question before. And we showed that it would take hundreds of millions of test-drive miles, maybe billions, to demonstrate that autonomous vehicles are safer than humans with any kind of statistical certainty. The industry and regulators need to look at other ways to make sure autonomous vehicles are safe—such as simulations, mathematical modeling, or limited pilot studies. We’re already seeing some of that today. It just goes to show that part of innovation is asking those hard questions, and answering them.
Next Stop, Neptune?
WHY WE CAN’T RELY ON TEST-DRIVING ALONE TO ASSESS THE SAFETY OF AUTONOMOUS VEHICLES

More than 90 percent of motor vehicle crashes in the United States are caused by human error, such as drunk driving, speeding, and fatigue. Technology heavyweights are betting that driverless cars will become the safer and more efficient ride of the future, greatly reducing the number of crashes—and associated deaths, injuries, and other losses—on our roadways.

Understandably, people want to know just how safe these autonomous vehicles (AVs) are, and especially whether they’re safer than human drivers. Test-driving seems like a logical way to assess the safety of AVs—until you begin to calculate the distance and time required.

That’s because fatalities are quite rare compared with the number of miles Americans drive every year, causing slightly over one death every 100 million miles. So, when it comes to fatality rates, AVs would have to rack up a truly astronomical distance to prove that they’re safer than human drivers. In fact, if you have a fleet of 100 test AVs that are 20 percent safer than the average human driver, you’d have to drive them a total of 5 billion miles to prove it—a journey involving about 225 years of driving around the clock at 25 mph. For crashes and injuries, the distance and time required are less vast but still daunting.

Is there any way to get these numbers down? Not by much, even if we’re willing to accept less-precise or less-certain findings. In fact, choosing different thresholds can drive the numbers even higher.

But this doesn’t mean that driverless cars can never be deemed safe enough for the open road—just that holding out for data from test drives would mean waiting a long, long time. Instead of putting AVs on near-indefinite hold, regulators should pursue additional options for reducing uncertainty about their safety.

Even with other methods, though, it might prove impossible to fully assess AV safety without actually making driverless vehicles widely available. So, policymakers should look for ways to reduce risk even if they can’t quantify it. They must also balance the pursuit for certainty against the possible consequences of postponing widespread use of AVs. These include not only perpetuating the fatalities human drivers cause but also missing out on opportunities to increase mobility, improve energy efficiency, and regain the value of time spent traveling.

More than 35,000 Americans died in motor vehicle accidents in 2015, including lawmakers, insurance companies, manufacturers, and, of course, consumers. About 3 trillion miles annually.

AVs WOULD HAVE TO BE TEST-DRIVEN ASTRONOMICAL DISTANCES TO SHOW THEY ARE 20 PERCENT BETTER THAN HUMAN DRIVERS AT . . .

AVOIDING CRASHES 28 million miles or 1.3 years
AVOIDING INJURIES 170 million miles or 3.2 years
AVOIDING FATALITIES 5 billion miles (about the distance of a round trip to Neptune) or 225 years

NOTE: Confidence interval = 95%. Times provided assume a fleet of 100 test AVs driving continuously at an average of 25 mph. Crash and injury rates used here include police-reported incidents and estimates of unreported incidents.

2015 fatality data are from the Bureau of Transportation Statistics.

Adapted from Driving to Safety: How Many Miles of Driving Would It Take to Demonstrate Autonomous Vehicle Reliability? by Nidhi Kalra and Susan M. Paddock, RR-1478-RC, 2016, available at www.rand.org/t/RR1478. Funding for this study was provided by philanthropic contributions from RAND supporters and income from operations. We especially appreciate the support from the RAND Justice, Infrastructure, and Environment Advisory Board and the National Cooperative Highway Research Program.
Americans spend more on health care than any other nation in the world. Yet from birth to old age, Americans live shorter, sicker lives than people in most other wealthy countries.

A two-year research project at RAND adds some weight to a theory that might explain why. It found better health outcomes in countries that spend more on social safety-net programs like child care subsidies or old-age benefits—even when they spend less on hospital stays and medical tests.

Health care alone, in other words, can only go so far to promote health. Evidence has been accumulating for years that where and how people live plays at least as important a role in how well, and how long.

The RAND study put a number to that idea. Every percentage-point increase in overall spending invested in social-welfare programs was associated with 18 more days of life, on average, for every man, woman, and child.
Every percentage-point increase in overall spending invested in social-welfare programs was associated with 18 more days of life, on average, for every man, woman, and child.
When a prescription won’t suffice

Dr. Ellen Rothman could hear the tap-tap of dripping water coming from somewhere in the single-room apartment, behind the three bunk beds on the wall and the mattress on the floor. Rothman, the chief medical officer of the Martin Luther King Jr. Outpatient Center in South Los Angeles, had come on a house call. The woman who lived here with her husband and six children had become a frequent patient at the clinic as doctors struggled to control her asthma.

Rothman could see from the woman’s living conditions that she would be back. The home was so crowded that there was barely room to step. It had no place for the children to play, no place for the woman to catch a breath. And that dripping faucet meant mold was almost certainly spreading through the walls.

“I could give her as much asthma medicine as I wanted,” Rothman said. “If you don’t have access to the right kinds of food, the right kinds of sanitation, the right kinds of housing, it doesn’t matter how many asthma attacks we treat. You’re going to have more.”

A health paradox

America spent $3.2 trillion on health care in 2015, nearly $10,000 per person. Yet by the most basic measure of population health—life expectancy—it ranked No. 28 among 35 of the world’s most advanced nations.

Researchers have called this the American health care paradox, the spend-more-get-less model of health care. Americans, one writer quipped, take a risk with their health just by living in America. And the weight of research has come to rest on another statistic as a likely explanation: Nearly two-thirds of those same advanced countries spend more of their budgets on social welfare.

At least part of what’s ailing health care in America, according to that theory, is its very focus on health care alone. America’s vaunted medical system can, and does, provide some of the best care in the world—but it will always be playing catch-up to what happens outside the doctor’s office.

Too many fast-food restaurants and not enough parks. Poverty, unemployment, segregation, disorder. Even the everyday grind of chronic stress. More and more, research suggests that those should be treated as medical problems, not just social ills—and that addressing them could yield better health at lower cost.

RAND: Strengthening the link

The RAND project set out to test that theory. It brought together researchers from RAND offices in the United States and the United Kingdom, as well as students from the Pardee RAND Graduate School. It not only confirmed a link between social welfare spending and public health; it also found the link strengthened as the focus expanded to include more countries across more years.

Those social programs ranged from child care allowances to rent subsidies to unemployment benefits. But the strongest health outcomes were linked to public pensions and other old-age benefits—and in some surprising ways. Countries that spent more on old-age programs tended to have longer life expectancies, but also lower
Out in the streets

Anthony Haynes (right, and below) spent more than five years living on the streets of Los Angeles with little more than an old Raiders jacket to keep him warm. The intersection of poverty and poor health was his daily reality.

He fought drug addictions without treatment, fought the shadows of mental illness without diagnosis. A doctor once noticed his badly swollen ankles and told him he had to elevate his feet. He could only laugh: Where?

“You see so much violence, you hear so much negativity, you’re just waiting for your turn,” he said. “It takes a physical toll. It got to a point, it was like I had a nervous condition.”

He lives now in a one-bedroom apartment run by Skid Row Housing Trust, a nonprofit that makes health and well-being as much a part of its mission as housing. “For me, day one that I moved in, everything was perfect, everything fell into order for me,” he says.

“I just turned 50,” he adds, “and I feel healthier than I’ve ever felt.”
levels of infant mortality. One possible explanation: Those old-age programs might serve as a marker of the overall strength of the social safety net.

The study found stronger health links with government spending than with private or charity spending. It found those impacts were especially pronounced in places with high levels of social and economic inequality. And it found the same pattern when it zoomed in on the United States: Individual states that spend more on public-welfare programs tend to have better health.

“It makes you think a lot more about how governments plan and spend their pots of money,” said Alex Sutherland, a researcher at RAND Europe who helped lead the study. “It illustrates the potential impact, and the potential importance, of thinking about these kinds of expenditures and how they impact public health.”

‘You have to go upstream’

The researchers cautioned that their study shows only an association—that the same countries that spend more on social welfare also have better health—not how, or even whether, one would cause the other. Nonetheless, years of research at RAND have come to the same conclusions, linking an array of social problems to health outcomes.

A 2009 study, for example, found that people in low-income neighborhoods show more signs of physical “wear and tear,” such as high blood pressure. A more recent study found that people living in wealthier neighborhoods have lower rates of heart disease.

RAND researchers have shown that neighborhood satisfaction is linked to sleep quality; that women living in neighborhoods with less sprawl tend to have healthier hearts; and that the quality of your high school can predict your general health ten years later.

“Where people live, what kinds of educational opportunities they have access to—these all seem to have strong effects on health,” said Kathryn Pitkin Derose, a senior policy researcher at RAND. Her work has focused on that link between social conditions and population health; her latest study looks at whether community gardens can address food insecurity and improve the health and treatment adherence of people living with HIV in the Dominican Republic.

She uses a simile that has become common in public-health circles to explain that need for a broader view of health care. The current system, she says, is like a lifeguard standing on the banks of a rushing river, always jumping in to rescue people at the last moment as they struggle in the water. What is needed, she says, is a new perspective—a new focus on what causes so many people to fall into the river in the first place, and on addressing those problems before more people follow.

“You have to go upstream,” she says, “to see what’s really affecting people’s health.”
Napa: A leader in improving community health

Napa County, Calif., may have a reputation for high life and fine wine. But that ignores the migrant workers crowded into shoddy apartments, the waiters working part-time jobs with no health benefits.

The county has become a quiet leader in addressing the social and economic side of health. It has a 50-page plan to improve community health not just by expanding access to medical services, but also through parenting classes, financial-literacy programs, and infrastructure improvements.

Its chief public health officer, Dr. Karen Relucio (right), sees a direct line from education to better jobs to health insurance, or from adequate housing to safer living conditions to healthier lives. She spent most of her career as an HIV specialist, confident in the healing power of medicine—until one of her patients lost his home. His health disintegrated, despite the best efforts of his doctors, after he moved into a cockroach-infested room in a rough neighborhood. He died soon afterward.

“It really became extremely apparent that the social conditions in which he lived were just going to keep him unhealthy,” she says now. “No matter how many times I saw him at the clinic.”

“I used to believe that practicing evidence-based medicine and providing quality care could actually make somebody healthy,” she adds. “But what I’m seeing at the doctor’s office is only a small percentage of a patient’s life. It’s hard for them to take care of their physical health when their basic needs aren’t being met.”
It was after midnight when the guided-missile destroyer USS *Oscar Austin* eased into a narrow channel leading toward the Baltic Sea. Three other destroyers followed behind.

The commander, John Cordle, an accomplished and experienced Navy captain, had gone 36 hours with no real sleep. Now, as the ship started its passage on a routine training mission, he swayed on his feet, gripping an overhead cable to keep himself upright and awake. The lights were dim, the ship silent.

He snapped awake. The navigator was saying they had lost their position. In the haze of fatigue and confusion, Cordle ordered the ship to slow—forgetting the three other destroyers coming up fast behind him. A crewmember had to remind him to warn them off.

He tells the story now to junior officers as a warning—a warning backed by years of RAND research that has shown, again and again, the staggering toll that poor sleep takes on our society. Researchers have found that our chronic sleep deprivation impacts everything from the quality of our work to the health and well-being of our children—even the basic readiness of our military.

“I let myself get so tired that when the crew really needed me to step in and make a decision, I was too tired to understand what was
Some of the Costs of Staying Awake

1.2 MILLION ANNUAL WORKING DAYS LOST

A BAD COMMUTE =
16 MINUTES LOST
SLEEP PER DAY =
OVER 65 HOURS LOST
SLEEP PER YEAR

TEENAGERS’ MOODINESS — A PRODUCT OF CHRONIC SLEEP DEPRIVATION?

THE U.S. ECONOMY LOSES UP TO $411 BILLION PER YEAR TO SLEEP DEPRIVATION

SHIFT WORK, WITH ITS IRREGULAR OVERNIGHT HOURS, IS A PROBABLE CARCINOGEN

BACKGROUND: MITSHU/GETTY IMAGES; EYES: RAND PHOTOGRAPHY
really going on,” Cordle says now. “There’s this perception that you can force yourself to just suck it up and get through it. But it’s like being drunk: Your brain shuts down.”

Dollars and cents

Our coffee-pounding, cell phone—buzzing, stay-up-late-and-get-up-early culture costs the American economy as much as $411 billion in lost productivity every year, a recent RAND study found. Those baggy eyes and foggy minds that corporate America so often treats like a badge of honor add up to around 1.2 million annual working days lost.

Poor sleep has been linked to seven of the leading causes of death in the United States, including cardiovascular disease and diabetes. A recent study by the AAA auto club found that drivers who sleep just four or five hours a night have a crash rate more than five times higher than those who get seven hours. The International Agency for Research on Cancer has even named shift work, with its irregular overnight hours, a probable carcinogen.

“How we sleep affects everything we do,” said Wendy Troxel, a senior behavioral and social scientist at RAND and a national authority on the social science of sleep. “When we don’t sleep well, it affects every aspect of our health and our relationships.”

Her research has opened new windows onto the importance of sleep, not just as a biological necessity, but as a social one. Poor sleep, she has shown, is both a source and a sign of trouble—a clue to better understanding why people under stress, struggling, caught in bad relationships or impoverished neighborhoods, often have worse health. A better focus on sleep might save marriages, improve mortality rates—even bolster world economies.

Troxel worked with a team of researchers from RAND Europe to show just how valuable a little more sleep can be. Their recent study demonstrated that quality sleep can predict workplace productivity—and our chronic lack of it acts as a drag on the entire economy. They also surveyed thousands of British workers to show how everyday life in our hurried, hassled, 9-to-5 world eats away at our bedtime.

People struggling with financial problems, for example, got ten minutes less sleep, on average, every night. Those facing unrealistic time pressures at work lost another eight minutes. A bad commute? More than 16 minutes. And, for comparison, having children: around four minutes.

That may not sound like much, but the toll adds up fast. The researchers estimated that the United States loses between $280 billion and $411 billion every year to the absenteeism, presenteeism, and outright mortality caused by sleep deprivation. Japan, with its smaller economy, loses up to $138 billion, followed by Germany (up to $60 billion), the United Kingdom (up to $50 billion), and Canada (up to $21 billion).

And the fix doesn’t require that we all unplug and check out at 8 p.m. If every worker who gets less than six hours of sleep managed to get six or seven hours instead, that would boost the American economy by around $226 billion every year.

“I’m an economist by trade. We usually care about things you do when you’re awake—you go to work, you provide your labor, you get wages,” said Marco Hafner, a research leader at RAND Europe and the report’s lead author. But then, he says, he had children: “I started to realize that sleep is something that affects your productivity, affects your life.”
Tired teens

The researchers identified one other factor dragging down economic productivity: the skills and knowledge that teenagers leave on the classroom table because they’re too tired to learn. This has become a focus of Troxel’s research in recent years, one that she sees play out every morning when she goes to shake her adolescent son out of bed.

Teenagers are wired to go to sleep and wake up later than adults; changes in their brain chemistry set their internal clocks back around two hours. Waking them at 6 a.m. for an early class, Troxel says, is the same as waking an adult at 4 a.m. Research has shown that giving high-school students an extra hour of sleep in the morning can improve their average grades by nearly 8 percent.

But the sleep toll for teenagers goes far beyond concentration problems in those early-morning classes. Troxel’s research has shown that teens who have trouble sleeping are more likely to use alcohol or marijuana. Not surprisingly, she also has shown that around one in five teens slugs energy drinks to stay awake, a habit linked to even worse sleep.

One possible solution—later school start times—has often proven to be as difficult to implement as it is obvious. The changes that would be required to bus schedules alone have scared many districts away. But Troxel, who is helping to organize a first-ever national conference on adolescent sleep and school start times, offers a compelling argument. As she said in a recent TEDx talk: “Many of the, shall we say, ‘unpleasant’ characteristics that we chalk up to being a teenager—moodiness, irritability, laziness, depression—could be a product of chronic sleep deprivation.”
Tired troops

Sleep deprivation, the renowned World War II Army Major General Aubrey Newman once said, works like termites in a house—“gnawing quietly and unseen.” The quote opens a RAND report that showed how pervasive sleep problems are in the military, and how damaging.

Troxel and colleagues found that nearly a third of all service members get five hours of sleep a night or less. Those who had experienced combat were especially likely to report poor sleep and frequent nightmares, but even service members who had never deployed reported higher rates of sleep problems. Poor sleep, the researchers concluded, has become hardwired into the very culture of the military.

More than half of the hundreds of service members the researchers surveyed said sleep problems interfere with their daily work. Sleep problems also were associated with poor physical health, higher rates of depression and post-traumatic stress, and lower perceptions of unit readiness.

But the military, unlike other major organizations, has taken steps to educate its rank and file about the importance of getting a good night’s sleep. Recent Army guidelines elevate sleep to the same level as good nutrition and exercise as a source of health. And the Navy has been experimenting for years with its watch schedules, trying to make shipboard life more responsive to the circadian needs of its sailors.

One of the most visible and outspoken champions of that effort has been a destroyer captain who knows all too well what can go wrong when sleep is treated like a luxury.

John Cordle, now retired from the Navy, spent his career after that bleary night passage to the Baltic on the Oscar Austin trying to reconfigure ship schedules to get his crew-members better sleep. Working with naval researchers, he helped pioneer a watch order with longer and more reliable rest periods that has become standard on U.S. submarines and a recommended option for surface ships. The Naval Postgraduate School now devotes an entire website to their work on sleep and crew endurance.

“It’s not about coddling your people. It’s about operational readiness,” he said. “There’s going to come a time when you’re the only person on the ship that has the answer, that can save the ship from disaster. You’re never going to know when it’s going to happen. You have to be ready.”
SEVEN STEPS
TO BETTER SLEEP

Seven hours. That’s what the research says we should all get, bare minimum, every night. And the reality is that more than a third of us don’t even get that much.

Here are seven tips from RAND experts to help you get your seven hours:

1. SET A CONSISTENT WAKE-UP TIME
   Even oversleeping on the weekends has been linked to potentially harmful disruptions in sleep patterns.

2. LIMIT TIME SPENT IN BED ON ACTIVITIES OTHER THAN SLEEPING
   You want to create a strong learned association between bed and sleep—not television or work.

3. DO NOT STAY IN BED UNLESS ASLEEP
   Do something distracting but not overly stimulating if you’re having trouble falling asleep.

4. LIMIT THE USE OF ELECTRONIC DEVICES BEFORE BEDTIME
   Screen time may suppress levels of melatonin, a crucial sleep hormone.

5. LIMIT THE CONSUMPTION OF SUBSTANCES THAT MAY IMPAIR SLEEP QUALITY
   This means caffeine, of course, but also alcohol and nicotine.

6. ADDRESS STRESSFUL ISSUES LONG BEFORE BEDTIME
   One study suggested setting some time aside before bed to address stressful or emotional issues.

7. EXERCISE
   Physical activity is consistently associated with better sleep outcomes.

Why Sleep Matters—The Economic Costs of Insufficient Sleep: A Cross-Country Comparative Analysis is available for free download at www.rand.org/t/RR1791

Additional Reading
Sleep in the Military: Promoting Healthy Sleep Among U.S. Servicemembers is available for free download at www.rand.org/t/RR739

Additional Viewing
Watch Wendy Troxel’s 10-minute TEDx Talk on Sleepy Teens: A Public Health Epidemic on YouTube
Along with fixing America’s dilapidated roads, bridges, transit, and airports, the plan envisions spending $52 billion in taxpayer money on electricity infrastructure, with a presumed emphasis on integrating advanced “smart-grid” technologies. While many consumers might see this as just another technology rollout that could be best left to the private sector and the free market, leaving the future of the electricity grid to chance should not be an option.

To maximize the potential benefits of a multibillion-dollar smart-grid investment, a closer examination of smart-grid technology and policy is needed.

A smart grid is an electric grid that connects electricity producers to consumers in new ways, including allowing for electricity and information to flow not just from the producers, but back to them as well. It includes the various pieces of equipment and devices that are used to produce, deliver, and monitor the electricity that keeps America’s lights on.

Specific cutting-edge technologies that might soon be more prominent in the electricity grid include “smart” electricity meters and controls that can selectively curtail consumer demand when electricity is used to avoid blackouts; distributed neighborhood-level electricity generation units such as combined heat and power systems that more efficiently use fuels; and household-scale batteries installed in individual customers’ homes to back up their rooftop solar panels when the sun isn’t shining.

So the term “smart grid” simply refers to an integrated...
and deliberate deployment of these technologies across the electricity system.

With U.S. smart-grid expenditures forecast at more than $3 billion in 2017 and the global smart-grid market expected to surpass $400 billion worldwide by 2020, President Trump’s pledge for even further infrastructure investment in the smart grid might seem inevitable. Yet there is much that the government and the private sector should seek to learn about consumer behavior and decisionmaking before committing to such a huge investment.

For example, a common theme reiterated during a recent Smart-Grid Interoperability Panel conference in Washington was that private-sector companies don’t actually fully understand what consumer preferences are for smart-grid technologies, nor is it clear how much consumers are willing to pay for them. The technologies are evolving so rapidly that regulatory agencies such as public utilities commissions, which are tasked with representing consumers’ best interests, have been hard-pressed to keep up.

The future smart grid is likely to have ownership that spans government (through publicly owned power and transmission lines), the private sector (independent wind farms or utility-owned generators), and private citizens (household-level battery backup systems or rooftop solar panels). Yet a functioning integrated electricity system is a basic public good, essential to the health, safety, and well-being of modern society. So it’s in the public interest for government to take an active role to ensure success of the grid, and for consumers to be informed about choices they can make.

At the same time, the environmental footprint of today’s fossil fuel–based electricity system degrades local air quality, and produces greenhouse gas emissions that contribute to global climate change—meaning that a true smart grid would need to be more efficient and green than its current counterpart, not just secure, reliable, and affordable.

What will constitute the best choices for the smart grid? The answer will vary from user to user, but a few basic expectations should be met. Electricity service should accommodate an increasingly diverse set of needs for different consumers. The rollout of new smart-grid technology presents an opportunity to make cost-effective energy generation and distribution changes that improve local air quality and that both mitigate—and adapt to—future climate change.

Those developing new systems will need to account for multiple objectives, including affordability, security, and reliability. And the United States should also take into account the development of new high-tech domestic industries—and the associated high-tech jobs—in the process of deploying these technologies.

There will almost certainly be trade-offs to what can realistically be achieved. Understanding how an optimal smart grid should operate starts by understanding the preferences and constraints of the various stakeholders—from multistate utility companies to individual homeowners and industrial consumers—and understanding how technology can or cannot meet these objectives.

Without a thorough examination of all these factors, complemented by input from the public about what’s important, infrastructure investments may not be made wisely and an important, once-in-a-generation opportunity could be missed. ■

A version of this commentary appeared on insidesources.com in December 2016.
Greer, whose service to RAND spans nearly 30 years of advisory and leadership roles, has the passion and the pull to carry out such a change. He’s a Presidential Medal of Freedom winner, a recipient of the MacArthur Foundation’s “genius grant,” and the author of a book on caring for the homeless called *Waking Up in America*.

What he shares with RAND, he said, is a commitment to improving lives, and to the search for better ways to help those most in need. “It lets me realize that there is great optimism in the world, to know that an institution like RAND exists,” he said.

Greer has been closely involved in RAND’s health-policy work since the late 1980s, when he served as an early advisor to the Drug Policy Research Center. He currently serves on the RAND Health Board of Advisors and on the RAND Board of Trustees. He’s the chairman of the Pardee RAND Graduate School Board of Governors.

He also has channeled his compassion for those in need into philanthropic support to help RAND address the health issues and disparities he sees every day. His gifts also have supported Pardee RAND graduate students to become the future leaders and innovators of public policy.

His medical career has followed a path he set for himself when he was still an intern in Miami, treating a man dying of tuberculosis whose records listed no known address, not even a name. Greer went looking for answers and discovered an entire community living in desperation and squalor under the city’s highways. The experience convinced him to set up a clinic that now serves thousands of homeless patients every year. He also founded a primary-care clinic for disadvantaged children and adults in Miami’s Little Havana neighborhood.

“It’s a life that might be distilled into a question Dr. Greer asks all of us,” President Barack Obama said as he awarded Greer the Medal of Freedom, the nation’s highest civilian honor, in 2009. “If we don’t fight injustice, who will?”

Greer now serves as the associate dean for community engagement at Florida International University’s Herbert Wertheim College of Medicine. There, he has helped pioneer an approach to medicine that he describes as household centered. It embeds small teams of medical, law, and social-work students in the neighborhoods of Miami to get to know people where they live, and the social conditions directing their health.

He brought in RAND researchers to evaluate the program, after early results suggested it reduced emergency-room visits by nearly two-thirds. The researchers developed a way to measure outcomes based more on observation than on the intrusive surveys so common in health work, a gentler approach to people in their own homes.

Greer also has sent young faculty members from disadvantaged groups to Pardee RAND as part of a program that offers crash-course introductions to policy analysis. Many of them are first-generation college graduates from Latin America or Africa.

He describes RAND as “an American treasure—a spectacular place.”

“They take their responsibility, that we’re here for the public good, extremely seriously,” he said. “For too long, leaders in this country have had an opinion and then looked for the facts to back them up.”

“As things go on in the world and I become worried, it’s always nice to have an anchor like RAND that looks purely at the evidence, at the facts.”
No, RAND doesn’t have an on-site spa or nap pods where workers can take an after-lunch siesta. But RAND’s old headquarters, built in 1951 and demolished in 2005, has had an influence on how architecture contributes to collaboration.

RAND’s previous headquarters at 1700 Main Street in Santa Monica was designed on a RAND mathematician’s vision for a structure that would facilitate chance meetings among researchers. The idea was that these random encounters would promote innovative collaborations among researchers with different areas of expertise. Based on accounts of the scientists who worked there, the approach did just that. The building incorporated multiple ways to reach your destination and blurred the lines between indoors and out. From the air, RAND’s headquarters resembled a lattice with office space arranged around eight courtyards.

Silicon Valley tech firms have embraced this approach as they create new corporate structures. For example, Apple’s round spaceship-style building was designed to give scientists easy access to each other’s offices and labs. Google’s new building will blur the distinction between inside and out with large translucent canopies covering movable clusters of offices.

Designed by architect Frank Gehry, Facebook’s open plan complex is perhaps RAND’s closest relative. As Michael Kubo described RAND’s old building, “Essentially, it’s randomness generated by math—engineered to engage human inhabitants, just like Facebook’s new office.”

Meanwhile, RAND researchers are still holding out hope for those nap pods.

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