TREND

Analysis of the Facts, Numbers, and Trends Shaping the World
THE PEW CHARITABLE TRUSTS

THE WONDER OF MODERN MEDICINE

FROM TARGETED CANCER THERAPIES TO ROBOTIC SURGERY TO AI-ASSISTED X-RAY ANALYSIS, MEDICAL INNOVATION THAT ONCE SEEMED THE STUFF OF SCIENCE FICTION IS NOW TRANSFORMING CARE.

innovate

\ˈi-nə-ˌvāt \

verb

1. to renew, alter
2. to introduce new methods
3. to invent medical treatments that transform lives

Founded in 1948, The Pew Charitable Trusts uses data to make a difference. Pew addresses the challenges of a changing world by illuminating issues, creating common ground, and advancing ambitious projects that lead to tangible progress.

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Cover illustration: Richard Friend/The Pew Charitable Trusts

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The Wonder of Modern Medicine

We are living in a time of remarkable medical innovation. While new medications and surgical techniques continue to be discovered, delivering relief for patients and their loved ones, some of the newest advancements are awe-inspiring in their potential to touch every one of us.

As medical futurist Bertalan Meskó, a physician and scholar, writes in this issue of *Trend*, artificial intelligence in just a few short years has upended our understanding of what can be possible in medical care, from smartwatches that detect atrial fibrillation to genetic tests so simple they can be conducted in the privacy of our homes. AI can now analyze medical imaging and pathology slides at accuracy rates that rival specialists.

Along with these developments comes a need for new understanding between doctors and patients and between medical researchers and policymakers. "Medical innovation today is no longer confined to the invention of drugs or devices within the walls of research labs, but a living ecosystem where science, technology, patient empowerment, and society converge," Meskó tells us.

Public health and medical innovation have been central to the mission of The Pew Charitable Trusts from its founding more than 75 years ago. For the past four decades, we have supported the Pew Scholars Program in the Biomedical Sciences, funding young, promising researchers. That program—whose alumni now include six Nobel Prize winners—led to the creation of the Pew Latin American Fellows Program in the Biomedical Sciences, supporting young scientists from that region, and the Pew-Stewart Scholars Program for Cancer Research, which for more than a decade has assisted young researchers seeking to accelerate discovery and

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advance progress toward a cure for cancer.

Ziyang Zhang, a Pew-Stewart scholar at the University of California, Berkeley, writes in this issue about a medical innovation that can help many cancer patients undergoing chemotherapy. Although significantly boosting cancer survival, standard chemotherapies are broadly toxic—as Zhang writes, "the medical equivalent of weeding a garden with a bulldozer," killing healthy cells alongside cancerous ones and often leaving patients fatigued and nauseated.

But Zhang and other researchers are working at the molecular level to determine what makes cancer cells unique and then to attack them directly, limiting damage to normal tissue. Called targeted therapy, the new approach is transforming modern cancer treatment by creating drugs that are more effective in fighting cancer with fewer side effects. And additional research is finding ways to boost the body's own immune system to target cancer.

Pew also focuses directly on public health issues, with data playing a key role in innovative approaches. While physicians, of course, rely on patient data such as blood pressure and other vital signs to diagnose and guide treatments, public health agencies use data to keep communities healthy.

The need for modernizing how data is collected and provided to health agencies was evident during the COVID-19 pandemic, when automated electronic case reporting was rare and most health information was still being transmitted by fax. The states, where so much innovation happens in many policy areas, saw the need to move more quickly.

In this issue, Kathy Talkington, who oversees Pew's work on public health issues, reports that more than half—53%—of state, local, Tribal, and territorial public health agencies have upgraded their systems and receive digitized case data for at least three-quarters of the health conditions that physicians and other providers are required to report.

Still another key use of data: the two-decade-old national syndromic surveillance program that collects digital data on the symptoms that patients report in hospital emergency rooms, allowing near-real-time understanding of conditions and concerns facing the public. The program was initially created in response to terrorist threats such as anthrax sent by mail; an example of its broader use came when wildfires swept Oregon in 2020. Patients with respiratory symptoms filled hospitals, and public officials were able to use near-instantaneous data to track the smoke's health effects and issue targeted warnings to the public.

All of these medical advances have done wonders for patients and for public health. As innovative as these discoveries and new methods are proving to be, we will always face disease and illness; they are a core function of living. And the work of medical innovation, now entering a new and dramatic phase through AI and technology, will continue to evolve and improve.

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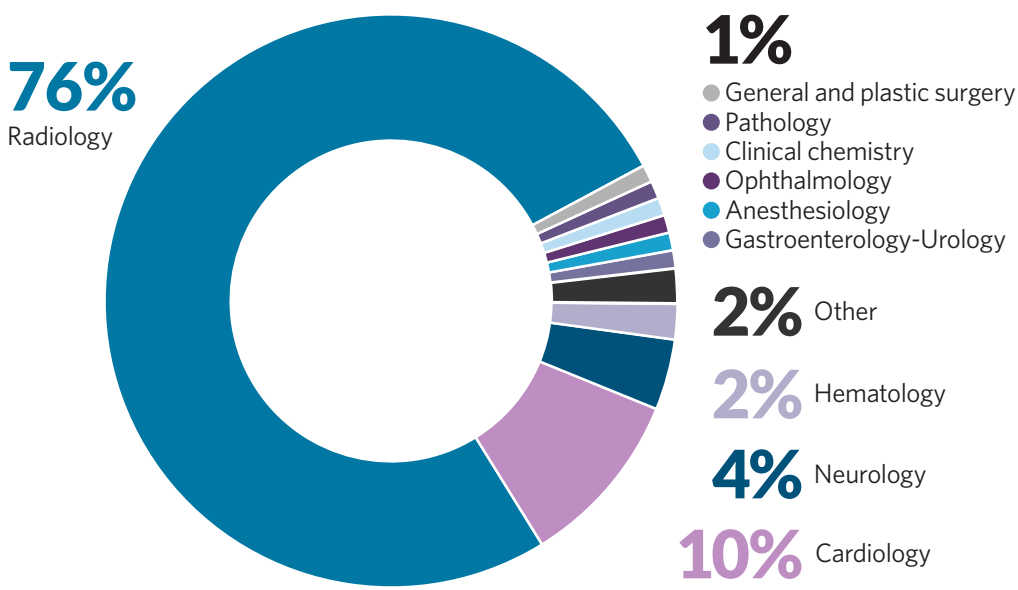
Medical innovations

Medical innovations have been improving patient care—and outcomes—for decades. Today's cutting-edge care—from robotic surgeries, to AI-assisted medical devices, to clinical trials—is reaching larger numbers of Americans in many different areas of health care.

TODAY, FDA-APPROVED AI-ENABLED MEDICAL DEVICES ARE USED IN A WIDE RANGE OF MEDICAL SPECIALTIES.



Source: FDA

39%

Improved survival rates

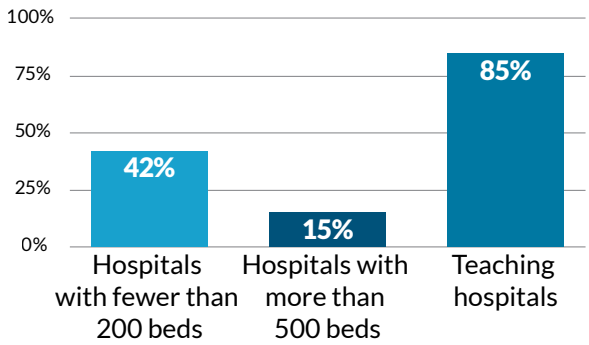
SEPSIS—WHEN THE IMMUNE SYSTEM OVERREACTS TO A SEVERE INFECTION, WHICH CAN QUICKLY LEAD TO ORGAN FAILURE—AFFECTS 1.7 MILLION ADULTS ANNUALLY AND CONTRIBUTES TO 1 IN EVERY 3 HOSPITAL DEATHS.

A new diagnostic tool called IntelliSep helps predict which patients are likely to develop sepsis, so they can be quickly treated. Louisiana's Our Lady of the Lake Regional Medical Center, where the tool was developed in partnership with Louisiana State University and the company Cytovale, has improved sepsis patients' survival rates by 39%.

ONCE THE EXCLUSIVE PROVENANCE OF TEACHING HOSPITALS, ROBOTIC SURGERIES ARE NOW COMMON IN A RANGE OF DIFFERENT TYPES AND SIZES OF FACILITIES.

Different hospital types by %

Source: Market.us News

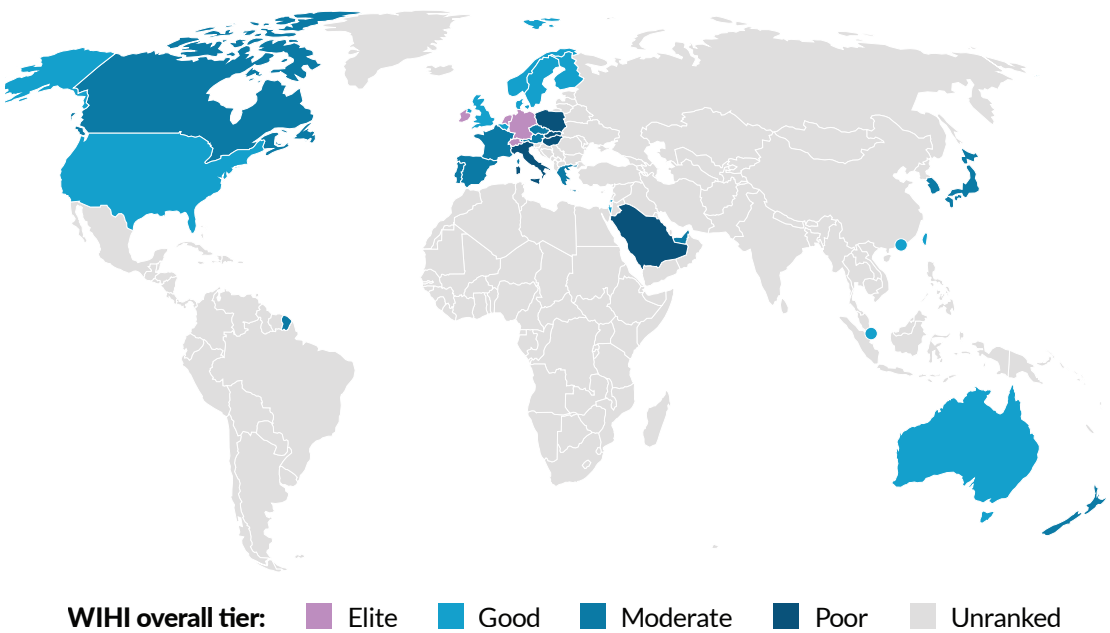


CLINICAL TRIALS TEST PROMISING NEW TREATMENTS AND ARE OFTEN A PATIENT'S LAST-HOPE CHANCE FOR A CURE—SOME 15% OF AMERICANS SURVEYED SAID THEY OR A FAMILY MEMBER HAD PARTICIPATED IN ONE IN 2025.

	2025	2017	2016
Yes	14.8%	13.9%	12.7%
No	80.5%	77.0%	79.2%
Not sure	4.7%	9.1%	8.1%

Source: Research America surveys

THE U.S. RANKS ABOVE MOST OF EUROPE IN THE 2024 WORLD INDEX OF HEALTHCARE INNOVATION (WIHI), WHICH RANKS HEALTH CARE SYSTEMS ON QUALITY, CHOICE, SCIENCE & TECHNOLOGY, AND FISCAL SUSTAINABILITY.



Source: FREOPP World Index of Healthcare Innovation

The New Frontiers of Medical Innovation Are Already Here

From artificial intelligence to patient-driven insights, innovations in medical care that once seemed the stuff of science fiction are current realities—and the future seems nearly limitless.

BY BERTALAN MESKÓ

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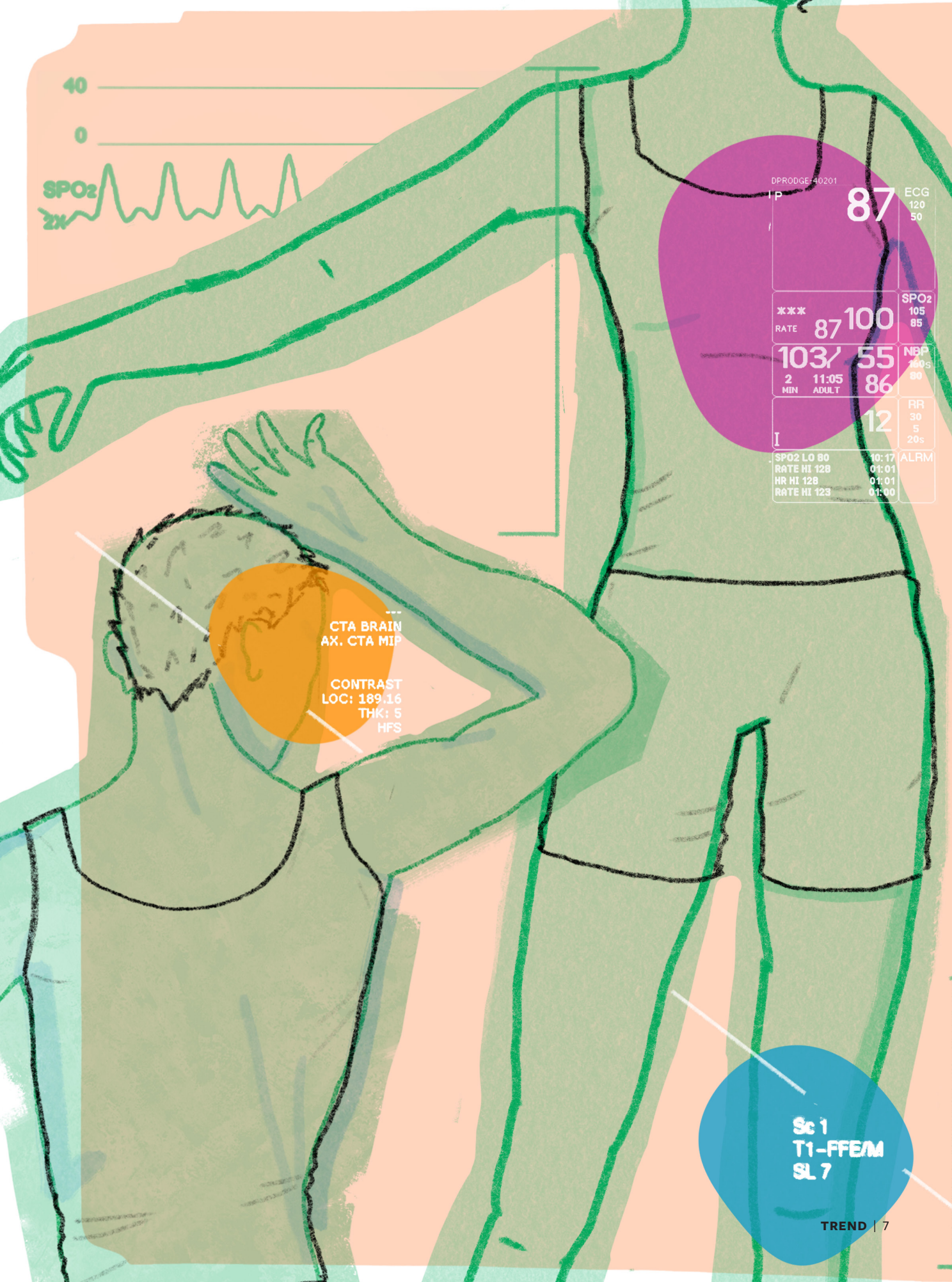
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A few decades ago, innovation in medicine used to mean a new pill, a new machine, or a new surgical technique. Today, it means a generative artificial intelligence (AI) chatbot that helps to prevent depression, a smartwatch that catches atrial fibrillation to save lives, or a genetic test so easy to use that it can be taken in the privacy of a patient's home. What we call "medical innovation" has undergone radical changes, and with that comes new challenges: Policies, regulations, guidelines, and, even more importantly, our culture and understanding must change with it so that we can enjoy the benefits of the future of health care.

That requires a change in thinking about medical professionals and ourselves. Since the dawn of medicine, doctors have been the most respected figures in a community—they knew everything about the human body, its health, and diseases. They used to occupy the so-called ivory tower of medicine in which they got access to all the information, technologies, studies, papers, textbooks, experience, and expertise they needed to care for patients. The way this centuries-old status quo has started to take shape has had a huge impact on how we define medical innovation, where it's coming from, and who makes it accessible for the masses.

MEDICAL INNOVATION TODAY IS NO LONGER CONFINED TO THE INVENTION OF DRUGS OR DEVICES WITHIN THE WALLS OF RESEARCH LABS, BUT IS A LIVING ECOSYSTEM WHERE SCIENCE, TECHNOLOGY, PATIENT EMPOWERMENT, AND SOCIETY CONVERGE.

But the beginning of the 21st century brought some unprecedented developments: global supply chains, the rise of the internet, social media, and now AI.

The ivory tower started breaking down as patients could access the same details and insights as their health care professionals. This has changed the dynamics of the doctor-patient relationship from a traditional hierarchy to more of a partnership in which all parties sit at the same table to help make the best possible medical decisions.

This dynamic is further complicated by the emergence of a new member, a technological entity known as AI, which is growing to deserve a seat at the same table. It can elevate decision-making and serve as the medical assistant we all have been hoping for.

Medical innovation today is no longer confined to the invention of drugs or devices within the walls of research labs, but is a living ecosystem where science, technology, patient empowerment, and society converge. Innovation can emerge from a clinician developing an AI-based assistant, from a community of patients sharing data and stories online, or from a tech startup turning smartphone sensors into diagnostic tools. Exploring a few factors can help with better understanding this phenomenon.

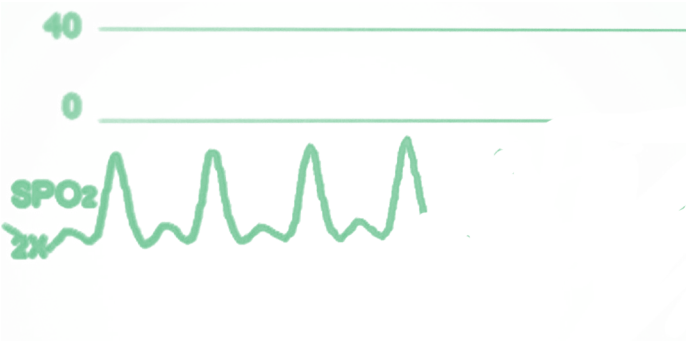
A look at just one example shows the power of medical innovation today as well as a staggering evolution of technologies. Digital therapeutics (DTx) offer evidence-based, clinically backed solutions to manage and/or improve health conditions via software and/or other digital health technologies that complement traditional treatment regimes. With DTx, the use of a smartphone app or an AI algorithm can lead patients to similar outcomes and results as from taking a medication—one well-known example is reSET, a prescription digital therapeutic that uses cognitive behavioral therapy to improve outcomes in patients with substance use disorder. While it might seem like DTx is an idea out of science fiction, a recent study analyzing trends in China, the U.S., Germany, and Belgium identified over 500 DTx, with more than 100 new ones getting approved each year.

The focus of medical innovation has shifted from health care institutions to wherever patients are, essentially making them the point-of-care. For example, 20 years ago implantable cardioverter-

defibrillators, devices that continuously monitor the heart's rhythm and automatically deliver an electric shock when they detect life-threatening rhythms, and drug-eluting stents, which slowly release medication to help keep arteries open, were hailed as breakthrough medical innovations for preventing sudden cardiac death or reopening blocked arteries. Today, an over-the-counter smartwatch can detect atrial fibrillation early and alert its wearer to seek care before even the first symptoms appear. Decades ago, screening innovation might have meant more advanced CT scans that facilitated earlier tumor detection. Today AI algorithms can analyze medical imaging and pathology slides with an accuracy rivaling that of specialists. While innovation in diabetes management might have meant a new generation of genetically modified human insulin or more portable insulin pumps, patients today can wear continuous glucose monitors connected to smartphones to track blood sugar in real time and integrate these monitors with AI-powered apps that provide personalized lifestyle or dosing advice.

And the list goes on. One company delivers vaccines and medical supplies to low-resource regions in central Africa with drones that can cover huge distances even under harsh weather conditions. It is already possible to 3D-print certain medical equipment, customized casts for broken arms, and uniquely shaped medications for kids. With 3D bioprinters, even printing out skin, cartilage, or liver tissues has been proved in peer-reviewed studies. Other tools help patients to take blood samples at home with tiny devices to facilitate their role in clinical trials. Handheld vein finders help a nurse or a phlebotomist take blood samples on the first try. Also, robots have demonstrated the ability to draw blood with high accuracy, potentially surpassing human professionals in some instances and streamlining the blood-drawing process.

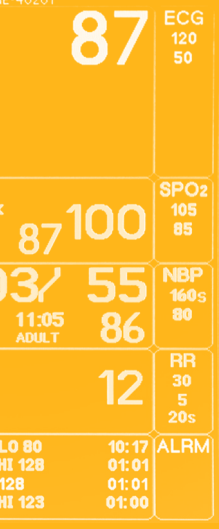
It used to take decades for a medical innovation to go from a patent to a product stage. The first nuclear magnetic resonance patents related to medical imaging were filed in the 1950s, but the first clinical MRI scanners didn't become widely available until the late 1970s or early 1980s. The link between human papillomavirus (HPV) and cervical



cancer was established in the 1980s; however, it took until 2006 for the first HPV preventive treatment (Gardasil) to be approved. In contrast, it took less than a decade for an innovative patent for a smartphone case that could obtain ECG data (in the early 2010s) to become a credit card–size device that uses an algorithm to analyze those readings and identify cardiac rhythm issues without human intervention. And today, NASA's cutting-edge astronaut health monitoring program, which includes wearable biosensors and real-time immune system monitoring, is filtering down to create better remote care for patients on Earth.

For example, while ultrasound was invented earlier, NASA research and training programs significantly advanced the miniaturization and remote use of ultrasound, paving the way for today's portable, smartphone-connected devices. AI is no longer just another technology; it's becoming the engine of medical innovation itself. It accelerates discovery by screening drug compounds, decoding proteins, and uncovering disease pathways at unprecedented speed. A staggering example is how DeepMind's AlphaFold, from the parent company of Google, has mapped the structures of more than 200 million proteins, enabling researchers to identify molecular pathways involved in diseases such as cancer and Parkinson's more rapidly than ever before.

AI has transformed diagnostics, from its ability to read radiology and pathology scans to powering smartphone apps that detect digital biomarkers in a person's voice or movement to either diagnose neurological conditions or facilitate rehabilitation after a stroke. AI empowers patients through health copilots and wearables that put monitoring and guidance directly in their hands. It reshapes workflows by supporting doctors with decision-making and reducing administrative burdens, a critical lifeline amid workforce shortages. And it opens entirely new frontiers, from creating digital



AI HAS TRANSFORMED DIAGNOSTICS, FROM ITS ABILITY TO READ RADIOLOGY AND PATHOLOGY SCANS TO POWERING SMARTPHONE APPS THAT DETECT DIGITAL BIOMARKERS IN A PERSON'S VOICE OR MOVEMENT TO EITHER DIAGNOSE NEUROLOGICAL CONDITIONS OR FACILITATE REHABILITATION AFTER A STROKE.

twins that simulate individual patients to predicting disease risks before symptoms appear.

There is one more exciting aspect of AI boosting medical innovation: finding unusual associations. AI can connect dots between seemingly very different fields that no life science researcher or clinician could find before. Take MRI scans as an example. Radiologists have traditionally needed a complete, high-resolution image before they can interpret it. AI, however, can be trained to recognize patterns from only partial data. That means the scanner doesn't need to collect every slice of information, which cuts down the time a patient spends in the machine by about 25%, while still producing images accurate enough for diagnosis. Also, researchers trained an AI model to analyze 10-second-long voice recordings to diagnose type 2 diabetes based on certain acoustic features instead of blood sugar levels. This new noninvasive method could help catch diabetes even earlier.

I can even go as far as to predict that the real era of the art of medicine will come with the era of AI. When AI discovers new treatments and runs in silico clinical trials—computer-simulated clinical studies that use virtual patient populations to test how a treatment might work—that physicians, pharma companies, or medical innovators would never think of, our job will be understanding how it has been able to achieve that.

The U.S. Food and Drug Administration has been one of the most forward-looking regulatory agencies worldwide in bringing advanced technologies to the market. When I first analyzed its database, looking specifically for AI-based and approved or cleared medical technologies, I found 64 in 2020. Today its official database contains more than 1,250 of them, demonstrating extraordinary progress. Radiology is the most AI-invested medical specialty—almost 80% of approved devices—with cardiology a distant second. Specialties such as neurology, hematology, gastroenterology, urology, and ophthalmology also have a handful of devices.

So, understanding all these new aspects of medical innovation, what is next for all of us? First, it is time to shift from patient centricity to patient design. Pharmaceutical companies and medical innovators have been proudly claiming themselves patient-centric, saying that they focus on patient needs. But patient design ensures that patients are involved at the highest level of decision-making within a company, organization, or health care

institution. This is the only viable way of including patient voices in the final design of products, services, or guidelines.

In the Netherlands, professor Stefaan Bergé redesigned his oral and maxillofacial surgery department based on patients' suggestions.

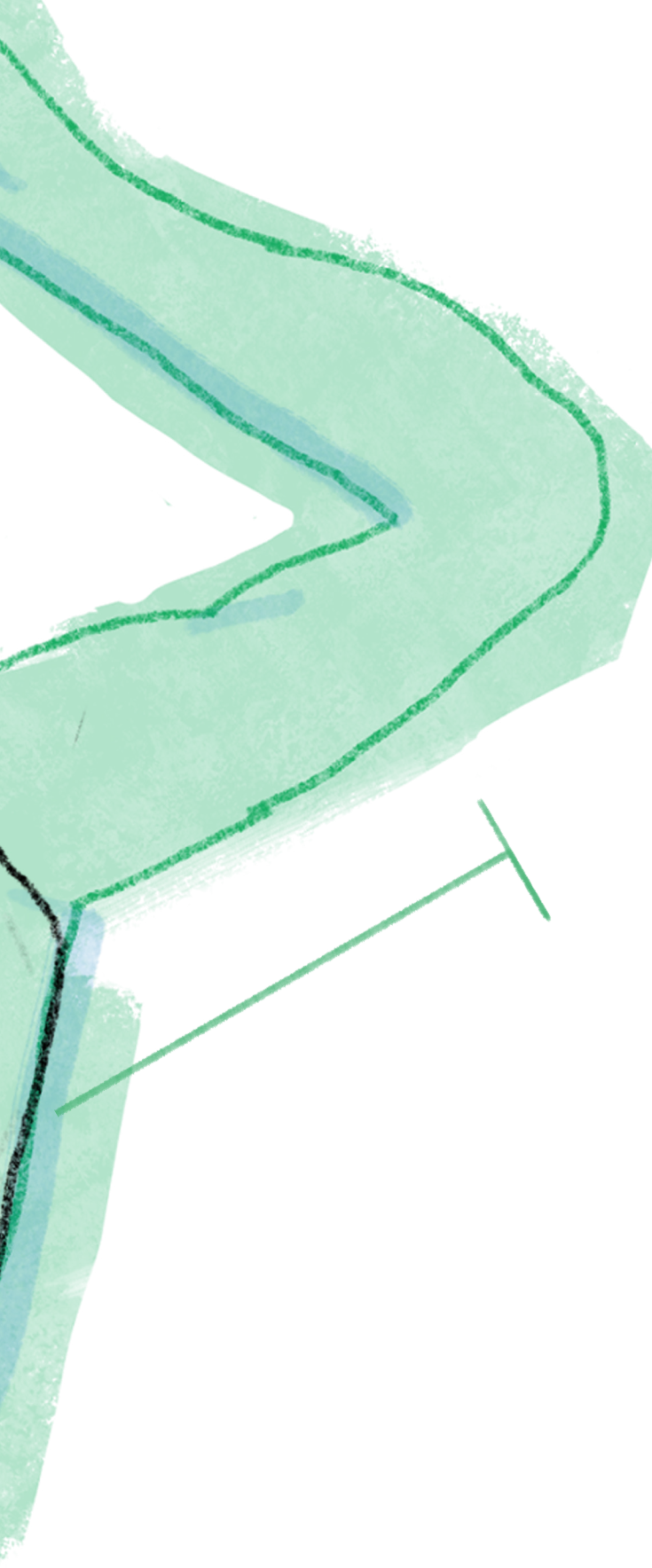
The new space has modern architecture and large windows, with one side housing a simple round table with a desktop computer and a projector where the doctor and patient can chat. They then cross a blue line to enter the examination space and the boundaries of the clinic. Patient satisfaction has soared and the physicians report less stress, benefiting from the partnership they can build with their patients in such an environment.

Second, regulators and policymakers face a new level of challenges in this era. As patients get access to technologies before they are even regulated and rolled out to the market, regulators have to think ahead and use established futures methods to better foresee upcoming opportunities, technological developments, and the accompanying challenges. This was perfectly captured in the discussions on how current and future models of large language models such as ChatGPT could be addressed. When future iterations of ChatGPT-like tools can handle images, sound, video, and full documents, the question is whether regulators could immediately address them and allow such productivity tools to enter the health care market.

Also, we should not wait for a medical catastrophe to adopt a technology faster. For example, telemedicine and remote care services existed for years before COVID-19 forced their widespread adoption. In the U.S., the federal government for the first time started allowing patients with opioid use disorder to receive buprenorphine, a medication proved to reduce overdose deaths, without a previous in-person visit. In Belgium, lawmakers enacted the Royal Decree of 13 May 2020, which allowed health care providers to charge for remote consultations under the national health insurance. This was just one month after the first lockdowns.

And finally, we should all enjoy the benefits of medical innovations. When it comes to health, even the most impressive breakthroughs can never feel truly enough, because as long as people remain sick or uncured, the work of innovation is not finished.

And while challenges remain—Pew Research Center reports that Americans' trust in science remains lower than it was before the COVID-19



pandemic and that about half of U.S. adults (51%) say they are more concerned than excited about AI— the next frontier seems even more exciting.

Digital twins could be developed based on a person's metabolomic background to test drugs and treatments on them first. Imagine a virtual copy of your body with all its metabolic and molecular background, where therapies can be tried safely before being applied in real life. AI agents that could not only take over the mundane part of medical administration but could even perform a series of digital tasks requested by medical professionals. Longevity interventions that could help detect diseases as early as possible or outright prevent them from happening by simply accessing huge amounts of data about our health.

Medical innovation has always been about extending lives, but in this new era, it is also about expanding possibilities: of what health means, where care happens, and who gets to shape it. The real question is not whether we can develop these technologies, but whether we will build the trust, culture, and foresight to use them wisely. The future of medicine will not arrive fully formed; it will be shaped by every policy we pass, every innovation we adopt, and every patient we invite to the table.

Bertalan Meskó, M.D., Ph.D., known as The Medical Futurist, is the director of The Medical Futurist Institute and serves as a private professor at Semmelweis Medical School in Budapest, Hungary.

He regularly shares his analyses on medicalfuturist.com. He is the author of the book Your Map to the Future.

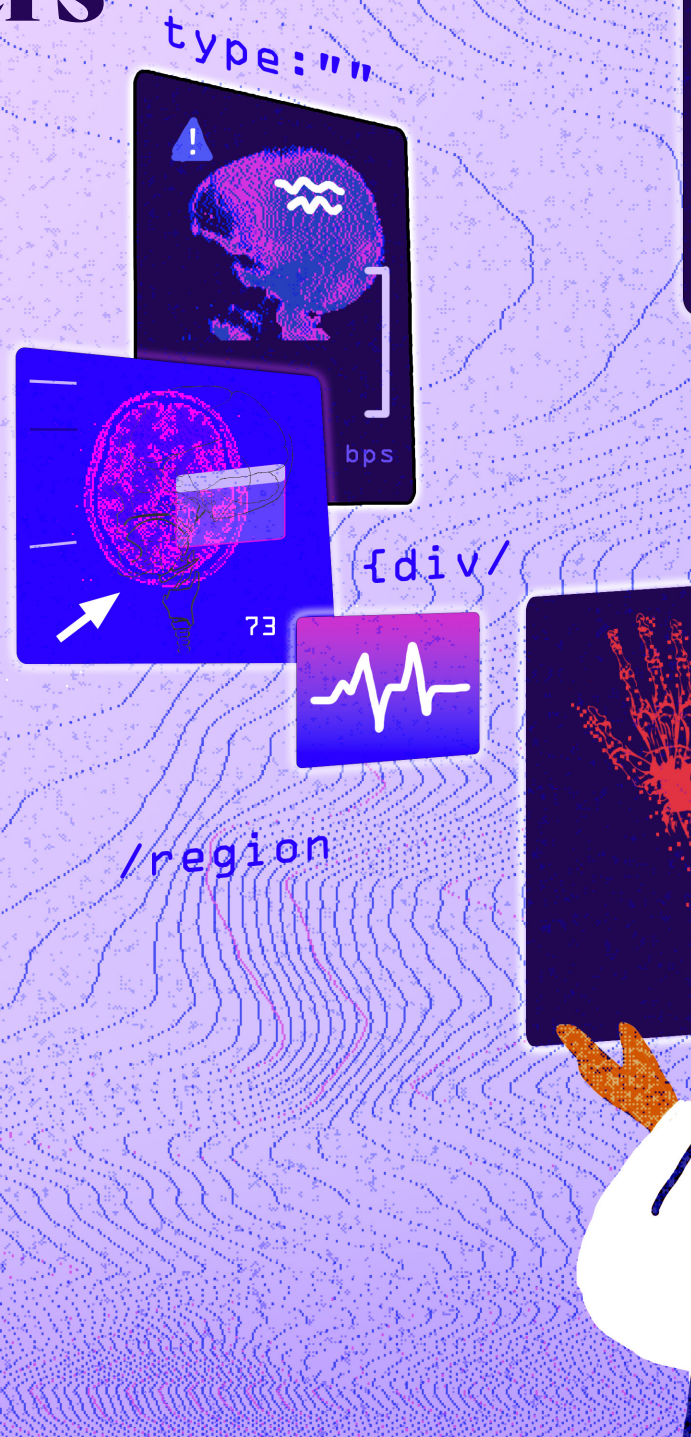
THE TAKEAWAY

Today, medical innovations are increasingly touched by technology, and with recent advances in AI, digital therapeutics, and wearable health monitors, the future of health care holds boundless promise.

From Medical Scans to AI Answers in Seconds

Why instant access to imaging interpretation will transform health care.

BY PRANAV RAJPURKAR AND SAMIR RAJPURKAR



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Modern medicine can image a perforation in your intestine with millimeter precision. But getting someone to tell you it's there? That takes hours. Sometimes until morning.

Consider this hypothetical yet very real situation: At 2:17 a.m., a 68-year-old woman with severe abdominal pain arrives in the emergency department (ED). The CT scan shows diverticulitis with possible perforation—a tear in the intestinal wall that could lead to life-threatening infection. The scan completes. The radiologist, covering three hospitals from home, won't read it until 4 a.m. The ED physician waits. The surgical resident waits. The patient's fever climbs. During waits like these, localized infections spread systemically. Obstructed blood flow progresses to tissue death. The time-sensitive window for intervention narrows. Then closes.

This isn't a technology problem. It's an availability problem. Artificial intelligence is approaching the capability to solve it—providing immediate answers to questions about medical images. Is there an air pocket? Does this require urgent surgery? The vision is simple: medical intelligence as infrastructure, available as a regulated software application that helps compute complex information, that any clinician can query to receive radiologist-comparable interpretations in seconds.

Now imagine that same patient. At 2:18 a.m., the ED physician receives a preliminary AI-derived interpretation: "acute diverticulitis with a small, contained perforation. Infection is localized with minimal surrounding inflammation. No large fluid collection or spreading infection. Recommended treatment: IV antibiotics and surgical consultation." Treatment starts immediately. The surgical resident calls the attending physician with data, not guesses. By 3 a.m., the treatment plan is set. At 7 a.m., the radiologist reviews the study during morning rounds, confirms the findings, and signs the final report. The patient is stable, already four hours into appropriate treatment.

This transformation is starting to happen.

Over the past decade, we authors have worked in this field. Pranav has advanced the foundational techniques in radiology AI that have made these capabilities practical—developing methods that can now detect findings at radiologist-comparable performance levels. Samir has spent three decades helping to implement technology transformations globally. Over the past several years, he's traveled to hospitals nationwide and talked to radiologists, emergency physicians, surgeons, and specialists about their real-world needs. What we've learned: The demand for immediate imaging interpretation is both urgent and universal, but the path forward requires thinking beyond productivity tools toward foundational capability.

The Food and Drug Administration has authorized nearly 1,000 AI tools for radiology, validating the technology's maturity to detect lung nodules, brain hemorrhages, bone fractures, and more. Yet most of these AI tools target similar conditions. What clinicians actually need is broader coverage. When a patient arrives with acute abdominal pain at 2 a.m., the ED physician needs a system that can identify acute diverticulitis or acute pancreatitis or small bowel obstruction—or dozens of other possible conditions.

Medical imaging is the natural starting point for this kind of comprehensive medical intelligence. The input and output are clearly defined—pixels in, interpretation out. Most diagnostic journeys flow through imaging: A patient presents with symptoms; imaging reveals pathology; treatment follows. With hundreds of millions of exams annually in the U.S. and interpretation often delaying immediate lifesaving decisions, the volume is massive and the urgency is real. Build an intelligence layer for medical imaging—a regulated API that turns images into answers—and you create a model for how medical intelligence could work across all of health care.

There is already a wealth of radiology AI focused on making existing workflows more efficient—helping to convert spoken observations into formatted text or drafting summary conclusions from detailed observations. These tools have value, but at 2 a.m., when immediate expertise isn't available, they don't solve the fundamental problem. They're optimizing the wrong bottleneck.

Medical intelligence that can answer any question about medical images solves an immediate need for doctors. An ED physician needs to know if there's acute pathology requiring urgent intervention. A surgeon needs to understand the degree of bowel obstruction. Same underlying intelligence,

different questions, all answered in seconds. The path forward isn't narrow detection tools or documentation assistants. It's an intelligence layer that serves whoever needs it, however they need it.

Consider speed—the most immediate opportunity. A patient develops sudden abdominal pain at 3 a.m. The ED physician needs to know: surgical emergency? In seconds comes the answer: "Free air visible below the diaphragm—indicates perforation of the stomach or intestine. Immediate surgical evaluation required." The surgical team mobilizes while the patient is still in the scanner. An elderly patient arrives with back pain: "Abdominal aortic aneurysm with danger signs on the CT scan that it's becoming unstable—call vascular surgery immediately." A severely blocked kidney and showing infection at 3 a.m.: urgent urology called, not morning rounds. Even 30 minutes to 60 minutes of acceleration can meaningfully change outcomes for time-sensitive conditions.

But speed alone doesn't capture what becomes possible. Sophisticated triage becomes feasible: A patient presents at 2 a.m. with abdominal pain and fever. The surgical resident needs to know: operating room now, or medical management? Immediate interpretation: "acute diverticulitis with a small, contained perforation. Air pocket is localized. Mild surrounding inflammation. No large fluid collection." The resident starts antibiotics and monitoring, not surgery. Even this level of clinical detail—identifying what's present and characterizing severity—enables the right action at 2 a.m.

Or systematic screening: Kidney cysts appear incidentally on imaging all the time. If AI can accurately characterize them—distinguishing benign simple cysts from complex cysts that require follow-up—physicians could check their entire patient population: Who has cysts needing surveillance? The system flags patients that require monitoring. Such proactive population management determines who needs attention before problems become urgent.

Or quantitative tracking: Oncologists following tumor response need measurements across serial scans—is the cancer shrinking, stable, or growing? Automated measurements, comparing to priors, flagging progression or responsiveness to treatment foster consistent quantitative assessment of change over time, enabling data-driven treatment decisions that would otherwise require manual measurement of dozens of lesions across multiple points in time.

Most fundamentally, this solves systematic gaps in expertise availability. The access bottleneck manifests differently across settings—academic centers face significant workload pressures during peak hours; community hospitals depend on single specialists covering multiple facilities—but overnight and weekend coverage creates systematic gaps everywhere. Even hospitals with robust daytime staffing often have minimal overnight presence. ED physicians and surgeons wait for interpretations. The wait can stretch for hours. During that time, clinical conditions progress.

Building AI that generates preliminary interpretations—what we call semi-autonomy—creates continuous coverage while maintaining expert oversight. The AI provides immediate answers that clinicians can act on. The radiologist reviews and confirms, focusing attention on complex cases requiring nuanced judgment, quality assurance, and direct consultation when clinical questions demand human dialogue. This remains a very challenging technical problem. Systems that can handle the full breadth of imaging interpretation at radiologist-comparable performance don't exist in practice today. But the trajectory is clear, and the organizations investing now are building what will soon become standard capability.

The regulatory and legal path matters here. A system that generates complete radiology reports at radiologist-comparable performance and signs them autonomously—true full autonomy—requires thoughtful regulatory frameworks. Building standards for autonomous report generation takes time, appropriately so. The path forward doesn't require solving all these challenges simultaneously. Semi-autonomy—where AI generates preliminary interpretations with radiologist review—addresses immediate access needs while working within current regulatory standards. Across all these use cases, radiologists always review and confirm.

Many forward-thinking radiologists recognize this as the evolution their field needs. Facing unprecedented demand—hundreds of millions of exams annually, growing faster than the workforce—they understand: The bottleneck isn't radiologist capability. It's availability. This technology

doesn't replace radiologist expertise; it extends it across time and space. The radiologist covering three hospitals overnight can focus on the most complex cases while preliminary AI interpretations enable immediate clinical action on straightforward findings. The radiologist managing high volumes during peak hours can ensure that critical findings trigger immediate action even when the formal read comes hours later.

Different clinicians want different answers. Radiologists recognize the need for new capabilities to match unprecedented volume. ED physicians want immediate answers about acute pathology. Surgeons want triage guidance. Specialists want quantitative data. Build this capability, and different users access it in ways that serve their workflows.

These insights led us to work on what we call building the intelligence layer for medical imaging. We're developing systems that make radiologist-level interpretation accessible on demand, starting with comprehensive body CT interpretation and expanding across imaging types and anatomies. Early experience shows the model works: Clinicians get timely information; radiologists focus on complex cases and oversight; patients benefit from faster care.

When this intelligence layer becomes standard, it stops being a radiology department tool. It becomes foundational capability for entire health care organizations. Emergency departments make care plan decisions based on immediate answers to imaging questions. Surgical teams prioritize cases overnight with real-time interpretation. Critical findings trigger immediate action regardless of time or day. The result isn't merely faster care. It's fundamentally different care delivery—where the constraint is no longer waiting for expertise to become available.

For specialty medicine, this enables precision at scale. Cardiologists identify therapy candidates across their entire patient population. Neurologists get details about blocked blood vessels in the brain in minutes rather than hours. Organizations with this capability can promise 24/7 subspecialty-level interpretation, manage complex cases that would otherwise require transfer to more specialized facilities, and deliver data-driven precision medicine at scale.

Just as electronic health records transitioned from optional innovation to required capability, immediate access to medical imaging intelligence will become expected rather than exceptional. The question for health care leaders isn't, "Should we invest in this?" It's, "How quickly can we build this capability before it becomes the competitive baseline?"

The answer requires thinking about AI not as a productivity tool but as infrastructure. Reliable, always available, accessible to whoever needs it, supporting everything built upon it.

The first decade of medical AI proved the technology works. This decade is about building it into the intelligence layer health care depends on.

Within a decade, the waiting will seem strange. We'll wonder why we ever accepted that expertise, once created, couldn't be everywhere at once. That a scan could complete in minutes but interpretation took hours. That a perforation visible on a screen could remain unknown to the team caring for the patient.

Medical intelligence is becoming infrastructure—not because it's revolutionary, but because once you build it, the alternative becomes unthinkable. The organizations building this capability now aren't just improving health care delivery. They're establishing what it means to deliver care at all. That future—where any question about medical images receives an immediate answer, where patients everywhere have access to expert interpretation when clinical decisions happen—isn't distant. We're building it.

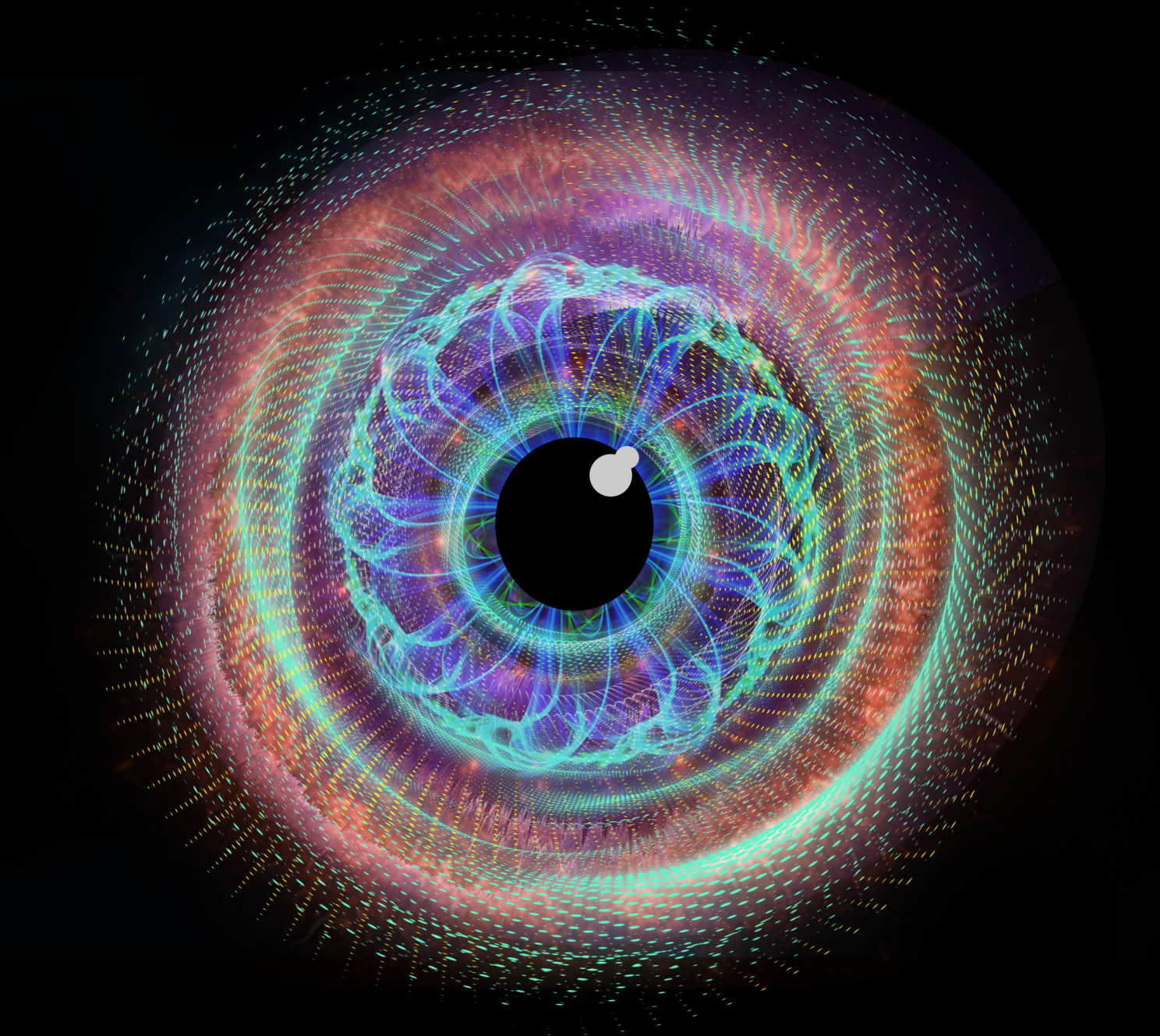
Pranav Rajpurkar, Ph.D., is an associate professor at Harvard Medical School and earned his Ph.D. from Stanford University. His research on medical AI has resulted in more than 150 publications, and he's been recognized by Forbes 30 Under 30, MIT Technology Review's Innovators Under 35, and Nature.

Samir Rajpurkar, MS, is CEO of a2z Radiology AI Inc., and brings three decades of award-winning enterprise-scale global technology transformations, leading teams of hundreds across more than 20 countries.

Together, they co-founded the company a2z Radiology AI in 2024.

THE TAKEAWAY

Artificial intelligence's analysis of medical imaging can speed care to patients and allow physicians to spend more time on complicated cases.



AN APP THAT IS TRANSFORMING VISION TESTS

Designed to serve isolated regions of Africa, the app is now finding a place in everyday care in the U.S., Western Europe, and elsewhere in the world—an example of reverse innovation in which new technologies intended for remote areas are used in the general population to improve medical care.

BY ANDREW BASTAWROUS

ILLUSTRATIONS BY DAVID LAM/
THE PEW CHARITABLE TRUSTS

It was the beginning of a long, difficult day in July 2012. I had left my home in Kenya before the sun rose that morning. My team and I had traveled for hours along dark, dusty roads until they gave out, and we rumbled across fields to reach the small village where we were setting up a temporary eye clinic.

As we approached the church hall where the clinic was being held, we were greeted by scores of people, young and old, patiently waiting to be seen by us—a traveling eye care team—despite the fact that it wasn't yet 8 a.m. I knew that many of these people had traveled many miles to be there and, as was often the case, we had our work cut out for us to set up the clinic quickly so we could start examining them.

One of the people in that queue, Mama Amanda, a grandmother clutching a long stick in her right arm, with a grandchild under her left, had been living with blindness for eight years. Her condition, cataracts, was completely treatable with a 10-minute operation, yet Mama Amanda had never had an eye test before.

Most people will have had their eyes checked by an optometrist or doctor at some point in their life. If you're based in the Global North, you've probably had your vision and eye health checked in a comfortable, air-conditioned room full of illuminated letter charts, machines, and gadgets.

Vision loss is one of the world's most common health issues. Almost everyone will need eye care in their lifetime, and a staggering 1.1 billion people worldwide have vision loss that could be treated today. Yet most of them will never have had their vision checked. In fact, more than 90% of people who need eye care can't access it—people like those waiting in the orderly line that I watched get longer by the minute on that long, hot day in 2012.

We started unpacking our bulky hospital equipment to set up the clinic. As I was carrying one of the larger machines from the minibus, I heard a bang from inside the hall. I rushed in to find Cosmas, a brilliant young IT expert on our team, peering at a blown fuse. The power supply to the hall had shorted and we were facing disaster—without electricity, none of our equipment would work, and we'd leave the long line of people outside disappointed.

Cosmas suggested we all go and wait outside so he could think about a workaround. As I took a quick walk around the village to clear my head, my thoughts were broken by a familiar sound—the overly loud ringtone of a Nokia mobile phone. It made me wonder that if a village like this with no reliable electricity supply or running water has a perfect mobile signal, was there some way that all these people disconnected from eye health care could be reached by that signal too?

There was another bang as Cosmas managed one of his genius fixes to get the power supply back up and running. We got the clinic set up by midmorning and were able to start testing and treating people.

While examining Mama Amanda, I confirmed that she had cataracts we could treat. The emotion it stirred in her, a sharp blend of despair and hope, was one I have come to know too well now. Despair because the cure had been there all along, yet she had spent years in darkness, alone and frightened. Her world had shrunk to the walls of her small home, and her granddaughter had become her eyes, her guide, her voice in the market, her link to the world—at the cost to her granddaughter's childhood and schooling. And then hope, fierce and immediate, because maybe tomorrow everything could change; her story did not have to end the way it had begun.

The thought planted in my mind that morning—that maybe mobile phones could be the key to better eye health—began to grow. People like Mama Amanda were everywhere, invisible. Yet

ALMOST EVERYONE WILL NEED EYE CARE IN THEIR LIFETIME, AND A STAGGERING 1.1 BILLION PEOPLE WORLDWIDE HAVE VISION LOSS THAT COULD BE TREATED TODAY.

technology and connectivity were in unlikely places and might change the future. Working with my team in Kenya and a host of incredible collaborators from across the world, we began to test different ways that smartphones—just becoming popular at that time—could help address the vast need for eye health care in countries like Kenya.

After a few false starts, we developed a proof of concept for an app we eventually called Peek Acuity. The idea was simple: Peek Acuity replicates the illuminated chart with letters that anyone who has ever had their eyes tested will be familiar with. The difference is that with just a few minutes of training, anyone can use the app to accurately check another person's vision. And to work it only requires a standard smartphone—not the bulky, unreliable equipment we had to grapple with that day in Kenya.

Peek Acuity is now used in more than 100 countries, making it an example of reverse innovation—the concept where something developed for use in low-resource settings becomes widely available in more economically developed nations too, benefiting everyone. In fact, eye health is a real hotbed of reverse innovation. When I started working in global public eye health 20 years ago, I was hugely inspired by organizations like Aravind Eye Hospital in India, which developed a high-volume, low-cost way of performing cataract surgery that has now literally saved the sight of millions of people worldwide—and does so at a volume and quality comparable to the whole of the British National Health Service, at a fraction of the cost.

In other areas of health, reverse innovation has brought new approaches and technologies that have saved millions of lives. For example, oral rehydration therapy to treat life-threatening dehydration caused by diarrhea was originally developed in Bangladesh, and is now a standard of care worldwide that's estimated to have saved more than 70 million lives since its introduction in the late 1970s. Another example, the Cardiopad, a tablet device that can accurately read a patient's heart rates and send them to a remote cardiologist for analysis, was invented in Cameroon and is now being used in outpost towns in western Europe.

The power of reverse innovation lies in its ability to focus on the solution, rather than getting distracted by how to get there. For example, when we were developing Peek, one of the problems we needed to solve was ensuring that vision tests were done at a standard distance—usually 2 meters (about 7 feet)—between the person using the smartphone and the person being tested.

We were pretty sure that we could use the smartphone's front-facing camera to triangulate the distance of the person being tested and to flag the tester to adjust their distance if needed. Yet, after months of development, when we finally took the app out to be tested in situ, it was a failure, and the triangulation element was really erratic. However, a different tactic we tested concurrently proved to be 100% reliable, portable, and extremely cheap: a precut piece of string, measured out to exactly 2 meters. To this day, that's how our users working in large-scale eye health programs ensure an accurate testing distance. The string is cheap, easy, and it works every time.

In the last 20 years, medical innovation has exploded. In my early days practicing as an eye surgeon in the U.K.'s National Health Service, I could barely keep up with all the new techniques, technologies, and gadgets coming on the market. Yet, at the same time, I had a nagging thought at the back of my mind—with all of this sophisticated technology, there remained millions of people who couldn't access even basic eye care.

For more than 90% of the billion-plus people worldwide with eye issues, all they require is a pair of glasses—a 700-year-old invention—or cataract surgery, which was first recorded in historical documents from around 800 BCE. Incidentally, those ancient references to cataract surgeries are from India—a hotbed of ophthalmological innovation even then—and Egypt, where my parents were born.

In recent years, there's been a huge amount of excitement about how artificial intelligence and other cutting-edge technologies can create even more innovative ways to treat eye health. Yet I still find myself returning to a simple point: Technology alone doesn't solve eye health problems, people do. Perhaps that's why reverse innovation is such

an important concept in health today—and one that deserves more attention. In constrained circumstances, you'll always come up with the solution that works for the people it's designed to serve.

While Peek Acuity now is being used in over 100 countries, we soon realized an eye test alone would not be enough. We've gone on to build and integrate the app into a wider system that helps nongovernmental organizations, governments, and eye hospitals in the Global South understand where patients are needing treatment but are not accessing it, allowing them to put their scarce resources where they're really needed. The original eye test app also remains available—downloadable for anyone with an Android device. And we know that it's being used in all sorts of places, not just in the Global South, but also in the U.K.'s National Health Service and across the U.S., where parents check their children's vision and get them to the eye care they need.

Today, Peek works in partnership with eye health providers in 12 countries and our vision screening and data insights platform has helped more than 1.5 million people reach care. Over 100,000 people a week now receive an eye test using Peek, and we've cumulatively reached over 15 million people, two-thirds of them in the last two years, thanks to our incredible partners in eye health and a small cohort of forward-thinking philanthropists.

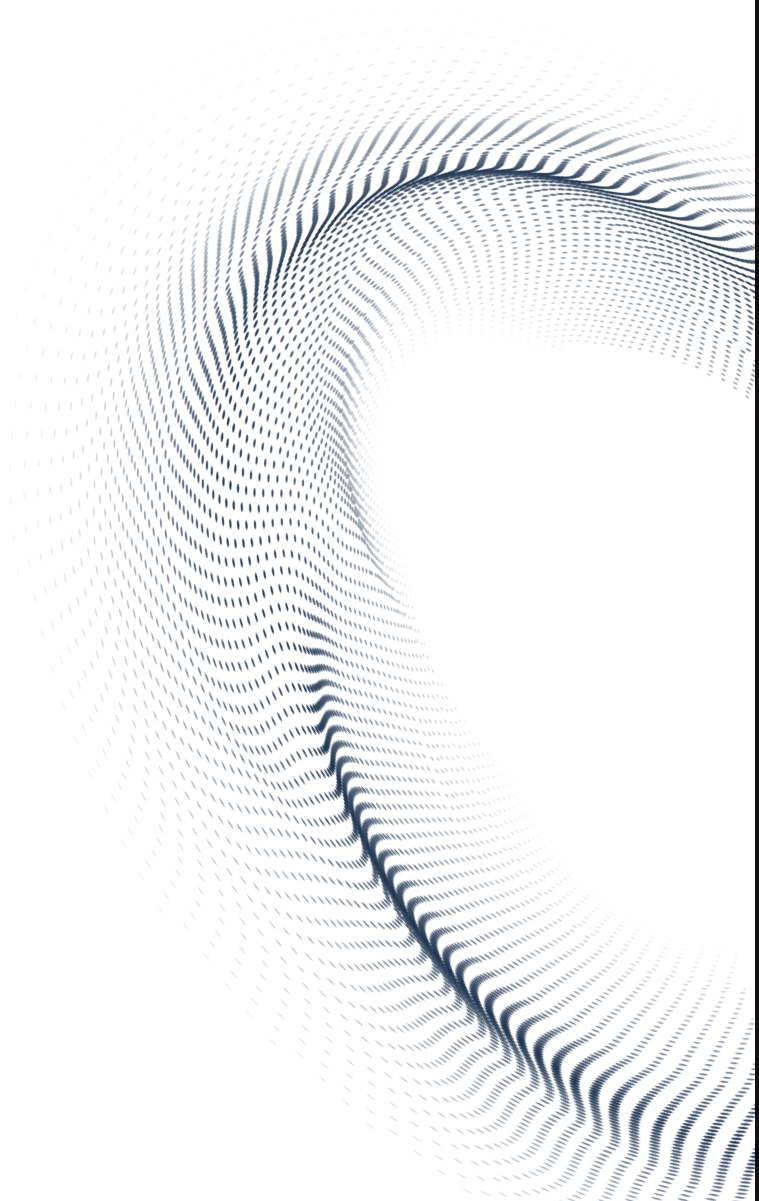
But that's just a drop in the ocean of need. Without major changes, close to 1.8 billion people are expected to be living with vision loss by 2050. We need to do so much more, and that's why we continue to explore new partnerships and ways of making eye health sustainable, powered by technology but always led by the people who use and benefit from our tools.

We didn't set out to create a reverse innovation that long, hot day in Kenya. Then, as now, my team and I were motivated by a single, simple idea: that everyone should have access to vision and eye health.

For the people Peek reaches the change is more than sight. It's the return of something no chart can measure. For Mama Amanda, it wasn't just that the world came back into focus, it was that her life came back to her. Independence. Dignity. The quiet pride of moving through her day without leaning on another's arm. Her granddaughter got back to school, her own dreams no longer on hold. And Mama Amanda was once again where her spirit belonged: in the kitchen with her favorite recipes, in the garden where her hands knew every stem, and in the heart of her family, giving more than she received.

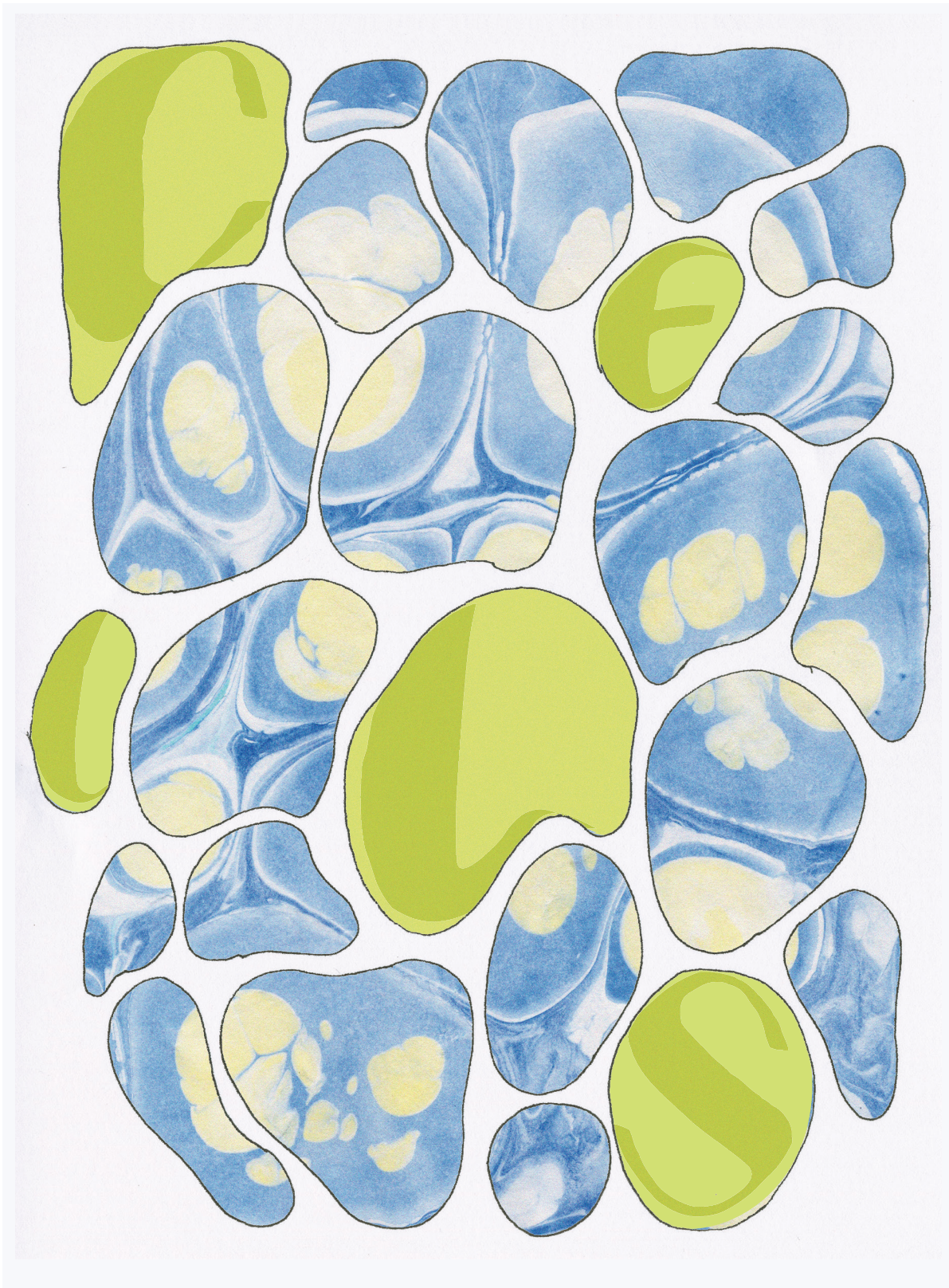
This is what can happen when technology and compassion walk hand in hand.

Andrew Bastawrous is a professor of global eye health at the London School of Hygiene & Tropical Medicine, and co-founder of Peek Vision, which is solely owned by the Peek Vision Foundation, a registered U.K. charity.



THE TAKEAWAY

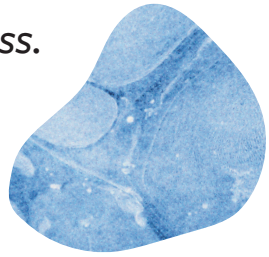
The power of reverse innovation—when a new technology for an underserved population expands to wider use—lies in its ability to focus on the solution, rather than getting distracted by how to get there.



ILLUSTRATIONS BY ALLIE TRIPP/
THE PEW CHARITABLE TRUSTS

The Future of Cancer Treatment Is Now: Targeted Therapy

Seeking to reduce the negative effects of chemotherapy, researchers are developing new treatments that target cancer cells and don't damage healthy cells in the process.



BY ZIYANG ZHANG

This year, more than 2 million Americans will hear the words "you have cancer." That's 5,500 people each day—about one every 15 seconds. And as upsetting as that phrase might be, even more distressing is the word that often comes next: chemotherapy.

Chemotherapy—the use of chemical agents to slow the growth of cancer cells—has proved to be an effective approach for treating a wide variety of cancers. Yet despite its ability to significantly boost cancer survival, it remains almost as frightening as the disease it's meant to cure. And rightly so. Standard chemotherapies are broadly toxic—the medical equivalent of weeding a garden with a bulldozer. They kill cancer cells but destroy healthy cells at the same time. This collateral damage precipitates the side effects—including severe fatigue, nausea, and hair loss—that give chemotherapy its notorious reputation.

But this situation is beginning to change. By unraveling the molecular secrets of cancer, we now know much more about the features that make cancer cells unique. Such "inside intelligence" uncovers molecular targets that allow us to attack cancer cells directly while limiting damage to normal tissue. This new approach—often called targeted therapy—is transforming modern cancer treatment, generating drugs that are more effective with fewer debilitating side effects. And in the decades to come, such targeted treatments will be developed for a broader variety of cancer types, potentially rendering targeted chemotherapy no more intimidating than taking a couple of aspirin.

TAKING AIM

When I began my scientific training, I wasn't focused on therapeutics. I was fascinated by chemistry and excited by the idea that, using chemical principles, I could design and synthesize molecules that had never before existed in the history of the universe. It wasn't until I was further along in my studies, as a graduate student and a postdoctoral fellow, that I discovered that the real power of chemistry is not just in producing

molecules that are novel; it's in making something that can benefit human health. Since then, I have dedicated my career to developing compounds that are fine-tuned to strike directly at the heart of disease.

I was still in middle school when a drug that many consider to be the first targeted cancer therapeutic hit the market in 2001. This landmark drug, called imitanib (brand name Gleevec), turned chronic myeloid leukemia (CML) from a fatal disease into a largely manageable condition. The key to Gleevec's success lies in the genetic roots of this form of leukemia. CML is caused by a chromosomal defect that produces a protein called BCR-ABL, a chronically active mutant that drives uncontrolled cell proliferation. Cancer cells become reliant on BCR-ABL, which regulates the activity of other cellular proteins, including those involved in cell growth. Inhibiting BCR-ABL deals cancer cells a lethal blow.

But finding a drug that could land that blow was a challenge. BCR-ABL is a type of protein called a kinase. Human cells make more than 500 different kinases, most of which rely on the energy-carrying molecule adenosine triphosphate (ATP) to fuel their activity. The prevailing thought at the time was that hitting one kinase would hit them all. However, by exploiting subtle chemical differences in the ATP-binding pocket of BCR-ABL, investigators were able to identify drugs that were selective for this particular kinase, shutting down its activity while leaving other cellular kinases unaffected.

The development of this targeted therapeutic was a lifesaver for people with CML. But Gleevec is just one drug that targets one protein in one fairly rare form of cancer. In fact, CML represents less than 0.3% of all cancers. Each cancer, in turn, is associated with its own set of mutations that affect cell growth, proliferation, and survival, meaning that every cancer type presents its own puzzle to solve. Although that might make the problem seem almost impossible to overcome, improvements in DNA sequencing technologies have allowed researchers to catalog these cancer-causing mutations—and to identify those that offer the most promising targets.

LEVERAGING CHEMISTRY

One of those potential targets is the protein Ras. Mutations in this protein are involved in an estimated 30% of all human cancers, so being able to inhibit Ras would potentially help hundreds of thousands of people. But Ras has turned out to be an even more challenging target than BCR-ABL. Throughout the 1990s, researchers around the world tried and failed to find a molecule that would bind to Ras and selectively hamper its activity. Enthusiasm for the search died down, and some investigators next pursued approaches for preventing Ras from getting where it needs to be inside the cell. These, too, ultimately failed.

Then Kevan Shokat and his colleagues at the University of California, San Francisco (UCSF) took another look at how mutant Ras differs from its normal counterpart. The protein, it turns out, has three hot spots that are targeted by mutations in different types of cancer. These mutations produce chemical changes that, Shokat reasoned, give each cancer-causing Ras a distinct chemical hook—one that could be exploited to specifically target that particular mutant protein. Shokat and his team took advantage of a mutation that rendered one form of Ras unusually chemically reactive, and they designed a molecule that could latch on to this cancer-causing Ras, inhibiting its activity.

After that initial discovery, published in 2013, additional chemical tinkering backed by biotech produced an inhibitor that was even more effective. It would take another 10 years of testing in clinical trials for the drug—called sotorasib—to gain approval from the Food and Drug Administration to become the first Ras-targeting therapeutic for people with non-small cell lung cancer. That was followed quickly by adagrasib, a drug developed by a competing group, which crossed the regulatory finish line soon after. As of August 2025, two Ras inhibitors have been approved by the FDA, with more than a dozen in clinical trials.

When I joined Shokat's lab at UCSF as a postdoctoral fellow in 2016, I was inspired by his success. But I wondered whether we could find inhibitors for more common Ras mutants, such as the one associated with colon cancer.

I looked at the change wrought by this particular mutation as I would a chemistry problem, and I pondered how I could selectively target its distinctive reactivity. For four years I worked on this chemical conundrum with no success, until one day I discovered that one of my compounds showed signs of being an effective inhibitor. The bad news? The inhibitor blocked the activity of the wrong protein. The good news: The protein it targeted was yet another cancer-causing Ras mutant.

After puzzling over this unexpected discovery (and questioning my chemical competence), I was able to tweak the structure of the compound to produce a molecule that struck its original target. So now I had compounds that inhibited two Ras mutants that are more common than the one that Shokat originally targeted. And by the time I left UCSF to start my own independent lab at the University of California, Berkeley, I had discovered a third.

Although none of these has yet yielded a drug that's being used to treat people with cancer, dozens of targeted Ras inhibitors are now being tested in clinical trials. And Ras is just one target. Therapeutics that target other cancer drivers are currently in clinical use. Inhibitors of the epidermal growth factor receptor have proved effective in treating non-small cell lung cancer. HER2 inhibitors are used against certain types of breast cancer. Drugs that inhibit B-Raf, a protein that interacts with Ras, are approved for the treatment of melanoma. And the list goes on.

ENLISTING IMMUNITY

The success of these targeted therapeutics offers great hope for the future of cancer treatment. But developing thousands of different drugs that are specific for all of the mutations we know to be associated with cancer is a Herculean task—even a Sisyphean one, considering that cancers frequently develop resistance to individual therapeutic compounds. Could there be another way to differentiate cancer cells from normal cells and eliminate only those cells that are malignant?

Our bodies may already harbor the secret to solving this problem. The immune system is designed to identify and destroy cells it sees as foreign. Perhaps we can come up with a way to boost the immune system's ability to recognize and target cancer.

The immune system works by training itself to tolerate the body's own proteins, cells, and tissues and purging those that don't belong, including cancer cells. The concept of unleashing the immune system to attack cancer actually dates to 1891, when William B. Coley tested a rudimentary treatment that involved injecting inoperable tumors with a mixture of heat-killed bacteria—a concoction that became known as "Coley's toxin." This unusual approach provoked an immune response that attacked not only the bacteria but also the tumor in which the faux infection was embedded.

But it wasn't until James Allison and Tasuku Honjo developed a way to enlist the immune system with molecular precision that immunotherapy became broadly adopted as a safe and effective way to treat cancer. Allison and Honjo shared a Nobel Prize for this work in 2018.

Immunotherapy is most effective when a

cancer cell has many mutations, as is the case in melanoma. The more a cell differs from its normal counterpart, the easier it is for the immune system to see.

So when a mutant protein harbors just a single amino acid change, such as the family of Ras mutants, it does not present much of an immunological target and can easily be overlooked. The question then becomes: What if we could design some sort of molecular flag that could chemically highlight these mutant amino acids in a way that makes them easier for the immune system to detect?

In my lab, we are working on using our Ras inhibitors as the basis for such flags. These molecules already bind selectively to the mutant proteins. We can then amplify this signal using an antibody that recognizes the inhibitor—the chemical equivalent of lighting a flare at a roadside accident. The antibodies alert and activate immune cells to remove the affected cell—in this case, cancer.

Enlisting the immune system to combat cancer also has an added benefit. When treating cancer with chemotherapy, even targeted chemotherapy, the drug has to inhibit all of the cancer-causing proteins in the body to be fully effective. But immunotherapy is self-reinforcing. Once the immune system knows what to look for, it will continue to search for and eliminate not just the mutant proteins but also any cancer cell that contains them.

MARCHING FORWARD

Although these efforts hold great promise for treating an ever-growing range of cancers, many challenges remain. The targets for which we currently have therapies have been, in some ways, the low-hanging fruit. And different cancers have access to their own personalized grab bag of molecular tricks. For example, how do we treat cancers for which the mutation eliminates a protein that is normally protective, leaving nothing behind to target? How do we develop inhibitors for cancer-driving proteins whose lack of defined structure makes them notoriously slippery targets? How do we approach cancers that exploit the body's natural barriers and hide in tissues that are hard to reach, such as the brain? And how do we stay one step ahead of the resistance that many tumors develop to evade even our best therapeutics?

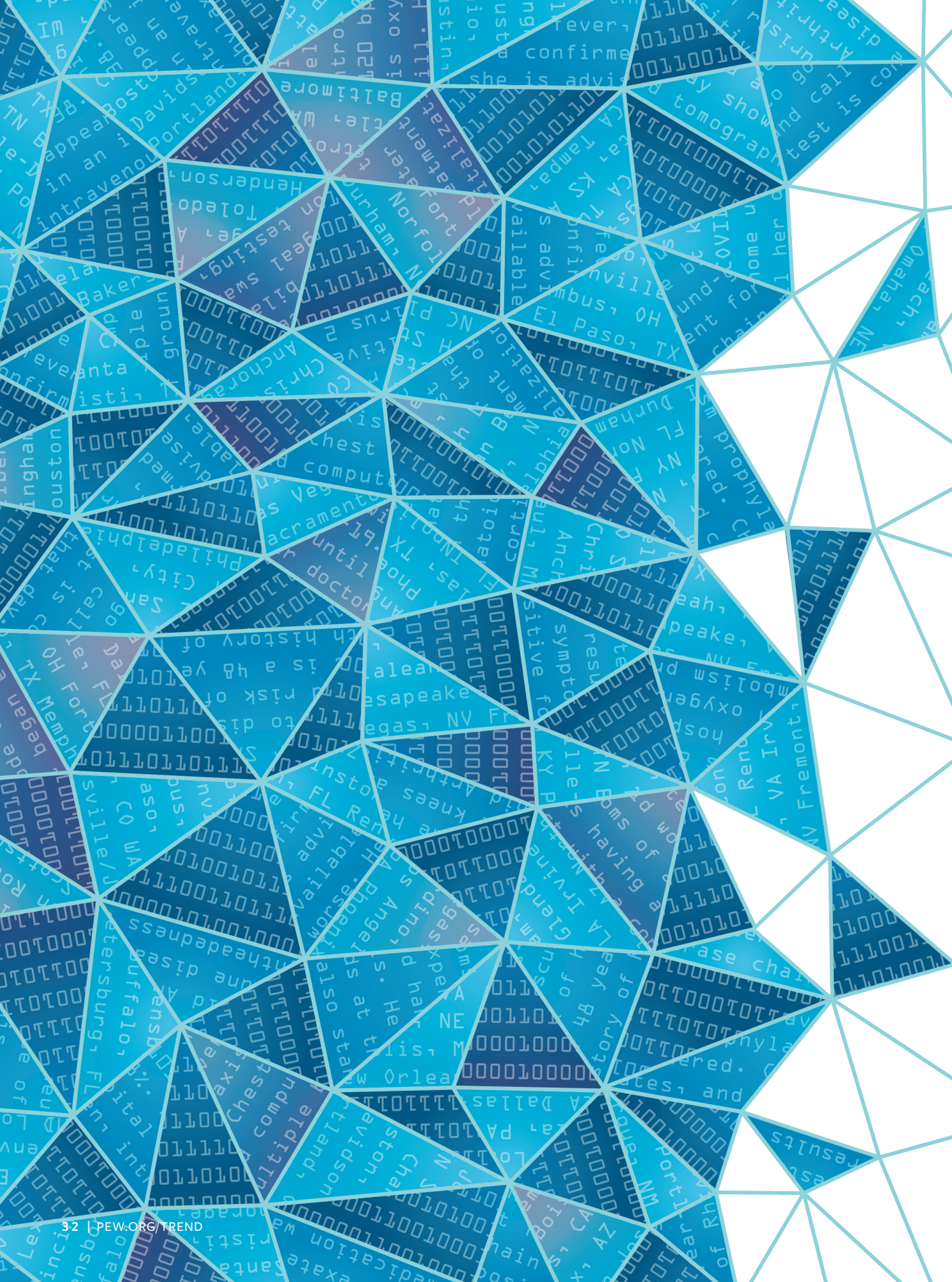
Tackling these problems and developing targeted therapeutics and immunotherapies with even greater specificity and minimal side effects will require even greater perseverance, creativity, and, of course, continued public support.

The good news is that many of the low-hanging fruits of today were once considered impossible not too long ago. While cancer will probably continue to be a formidable foe for some time to come, the promise of effective targeted therapeutics is already offering patients treatments that conjure more hope than fear.

Ziyang Zhang is a Pew-Stewart Scholar for Cancer Research who received his undergraduate degree in chemistry from Peking University in 2011 and then undertook Ph.D. research as a Howard Hughes Medical Institute predoctoral fellow studying the synthesis of novel antibiotics with Andrew Myers at Harvard University. After a productive postdoctoral fellowship in Kevan Shokat's lab, he joined the faculty at the University of California, Berkeley, in 2022.

THE TAKEAWAY

As researchers find more treatments that kill only cancer cells—targeted therapy—instead of attacking all fast-growing cells, patients are experiencing fewer side effects and better outcomes.



How Data Has Become a Medical Innovation

The automatic transfer of medical data from a patient's point of care to public health agencies is allowing agencies to spot emerging diseases and other trends and can help to keep communities healthier.

BY KATHY TALKINGTON

ILLUSTRATIONS BY NED DRUMMOND/THE PEW CHARITABLE TRUSTS

Public health as we know it started with data.

In 1854, hundreds of people in London's Soho neighborhood were dying from cholera. At the time, no one knew what caused the disease, but a public health pioneer named John Snow suspected it was in the water. He painstakingly collected and mapped data from people who had become ill and discovered the source: a water pump on Broadwick Street. The city removed the pump's handle, the outbreak dissipated, and epidemiology—the study of how diseases originate and spread—was born.

Data is even more vital to public health today than it was 170 years ago. Indeed, just as clinicians rely on patient data—blood pressure, glucose levels, and other vital signs—to diagnosis illnesses and guide treatment, public health agencies need data to keep communities healthy. Data enables them to detect disease hot spots, control the spread of infection, and direct limited resources as efficiently as possible to the populations that need them most.

But before public health agencies can start analyzing and using data, they must first collect it.

Just 20 years after John Snow's breakthrough, U.S. doctors started systematically reporting cases of disease to their health departments. Back then, they used postcards. In the 20th century, they progressed to phone and then fax. Today, despite the advent of electronic medical records and the internet, phone and fax often remain the way that cases get reported. This causes delays and errors in reporting that can cost lives and money. These challenges were especially stark during the COVID-19 pandemic, a time when many health departments received lab reports by fax. As *The New York Times* reported in September 2022: "The precise cost in needless illness and death cannot be quantified. … But federal experts are certain that the lack of comprehensive, timely data has also exacted a heavy toll."

Fortunately, the pandemic also sparked innovation. Though at the time doctors and public health agencies rarely used automated digital systems to share data, known as electronic case reporting, today about 53% of state, local, Tribal, and territorial public health agencies receive digitized case data for at least three-quarters of the health conditions that providers are required to report by law.

Indeed, the movement to bring public health into the digital age has many bright spots. Most lab results, which public health agencies use to confirm incidents of disease, are reported using automated systems. Immunization reports are increasingly digital. And public health agencies are using digital data from emergency rooms—known as syndromic surveillance—in increasingly creative ways to detect and respond to a wide range of infectious and environmental health threats.

MOST LAB RESULTS, WHICH PUBLIC HEALTH AGENCIES USE TO CONFIRM INCIDENTS OF DISEASE, ARE REPORTED USING AUTOMATED SYSTEMS.

Health departments are also pioneering partnerships with insurers such as Medicaid and harnessing their claims data to inform and improve treatments for chronic diseases. Some are looking outside of health care and engaging with social services agencies, corrections departments, educational institutions, and others to better understand the social and economic factors that drive health outcomes and then design more effective programs to prevent diseases. Other intrepid agencies are even exploring how artificial intelligence can help them to overcome technological hurdles and workforce shortages.

These technological advances and creative uses of data are not yet the norm, but some state and local agencies are pointing toward a future of public health that takes full advantage of the innovations available to them.

Support from syndromic surveillance

Lab reports confirming the presence of a disease are vital to public health, but by the time public health agencies get them, the data is often days or weeks old—the time it takes for doctors to order tests and wait for the results. However, when diseases are spreading quickly, time is of the essence.

That's why, around the time of 9/11 and the anthrax attacks of 2001, the U.S. government established the national syndromic surveillance program to serve as a sentinel against bioterrorist attacks. By collecting digital data on just the symptoms that patients reported in emergency departments, the Centers for Disease Control and Prevention (CDC) and state public health departments could detect threats in near real time.

Today, public health departments across the country are using syndromic surveillance data to track not just infectious diseases but also environmental and behavioral health issues that arise from wildfire smoke, extreme heat, substance use, and automobile injuries, to name a few.

For example, when wildfires swept across Oregon in September 2020, hospitals filled with patients suffering from respiratory illnesses. As doctors treated people individually, public health officials also sprang into action, using real-time data from emergency rooms and urgent care centers to track the smoke's health effects and issue targeted warnings to vulnerable communities.

And in northern Idaho, where suicide has been a leading cause of death among youth, the regional health department in 2017 used syndromic surveillance to better understand and respond to childhood suicide risk. They did this by analyzing data on suicidal ideation or attempts from hospital emergency departments, which captured critical data often missed by traditional sources such as coroner reports. The health department monitored the data and generated weekly analyses that examined possible correlations of suicidal behavior with sex and age. It shared its analyses with the Suicide Prevention Action Network, which used the data to improve its efforts to prevent self-harm.

Data to curb chronic disease

Before the advent of vaccines, antibiotics, and modern sanitation, infectious diseases were the leading killers. But today, chronic diseases such as diabetes, hypertension, and asthma account for 70% of deaths and 86% of health care expenses in the United States. Yet the clinical data that doctors must report is still largely restricted to infectious diseases.

So, if doctors aren't required to report chronic disease data and cannot feasibly do so, where can public health agencies turn? One major source is insurance providers. They collect information daily on the types of illnesses that patients have, the treatments being recommended, and the medications being prescribed. Insurance providers use this data to determine reimbursement rates, assess the quality of care, and guide treatment, but public health agencies do not have ready access to this information.

To help overcome this gap, The Pew Charitable Trusts recently launched a project to build data-driven partnerships between state public health agencies and their Medicaid counterparts. Why Medicaid? First, as the nation's largest single payer, it can provide public health agencies with a large pool of claims data. Second, Medicaid serves people who would benefit most by more effective public health programs, including families with low incomes, people with disabilities, and older adults. And, lastly, Medicaid influences the practices of two critical constituencies: private insurers that contract with Medicaid and the 70% of doctors who accept Medicaid payments.

In 2020, the Centers for Medicare & Medicaid Services launched an initiative through its innovation accelerator program to help states reduce maternal mortality and severe maternal morbidity among Medicaid beneficiaries. Seven states participated in the program, which focused on strengthening partnerships and building the ability to analyze data to better understand and address maternal health outcomes.

Each state developed tailored data strategies by collaborating with public health agencies and maternal mortality review committees. For example, Delaware linked Medicaid data with maternal mortality data to gain a fuller picture of maternal deaths, while Kentucky focused on severe cardiac-related illnesses and developed a plan to identify, track, and ultimately reduce risk factors. Massachusetts integrated clinical and social data to identify and narrow disparities in maternal health outcomes that have left some populations at greater risk of harm. And Wyoming focused on identifying psychiatric and substance use-related risk factors associated with maternal death and illness.

Medicaid supported the states in drafting data use agreements, linking datasets, and identifying risk factors. Peer-to-peer learning further enriched the experience and fostered continued collaboration. The initiative demonstrated how Medicaid programs can use data partnerships and analytics to drive targeted, evidence-based interventions that improve maternal health outcomes—especially for low-income populations disproportionately affected by preventable complications.

Looking beyond health data

Medical care has a significant influence on whether a sick person gets well, but researchers estimate that medical social, economic, and environmental factors—where people live, what job opportunities they have, the quality of the education they receive, their access to affordable and nutritious food—account for about 80% of health outcomes. That's because the further upstream the root causes of illness can be addressed, the more efficient and effective the solutions are. Yet as challenging as it is to collect data from doctors, hospitals, and health insurers, it can be even more difficult for public health agencies to partner with social services agencies outside the health care sector. Fortunately, there are a growing number of models to emulate.

In 2017, when Alabama was facing an epidemic of opioid overdoses, its public health department launched a central data repository to pool information from a variety of state agencies, including public health, mental health, Medicaid, and corrections. The system allowed state officials to identify overdose hot spots, evaluate program

effectiveness, and secure funding for targeted interventions. For example, when state officials could see that overdoses per capita were much higher in one county than in others, they directed prevention and peer-support programs there. The database has since expanded beyond opioids to support broader public health efforts.

And across California from 2022 to 2024, a mix of state and local health departments, health systems, and social services agencies partnered to improve care for people experiencing homelessness. The project was facilitated by the California Health Care Foundation and Center for Health Care Strategies. In Alameda County, health care providers and community-based organizations collaborated to offer more integrated behavioral health and housing services that address underlying factors—substance use and lack of access to affordable housing—that drive homelessness. In San Diego County, a mix of academic institutions, health care providers, and organizations such as the YMCA created a real-time bed availability tracker and tool for referring people to temporary residential medical care.

Potential for artificial intelligence

While many state and local public health departments are experimenting with chatbots to communicate with the public, AI has also been tested and deployed to detect infectious and foodborne outbreaks by analyzing language in internet searches, news, and social media messages. It's also been used to accelerate the analysis of disease-causing microbes and their genomes, and even to analyze thermal imaging in hospital waiting rooms to predict daily flu counts.

AI might also help public health agencies overcome obstacles to data sharing and analysis. Interoperability—the concept that two different systems can communicate with each other—requires that multiple stakeholders develop a common language that their products will speak. It takes much time and attention to develop consensus on standards for so many different products and conditions across a broad and diverse group of software vendors, policymakers, public health practitioners, and health care providers.

Without interoperability, public health officials must spend a lot of time and money manually processing data. But AI programs can process data themselves, taking the burden off public health officials and letting health care providers focus on people, not paperwork. In April 2022, for example, about seven months before ChatGPT debuted, the CDC and the Georgia Tech Research Institute unveiled an AI tool that could analyze patients' records to classify the severity of COVID-19 in pregnant women. They found that software reached the same conclusions as a human clinician in 99.4% of 4,378 cases.

Since then, the development and adoption of AI tools in public health has grown dramatically.

New data dawning

These examples show how modernizing data strengthens public health. Privacy concerns, data silos, and inconsistent regulations can slow progress, so addressing these barriers will require thoughtful policy reform and stakeholder engagement.

And data alone is not enough. Agencies need long-term investments for skilled analysts, epidemiologists, and IT professionals to turn raw information into actionable insights. They also need community partnerships to ensure that interventions are culturally appropriate and responsive to local needs.

Emerging infections, chronic diseases, and environmental threats will continue to challenge our health systems. But with better data and deeper partnerships, public health agencies can detect and respond to threats more quickly, target resources more effectively, and improve health outcomes for all.

Kathy Talkington oversees teams of policy experts, scientists, and staff who lead engagement for The Pew Charitable Trusts' work on public health issues.

THE TAKEAWAY

Automatically transferring medical data to public health agencies allows experts to spot disease outbreaks, control the spread, and quickly direct limited resources to the people that need them the most.

INNOVATION CHANGES LIVES

Whether it's a doctor performing surgery or a patient needing a prosthetic, robots and microchips are transforming medical care—and improving how people work and live.

I USE A ROBOT TO PERFORM SURGERIES

By Daryl Marx, M.D.

My practice began in 2004, doing minimally invasive surgery—or laparoscopy—where you're doing advanced surgery through small incisions in the abdomen. In laparoscopic surgery, there's a camera that goes through one incision and instruments that go through separate small incisions. I could hold two instruments, and then I'd need someone else to hold another, and another person still for the camera—so multiple people doing all kinds of things, with everybody trying to read my mind in the operating field, where things can change rapidly. And the instruments were ridged straight sticks that didn't bend, and the ends of the equipment could only open and close and twist. This type of surgery surpassed the open method and gave patients shorter healing time and less pain.

When robotics came out, it was another game changer. I got a machine with four arms that I could control myself, all simultaneously, in real time—and the instruments were wristed, allowing rotation and 360-degree movement, which allowed me to address very complicated angles and work in very small spaces. I was in control of all aspects of the procedure, including the camera. I was trained in robotic surgery, using the da Vinci Si, in 2011. And

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MY KNEE HAS A COMPUTER

By Michael Britton

I was born and raised in Charleston, South Carolina, and lived there until after high school, when I joined the military. I served a total of 12 years in the Army, but it was kind of broken up—five years on active duty, then the reserves, and then I had a two-year break because of COVID. I finally came back on active duty after that, and that's when the accident happened, when I was stationed in Anchorage, Alaska.

I don't remember a lot of it, but I was on my motorcycle when I was run off the road, went through the median and into oncoming traffic, and collided with a van. My foot was amputated on-site.

I remember lying on the highway, and there was an Air Force nurse who had seen the accident—she ran up and performed first aid on me. She said I was very calm, but I knew something was wrong with my leg—but they wouldn't let me look at it because they didn't want me to go into shock.

I woke up in the hospital after three days in an induced coma and found they had also amputated my leg midthigh. Alaska doesn't have any soldier recovery units, a place for long-term healing where your whole job is the recovery. So my command team talked to me about going to a recovery unit close to my home and family or going to the Center for the Intrepid, a top-tier prosthetic place, in Texas. I chose CFI after looking it up and reading about it because I wanted the best care I could get. I did my physical therapy and my occupational therapy there, and I also got my prosthetics there—they have all of it in-house.

Getting fitted for my leg took some time. I met with my prosthetist, and she took some measurements of my residual limb and told me about the process. When she fitted me with my first socket, which is what holds the prosthetic in place, I had to stand in the parallel bars in my boxers while she wrapped my limb with plaster to make the mold that would be used to make the custom socket. They make a test socket out of plastic that you wear for a week or so, and then they make adjustments. And when you're happy with it, they make the real socket out of carbon fiber. I got to work with the prosthetist almost every day, getting fitted for the leg and then learning how to actually walk on it again.

My main leg is the Ottobock X3, which is a microprocessor knee. It has a computer in it that enables the knee to closely mimic the gait of my good leg. It also has other helpful functions that help me with everyday life, including adding resistance when I sit, stand, and walk downhill; stair mode, which lets me ascend and descend stairs using a natural step-over-step motion; stumble recovery; and different modes for different activities. It can hold a charge for about five days, depending on how active I am. And if I forget to charge it and the battery dies, it automatically switches to a safety mode with preprogrammed high flexion resistance.

The cool thing about CFI is you're there with other injured service members and talk and bond with them and see amputees that have, you know, gone through what you've started going through, and see different types of things that will help you out in the future. I was there for almost nine months; it's really definitely the coolest, most beneficial place I've seen. I still go there for all of my prosthetic needs, whether I need a minor

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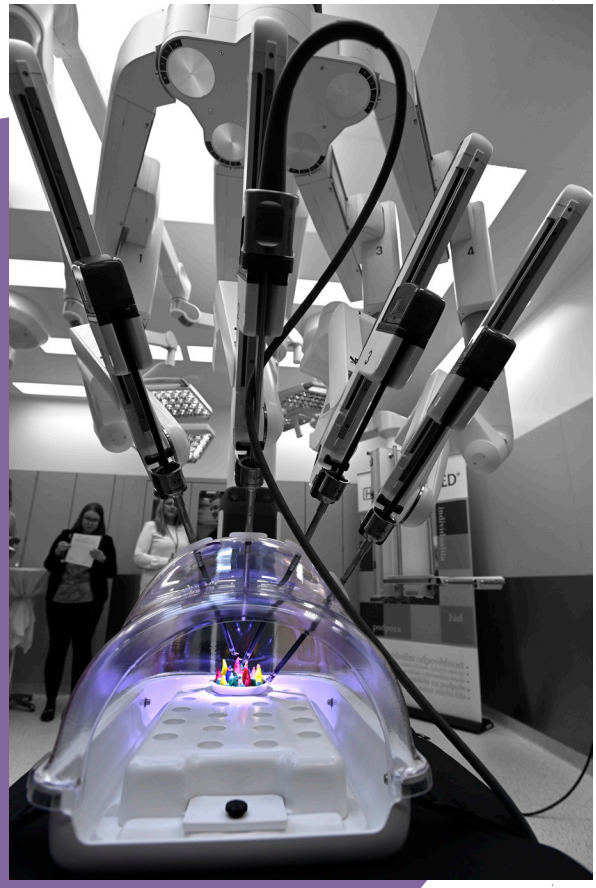

since then, the technology, instrumentation, and visualization have improved dramatically.

The patient experience has changed substantially over the last 10 or 15 years. Patients get a minimally invasive operation. This translates to less pain, minimal bleeding, and discharge to home much quicker than open or even laparoscopic surgery.

There are so many problems that patients avoid with robotic surgery. There's a decrease in postoperative hernias and bowel obstructions as well as a need for blood transfusions.

The lack of blood transfusions alone removes the concern for getting HIV or hepatitis from the transfusions, which you had to worry about 15 years ago. And the risk of infection is much lower too. Infection risk is proportional to the size of the incision and the duration that the incision is exposed to air. The smaller the cuts you can make—and the fewer—the less likely they are to get infected. And the most important thing I hear from patients is that it doesn't hurt as much. Robotic procedures are by far the least painful method of surgery.

I was recruited to come to Our Lady of the Lake, in Baton Rouge, Louisiana, because of my robotics expertise. As of this writing, I've done 5,015 robotic surgeries, making me one of a handful of U.S. surgeons with this level of experience. In my current role, along with performing surgery, I'm developing pathways that allow other surgeons to have open access to this technology throughout our hospital network.

I also train surgeons in robotic surgeries. I physically go into the operating room with them or can proctor them via telepresence. The most recent da Vinci design lets you log in to another surgeon's console with them as they operate. I can actually see what they see and talk with them in real time to help guide them. This can happen from anywhere in the country. I'm like a coach; I can give instructions on port placement, or say, "Hey, arm one, lift up," or I can draw on their screen and tell them, "This is the structure you need to be worried about."

The da Vinci machines have really evolved over

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adjustment, or if my nub starts shrinking and I stop fitting in my socket, they can remold it and make a new socket for me.

I also got to do a bunch of recreational therapy—we would do outings that would be anything from fishing to kayaking, and a lot of this was sponsored by Wounded Warrior Project. We went on trips: waterskiing; I got to go to Colorado twice to go snow skiing. Wounded Warrior Project also got us out into the community, letting us try things we normally wouldn't try on our own in a more relaxed environment, with others who have similar injuries. This made it easier to make mistakes and learn because you're doing it together and also forming bonds.

I have an app on my phone that connects to my leg and has different modes for different activities—golf, football, running, cycling, and many more functions you can add. The golf mode won't let my knee go past a certain angle, so that I don't have to worry about falling or, you know, the knee collapsing on me. So I just click on the activity I want, and it'll change to that mode and be ready to go. The app also lets me see what the battery life is on the leg. I think I got the hang of it all within the first month, but actually trusting the knee and being able to tolerate it more took probably six months.

And I have a backup leg with a mechanical knee, without the computers and smarts, but if anything goes wrong with my X3 I can still get around. The biggest difference between the two is the amount of muscle and focus I have to use—because the microprocessor is helping, you don't have to put as much thought into the steps it takes to make the knee bend, so can focus more on your surroundings. With the microprocessor knee, I use my glute muscle and some of my nub—it just pretty much walks for you—but with the mechanical knee I'm using the whole leg, so it's a lot more work to walk.

Today I can do a whole bunch of sports on my microprocessor knee; I've even competed in the Department of Defense Warrior Games. The first year I did track and field, swimming, and archery. And the second year it was all those and also recumbent bike, wheelchair basketball, wheelchair rugby, and sitting volleyball. Wounded Warrior Project helped here too because they gave all us vets a stipend to help cover food and stuff while we were at the games.

I wasn't really doing sporting events before the accident, but in the military, they told us soldiers all the time, "You're a professional athlete." The Warrior Games are a really cool and fun experience because you're on the team for your branch but competing against all the other branches. And it's so supportive there; you've got people cheering for you.

You know, when I got injured I thought I was gonna get a peg leg and walk around like a pirate. But the Ottobock X3 has been a game changer for me: I can do anything I want. Now I know this disability's not stopping me from doing anything—my options are pretty much limitless. It's all about your determination, and what you want to do—you're not limited to anything.

I may no longer be in the military, but I'm not disabled and sitting around the house—I do a lot of sports to stay active. I've started riding bikes more, and I think it's going to be one of my top sports now. It's good cardio and a good overall workout—and it keeps me moving.

time. When I was first working on the Si machine, it did not have vessel sealers, staplers, or very elegant ways to handle blood vessel work. As technology advanced, so did our capabilities. We could use fluorescents to identify blood flow to organ and biliary anatomy along with advanced stapling and vessel sealing. This was the Xi machine.

Today, the computing power of the da Vinci 5 is 10,000 times that of the Xi. It has its own insufflation system to blow carbon dioxide into a body cavity, which makes it easier for the surgeon to see everything within the cavity. The new machines even have "forced feedback," so I can actually feel tension on the tissue, whereas before I had to learn what they call visual haptics, meaning that I had to "see" the feel of the tissue. Today, video of my surgery uploads to my phone within a few minutes after I've completed the operation. So when I go into the waiting room to update the family, I can show them a video of the operation.

Going into surgery, I put my head into a headpiece that has multiple lenses and cameras that provide stereoscopic 3D 4K high-definition views. My arms go on an armrest, and my fingers go through two loops that are spring-loaded and attached to an arm with a sort of elbow that I can move freely. When I sit down and take over four arms of the robot, I can move them—opening and closing the instruments, cutting or closing, closing and sealing, or grabbing and retracting. At the same time, I have seven pedals on the floor with a variety of functions, such as energy application for sealing blood vessels or closing staplers, all while controlling each aspect of the instruments. If I want a knife to go through a sealed piece of tissue, it's controlled by one button, then another; if I want to grab a piece of tissue, I can grab it weakly, or, hitting a different button, I can grab it firmly. With the camera pedal, I can manipulate the camera for precise views of the operative field.

Today there are so many surgeries that were previously done with open incisions that are now done robotically—emergency appendectomies, bowel perforations, esophageal perforations, duodenal perforations, hysterectomies, gallbladder surgeries, and lung resections, to name a few. And now people go home within a couple days—possibly the same day—whereas before they were in the hospital for a week. From a surgeon's perspective, this is about as good as it's ever been in terms of patients' surgical experience.

Using this robot as extensions of ourselves, surgeons are going where no one has gone before for the benefit of our fellow man. And it will only get better from here.

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Dr. Bobby Mukkamala: The New AMA President on Medical Innovation and How It Benefits Cancer Patients—Like Him

Dr. Bobby Mukkamala has been an otolaryngologist—ear, nose, and throat surgeon—in Flint, Michigan, for 25 years and was sworn in as the 180th president of the American Medical Association in June. He was diagnosed with a brain tumor in November 2024 and continues to be treated for cancer.

FROM YOUR PERSPECTIVE AS A PHYSICIAN AND A PATIENT, WHAT IS THE STATE OF MEDICAL INNOVATION TODAY?

We live in a world of increasing threats to public health, such as we all experienced during the COVID-19 pandemic, in large part because our world is more interconnected now than it has ever been.

So our challenge is to maintain a sense of urgency—and innovative thinking—to respond to health threats. At the same time, we can be hopeful about the state of medical innovation today. I am—especially when I consider the host of new science that has been involved with my cancer treatment. The pathology on my brain tumor wasn't finalized in 24 hours like a typical pathology; it took several weeks of testing to discover that it was a grade 2 astrocytoma with an IDH mutation. This information dramatically changed my treatment options from typical radiation and chemotherapy to a cutting-edge pill that was FDA-approved just weeks before I needed it—after more than a decade of research. We will live longer with previously quickly fatal disease because of such innovative research.

WHAT INNOVATIONS EXCITE YOU THE MOST?

My own treatment for brain cancer is a testament to innovative approaches to science and medicine. If we abandon this progress by cutting research funding, we will reverse the enormous progress we've made, and people will suffer needlessly.

I was awake for the whole craniotomy surgery I underwent for my tumor, which was cutting-edge. Because I was awake, my amazing surgeon could talk to me while working through the language cortex of my brain to make sure he minimized risk to harming my ability to speak.

As a head and neck surgeon myself, I love the innovations that help me to help my patients have less bleeding, faster healing, and better cure rates.

I also have an excitement and a concern about the amazing pharmaceutical developments we've seen. To be able to treat cancer in a way that is specific to the genetics of a patient is amazing. I don't mind at all that the cellular nature of my brain tumor took a few extra weeks to figure out, because this specificity improves my prognosis immensely.

The concern comes from the cost of being cutting-edge. My daily treatment adds up to more than $200,000 a year. I appreciate this medication, but the impact of treatment like this on the overall cost of health care in our country worries me.

I WAS AWAKE FOR THE WHOLE CRANIOTOMY SURGERY I UNDERWENT FOR MY TUMOR, WHICH WAS CUTTING-EDGE. BECAUSE I WAS AWAKE, MY AMAZING SURGEON COULD TALK TO ME WHILE WORKING THROUGH THE LANGUAGE CORTEX OF MY BRAIN TO MAKE SURE HE MINIMIZED RISK TO HARMING MY ABILITY TO SPEAK.

FOR ALL THE OPTIMISM ABOUT INNOVATION, WHAT CHALLENGES CONTINUE IN MEDICAL CARE?

Access to care is too variable in our country. Between where I live in Flint and more affluent cities around me, access is dramatically different. If a neighbor had the same brain tumor as me, they would suffer for several more months, if not longer, waiting to have it removed—and that delay in care could significantly affect their chances of survival. The life expectancy of my ZIP code in the city of Flint is more than 10 years shorter than the life expectancy in the suburbs.

Another big challenge patients experience right now is a severe—and worsening—physician shortage across the U.S. in high-demand specialties. This is especially true in rural and underserved communities like mine. It's imperative that we address the underlying factors contributing to this shortage—which is projected to get much worse over the next decade. This includes addressing the administrative hassles and busywork that contribute to burnout, expanding residency opportunities, and increasing opportunities for foreign-born physicians practicing in the U.S.

And we need to fix the broken financial model that has decreased physician reimbursement through Medicare by more than 33% since 2000, which is exerting enormous financial pressure on physicians, like me, in private practice and forcing some to reduce their hours, lay off support staff, or close altogether—further reducing patient access to care. I want my focus to be on the health of my patients, not the finances of my office. I think there has been a generational change for this issue. My mom, a retired pediatrician in Flint, loved taking care of her kids. She worked hard for decades and never burned out. There is no way she could have lasted that long if faced with today's challenges.

WHAT IS THE ROLE OF PHYSICIANS AND HEALTH CARE WORKERS IN RELAYING INNOVATIONS TO PATIENTS?

Patients have a lot of questions, and it's important that physicians answer them to the best of our ability or help them get the answers they need. However, our ability as individuals to accelerate the evolution of the science behind better health is pretty limited. Thus, organizations like the American Medical Association are critical to improving health care by including the contributions of practicing physicians and other health care workers in the development of new tools. When new options become available—whether they're simple, like communicating health information between doctors through electronic health records, or a new medical instrument or drug, like my recently approved brain cancer pill—physician involvement is critical to making these useful to all of us.

Nowadays, commercials on TV show the bright, happy faces of people on new medications. But viewers seem to miss the quick list of side effects and danger from the new medication. That's where doctors come in. We have a critical role in sharing the science behind these new treatments so our patients get better care.

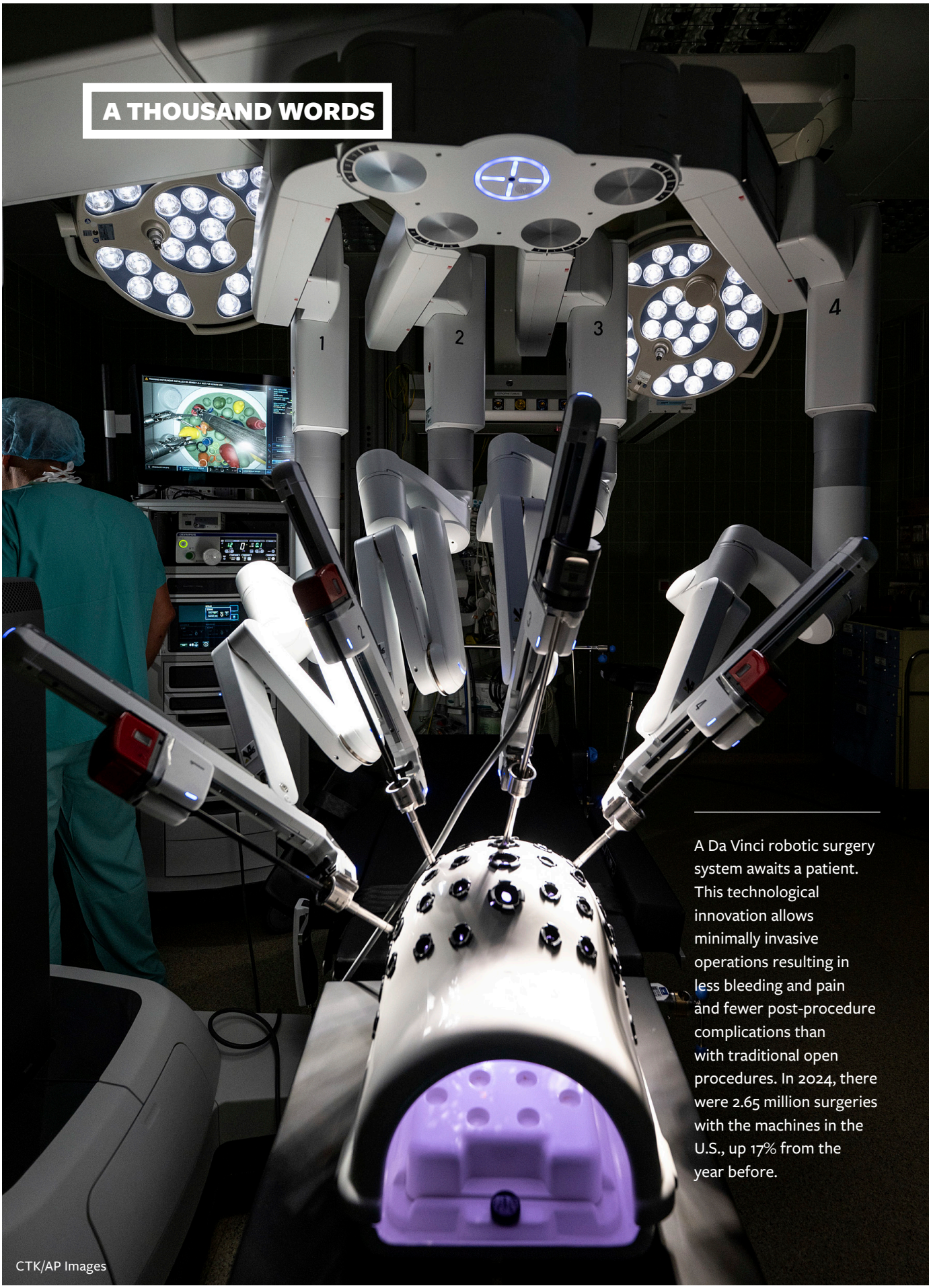
FOR ALL THE ATTENTION TO INNOVATION, WHAT IS THE ROLE OF PREVENTION?

If we want to live healthier lives, have a healthier country, and have more efficient health care expenses, disease prevention and preventing disease progression are critical. This requires counseling on disease prevention, routine screening for disease, and consultation with physicians if you're at elevated risk.

As it happens, I took my boards to become certified to practice lifestyle medicine one week after my brain tumor diagnosis. Thankfully I passed, because I think prevention is important if we are going to live longer and healthier.

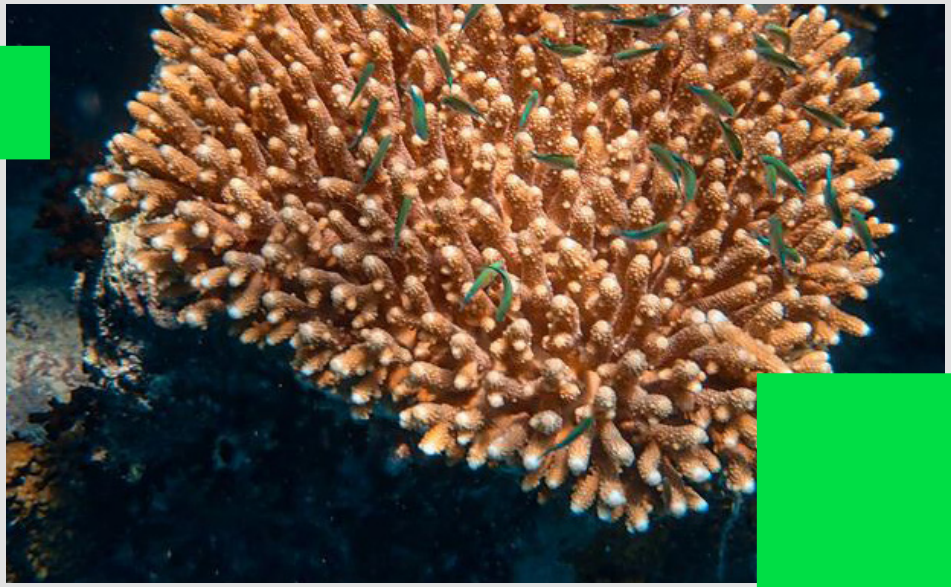
Mindfulness is also important. While cutting-edge development will always be important to living better lives, the basic function of our mind also has a critical impact on our well-being. In Flint, where children suffer from poverty, struggling families, and risks to their lives, taking a moment at the beginning of every school day to be guided through a mindful moment orients them to the classroom and what will happen that day—which, fortunately, is happening in our classrooms thanks to the Crim Fitness Foundation. When people suffer from diseases like cancers and strokes, their physical health is supplemented by their mental health. Making the connection between physical health and mental health may be one of the greatest innovations in recent medical thinking.

A THOUSAND WORDS



A Da Vinci robotic surgery system awaits a patient. This technological innovation allows minimally invasive operations resulting in less bleeding and pain and fewer post-procedure complications than with traditional open procedures. In 2024, there were 2.65 million surgeries with the machines in the U.S., up 17% from the year before.

CTK/AP Images



HEAR MORE ABOUT INNOVATIVE MEDICAL TREATMENTS

From Lab to Life: A podcast series from Pew

AFTER THE FACT >

Medical innovation often begins in the research lab. In this series from The Pew Charitable Trusts' "After the Fact" podcast, researchers from a range of fields discuss how they got involved in science, what motivates them, and how their work can improve the world. Listen at pewtrusts.org/afterthefact.

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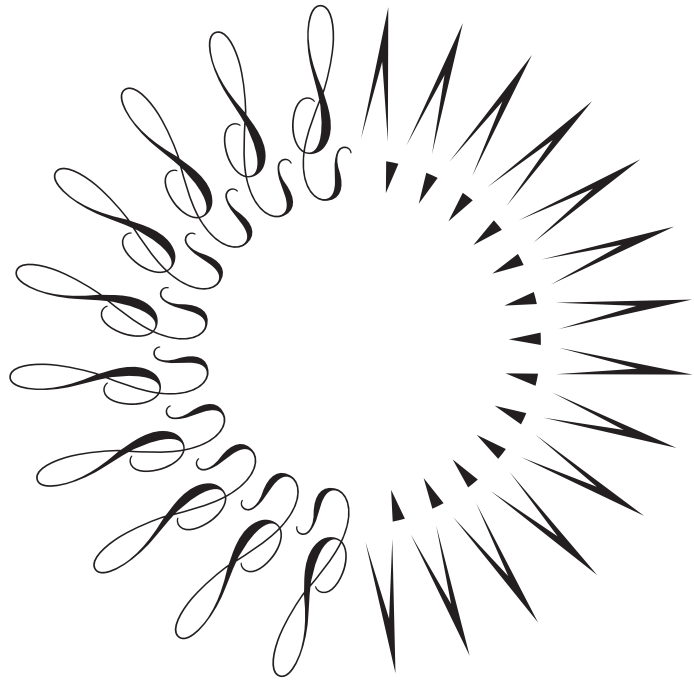

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