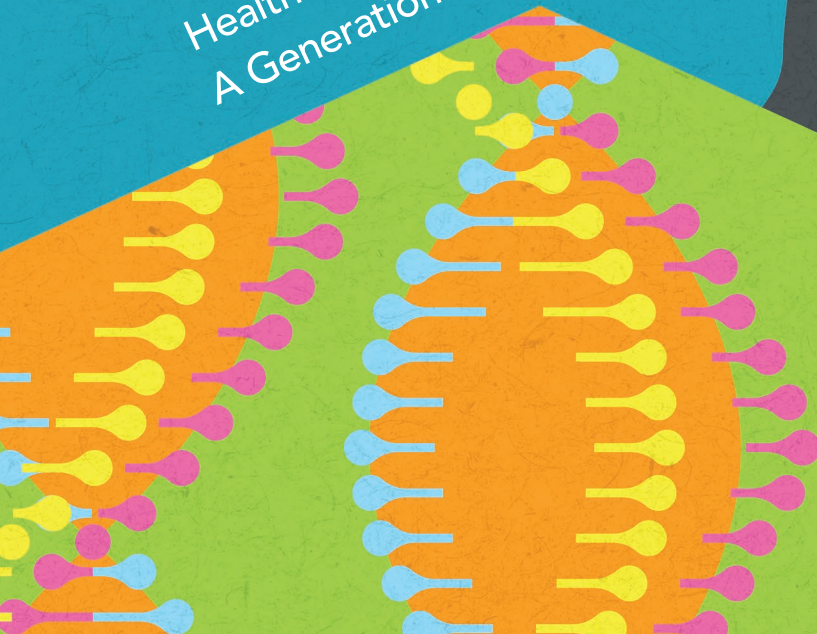


PENN Medicine



THE INNOVATION ISSUE

AI, Bots, and CRISPR
Health Innovation Everywhere
A Generation of Information in Medicine





THE PREP

ADDING DIMENSION

By Karen Kreeger

“Isn’t life a series of images that change as they repeat themselves?” – Andy Warhol

The derisive term “blobology” was once used to describe the not-so-clear knobby masses that could be discerned when trying to determine the shape of a protein. Now, with the latest advances in electron microscopy, almost every atom in a protein can be viewed and accounted for.

The improved technology that gives scientists this sharper view starts with a series of two-dimensional snapshots, like those above, of protein molecules flash-frozen in a thin layer of water. In this method, called cryo-EM, mathematical algorithms unite the pictures to bring the structure into sharp focus (inset).

Getting a look at life’s essential molecules in this deeper way has improved scientists’ understanding of a range of human functions, from how kidney stones form to the connection between a breast cancer protein and lupus. Cryo-EM is even on the cusp of helping scientists better understand how natural products and drugs interact with neurons and other cells in the body. These insights could improve the treatment of cancer, heart disease, and kidney disorders. The technique, which won the 2017 Nobel Prize in Chemistry, is the core of Penn’s new Beckman Center for Cryo-EM, which held its ribbon cutting and inaugural symposium in late May of this year.

Vera Moiseenkova-Bell, PhD, faculty director of the Center and a professor of Systems Pharmacology and Translational Therapeutics, reflects on the power of the technology: “Although we are still refining the details of our images,” she said, “cryo-EM gives us an unprecedented view of how significant compounds interact with human proteins.”

► [Read more at PennMedicine.org/magazine/cryo-em.](http://PennMedicine.org/magazine/cryo-em)



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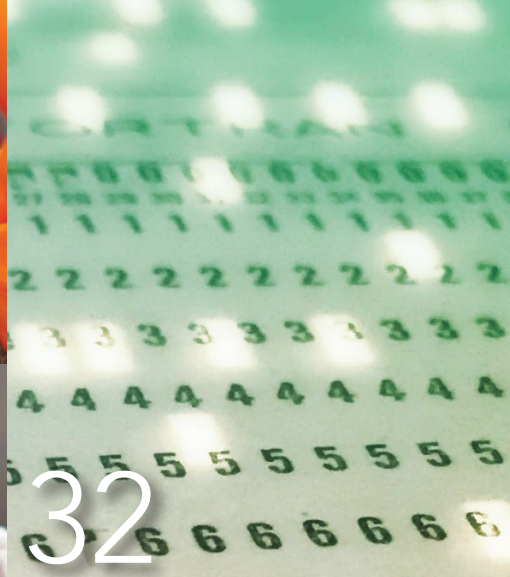
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Let's Play!

Playing games in the office is one of those Silicon Valley stereotypes that might make your eyes roll when it crops up in another industry. Without a doubt, the Center for Health Care Innovation is Penn Medicine's most Silicon Valley-esque enterprise, staffed with people who seemingly all have the word "Innovation" or "Design" in their job titles, sitting at bright tables surrounded by white boards, using the verb "iterate" with alarming frequency.

It's easy to get tripped up on the vocabulary. The term "innovation" itself is so often used in health care and in other fields these days that it sounds shallow and empty. In some places, it's just one more trendy piece of business jargon that makes people feel good about themselves for being hip to the times. As a person whose occupation is in words, and in the evidence-based realm of academic medicine and science, I aim to squash empty business jargon at every opportunity. So why have an "innovation issue" of *Penn Medicine*?

This issue exists because innovation is not a hollow term here. To see how, let's go back to games.

The card game I recently found myself playing with the innovation center's staff belies every stereotype. For starters, it was invented here. The "Accelerators in Health Care" game started with an idea from Executive Director David Asch, MD, MBA, and grew into a tangible object that has been professionally manufactured for sale and put into use in conferences and educational settings.

The game is more than a fun way to spend half an hour at work. It's also a collection of insights you can hold in your hands. It codifies two key ingredients of creativity—analogy and constraints—into phases of game play. Players try to think of innovative solutions to a health care challenge by drawing on analogies presented in the hand of "Accelerator" cards they've drawn. The analogies come from successful businesses outside of health care, celebrities, or common tropes—like a Netflix card (your solution should provide a vast, searchable library of resources), a Guy Fieri card (your solution amplifies an experience to its extreme), or a Frankenstein card (your solution combines two or more things that are not usually connected). In the next round, players try to sabotage one another's ideas with "Monkey Wrench" cards that represent constraints to progress, such as budget cuts.

You can see the results in the innovation center's work, such as a streamlined model they developed to care for patients with high blood pressure. The "breakthrough" moment, according to Chief Innovation Officer Roy Rosin, was primary care physician Matt Rusk's suggestion to design a hypertension clinic in the mold of Jiffy Lube, specialized to provide only the necessary services in a simplified setting—not sending patients to the equivalent of an auto mechanic when all they need is an oil change. The model involves only a few minutes with a doctor. Patients then interact via



text messages with a nurse and have supervised titration of medications outside of the office to get to a desired blood pressure. The result has been a leap from 30 percent of patients having blood pressure under control within six months, to 100 percent, with a greater average reduction in pressure as well. And primary care physicians gained back an hour of time per each patient that they could spend addressing more complex needs.

Fresh ideas—or ideas from seemingly unrelated fields, freshly applied to health care—are only a first step of innovation, as Asch is careful to point out. Vital next steps include testing those ideas and understanding which ones work best for a given patient population. The feature story on page 24 shows how the innovation center team walks the walk of that work.

Innovation doesn't just happen through the efforts of one center at Penn, of course. This issue's stories run the gamut from bioinformatics uses of artificial intelligence (p. 12) to a lifetime-spanning evolution of medical information technology (p. 32), to a literal use of games—video game technology—to apply augmented reality in surgery (p. 48).

The result, I hope, is an issue that is informative, instructive, and, yes, innovative. More than that, we've tried to play the Oprah Winfrey card, as described in the Accelerators game: "Generate delight by providing something joyfully unexpected, and beyond what is necessary."

Read on, and have fun! ☐

RE

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Perelman School of Medicine Students Take Their First Steps Towards Becoming Doctors

The Perelman School of Medicine at the University of Pennsylvania welcomed 150 new medical students from 28 states this summer during the 26th Annual White Coat Ceremony. This event served as a significant rite of passage for the entering class, marking the official beginning of their medical careers.

“This is an amazing time in your lives,” said Suzanne Rose, MD, MSEd, senior vice dean for Medical Education. “Many of you have dreamed of this goal from your days over 20 years ago in toddler scrubs pajamas. Some of you took a more circuitous path to reach this milestone. Many had to overcome hurdles—but you all achieved monumental success.”

One by one, the students took to the stage and shared fun facts about themselves—memories from high school and college, travel tales, secret hobbies and talents—before receiving their white coats and stethoscopes in the presence of their supportive family members, friends, and faculty. At the ceremony’s conclusion, the entire class and physicians in attendance recited the Declaration of Geneva, pledging their lives to the service of humanity and promising to treat every patient to the best of their ability, preserve patient privacy, and to share their medical knowledge in order to advance the health care profession.

Fun Facts About the 2019 PSOM Incoming Class

Never Have I Ever

Maryam Alausa: I’ve never eaten a peanut butter and jelly sandwich.



Alfredo Lucas: I was born in Venezuela and grew up in San Diego, so I have no concept of snow or winter.

“Great” Memories

Angela Chen: Three years ago, I ran a marathon on the Great Wall of China.



Hanna Jia: I once threw up over the Great Wall of China.

I Heart Science



Rohan Palanki: I didn’t go to my senior prom—I went to the science fair.

Kevin Sun: In high school, I gave a poster presentation to Bill Nye.

Getting Those ZZZs No Matter What



Sai Chaluvadi: There’s a Facebook group dedicated to pictures of me falling asleep in random places.

Max Shin: While in Peru, my friend found me sleepwalking in the middle of the Amazon rainforest.

It’s the Journey That Counts



Sabrina Bulas: I once rode camel named Michael Jackson around the Pyramids of Giza.

Andrea Jin: I biked across the country and was chased by a Chihuahua through the streets of Idaho.

Close Encounters of the Terrifying Kind



Lillian Chien: The very first time I went scuba diving, I swam headfirst into a manta ray.

Thilan Tudor: I bumped noses with a shark while snorkeling in Great Barrier Reef.

Not-so-casual Meet and Greets



Rishi Goel: I had dinner with Queen Elizabeth II.

Victoria Lord: I shook hands with the Dalai Lama.

The Pavilion's Topping Out Ceremony Marks a New Construction Milestone



“You’re not building a hospital,” Kevin Mahoney, CEO of the University of Pennsylvania Health System, told the construction crew gathered for the event. “You’re curing cancer. You’re curing heart disease. [These advances are] going to happen in Philadelphia, and you guys have been a big part of making it happen. Fifteen years from now, you’ll be able to tell your grandchildren, ‘I put that building up that allowed the doctors to do their magic.’ I’m so grateful for everything you’re doing.”

► [Read more about the philanthropic donors powering the Pavilion on p. 40.](#)

The Pavilion—Penn Medicine’s new, \$1.5 billion hospital and the largest capital building project in Penn’s history—is only about two years away from providing patients with exceptional, comprehensive care in a state-of-the-art, “future-proof” environment. In May, an official topping out ceremony was held to celebrate a momentous milestone in the facility’s development.

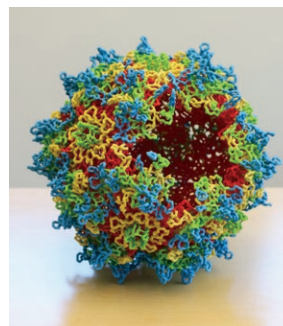
“Topping out” refers to placing the last beam atop a structure during its construction. In advance of the big day, hundreds of Penn Medicine employees and students were invited to join the construction crew in signing the final steel beam. In addition to being covered with hundreds of signatures, union numbers, and messages, the beam was fittingly topped with a small sculpture of Benjamin Franklin, allowing the innovative polymath who started it all to look down on the continued growth and future expansion of the health system he inspired.

Penn Pioneer Played Integral Role in Development of FDA-Approved Gene Therapy

In May, the U.S. Food and Drug Administration approved a new gene therapy that halts the progression of spinal muscle atrophy (SMA)—a fatal genetic disorder that causes children to lose the ability to walk, eat, and breathe. The onetime therapy, Zolgensma, is designed for children under two years old and produces the critical survival motor neuron protein needed to preserve a patient’s muscular function. For children with the rare disease and their families, the approval offers hope for a future that once seemed impossible.

Zolgensma is based on an adeno-associated virus (AAV) that serves as a vehicle to deliver a healthy replacement gene to take over for the missing or malfunctioning SMN1 gene. This fundamental platform was pioneered by James Wilson, MD, PhD, director of Penn’s Gene Therapy Program and Orphan Disease Center, and a professor of Medicine and Pediatrics. Following treatment, patients who participated in the Zolgensma clinical trial did not require permanent ventilation and most could successfully sit unassisted for more than five seconds—tremendous progress for a disease that typically takes the lives of all afflicted children before their second birthday.

“Of the more than 100 new AAVs that we discovered, it was AAV9 that stood out,” Wilson said. “This is a huge



milestone for the rare disease community because the approach can be leveraged across many different diseases.”

Wilson and his ambitious team of researchers continue to look ahead and work towards a future of transformative breakthroughs. An expanded partnership between Amicus Therapeutics and the Perelman School of Medicine, for instance, aims to foster collaborative research and advance the development of novel gene therapies for lysosomal disorders and other rare diseases, making it clear that SMA is just the beginning.



New Tara Miller Melanoma Center Advances Research and Honors a Passionate Patient Advocate

In July 2013, 28-year old Tara Miller received news that turned the promising law clerk’s world upside down: she had stage IV melanoma—the deadliest form of skin cancer. Though Miller’s burgeoning law career was suddenly halted by biopsies, brain surgeries, chemotherapy, and radiation, her endless positivity, incomparable strength, and commitment to finding a silver lining in the direst moments were undeterred. She recognized that while she could not control the spread of the cancer through her body or the odds that were stacked against her, she could control her response. She could fight—not just for herself, but for every melanoma patient.

With the support of her family, friends, community, and doctors, she established the Tara Miller Melanoma Foundation and organized the inaugural “Make the Best of It Bash,” named for her optimistic catchphrase. The annual event has raised more than \$3 million over the past five years to support research led by the Abramson Cancer Center (ACC)’s Melanoma Program—research Miller knew would not save her, but could prevent future patients from ever having the same experience. Miller passed away in 2014 just weeks before her 30th birthday, but her extraordinary, selfless legacy lives on in the foundation she created and the community she inspired to research, fundraise, and celebrate in her honor.

This May, the ACC announced the creation of the Tara Miller Melanoma Center, which will accelerate melanoma research and improve clinical outcomes for patients. The center was made possible by a gift from Miller’s parents, George and Debbie, and will build on her dream of finding a cure by supporting critical melanoma translational research, developing novel therapies, and providing patient education and supportive resources. ACC Director Robert H. Vonderheide, MD, DPhil, notes that the newly established Tara Miller Professorship in Melanoma Research and Patient Care will also ensure that Miller forever remains “a reminder to us to work as hard as we can every day to make a difference for our patients.”



Penn-CHOP Partnership Propels Pulmonary Research

Chronic lung diseases are becoming increasingly prevalent in the United States, and respiratory deficiencies and diseases continue to be a leading cause of death in pediatric patients. The newly established Penn-CHOP Lung Biology Institute (LBI), led by Edward E. Morrisey, PhD, scientific director of the Penn Institute of Regenerative Medicine, creates an innovative partnership that positions Penn Medicine and Children’s Hospital of Philadelphia at the forefront of pulmonary biology research.

Together, Penn and CHOP researchers will build on the work being done by the Penn Center for Pulmonary Biology (also led by Morrisey), collaborate with the Schools of Engineering and Veterinary Medicine, and foster a multidisciplinary, integrative research approach. The unique patient populations at Penn and CHOP with rare and complex diseases will mean LBI’s use of innovative cellular, genetic, and genomic technologies can identify the underlying causes of both chronic and rare respiratory diseases.



Breaking Barriers: Rachel Werner Named LDI Executive Director

The Leonard Davis Institute of Health Economics (LDI) has a new executive director: Rachel Werner, MD'98, PhD'04, GME'04, a professor of Medicine and Health Care Management and a practicing physician at the Corporal Michael J. Crescenz Veterans Affairs Medical Center.

Lauded by her colleagues as a visionary scholar, an enthusiastic mentor, and the perfect fit for this role, Werner has been a dedicated health services researcher for nearly two decades. She joined LDI in 2005 as a Senior Fellow and was integral in expanding its digital infrastructure, while also consistently publishing award-winning research that seamlessly combines the realms of health equity and quality measurement. As Werner—whose work focuses on the effects of health care policies on health care delivery—settles into this leadership role, she says her aim is to help take the institution to new heights, making “Penn the national leader in the field of health economics [and] LDI an even more vibrant, collaborative, and collegial place” for collaborative, high-quality research.

Werner is the first woman to hold the position in the health services research organization's 51-year history. In an interview with LDI's *Health Economist*, she notes that she prefers to be thought of as an executive director first—and one who brings a physician-economist perspective to the table for the first time—she understands the impact of women seeing proof that barriers can be broken and the proverbial glass ceiling can be shattered. “I think it's always a challenge to be the first woman to do anything. But it's really important to have visible female role models for women who are aspiring to other leadership positions or aspiring to careers in this field,” she said.



New PSOM Arrivals Named Presidential Assistant Professors

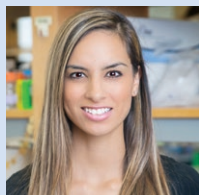
This spring, the Perelman School of Medicine (PSOM) recently welcomed two new faculty members who were chosen as Presidential Assistant Professors. Presidential Professorships are five-year-term chairs, awarded to outstanding scholars by University of Pennsylvania President Amy Gutmann.



César de la Fuente, PhD

Presidential Assistant Professor of Psychiatry, Microbiology, and Bioengineering

De la Fuente joined PSOM from the Massachusetts Institute of Technology, where he served as a postdoctoral associate. His current research aims to fight infectious disease and mental illness by combining techniques from protein design, engineering, computational biology, and microbiology. In addition to earning Presidential Professorships across three fields and leading the Machine Biology Group, he was also recently recognized on *MIT Technology Review's* list of 35 Innovators Under 35 and GEN's Top 10 Under 40.



Kellie Ann Jurado, PhD

Presidential Assistant Professor of Microbiology

Jurado comes to Penn from Yale University, where she was a postdoctoral fellow and received several major grants and fellowships, including the L'Oréal Women in Science Fellowship, the Charles H. Revson Senior Fellowship in Biomedical Science, and a Burroughs Wellcome Fund Postdoctoral Fellowship. She was also named a STAT Wunderkind by *STAT News*. Jurado's work examines how the immune system interacts with viral infections, such as Zika and enterovirus D68—an emerging viral infection that causes a polio-like disease in children.

How Do You Spell Research?

Penn Medicine studies published in recent months show the way.



Interferons (IFN) are proteins that inhibit cancer cells' ability to spread by activating the immune system. However, the IFN signaling pathway can be intercepted and manipulated by the invaders, prompting immune cells to hit the brakes. A study published in *Cell* suggests that understanding this stop and go pathway—and learning to boost the “go” signal and block the “stop” signal—can provide a biomarker for the efficacy of immunotherapy.



Nudging providers can help reduce unnecessary treatment. Introducing an adjusted default physician order into electronic medical records (EMRs) reduced the use of unnecessary imaging for patients with advanced cancer during palliative radiation therapy, according to a study published in *JAMA*. This nudge, which has been implemented throughout Penn Medicine, was one of the first of its kind designed to decrease a lower value, needless behavior—daily imaging—and has successfully saved time and improved the patient experience.



Neurons were long believed to come in a finite supply, but neuroscientists have since found that mammals' brains can develop new neurons over time. A study in mice has shown that neurons in the hippocampus's dentate gyrus replenish from a single type of stem cells. Harnessing these specific stem cells may someday aid brain regeneration because these new neurons are more flexible, allowing the brain to more effectively learn, store memories, adjust moods, and compensate after injury or aging. These findings were published in *Cell*.



Opioid addictions and overdoses have been shown to disproportionately affect cancer patients. To address this public health issue, researchers developed a pain management program for urologic cancer patients undergoing robotic surgery that provided them with non-narcotic pain relievers pre- and post-surgery, escalating to opioids only as needed. Pain scores after discharge indicated no difference among patients who received no prescription opioids vs. those who received ten pills of oxycodone or tramadol, indicating that controlling pain is possible while also reducing the number of opioid pills moving through the community.



Viable alternatives to sedative medications, such as listening to relaxing music, can potentially reduce anxiety in patients before they undergo regional anesthesia procedures, without the same risk of side effects. Researchers have found that patients who received disposable, noise-canceling headphones that played Marconi Union's “Weightless” (designed by sound therapists) showed similar changes in their anxiety levels when compared with patients who received an injection of midazolam. These findings were published in *Regional Anesthesia & Pain Medicine*.



An **app** that predicts the likelihood of a patient developing an incisional hernia following abdominal surgery has been developed. Using EMR data from nearly 30,000 patients, the team determined which procedures most often require a second surgery to repair hernias, as well as a list of risk factors. The app calculates a real-time risk score so surgeons and patients can incorporate the data into their decision-making process.



Twitter users' photos may provide a glimpse into their mental health. Researchers used computer vision algorithms and AI to determine that images tweeted by depressed and anxious individuals are marked by less vivid colors (often grayscale), lower aesthetic cohesion, suppressed expressions, and fewer depictions of family, friends, or recreational activities. With further development, this tool offers expanded screening and monitoring possibilities beyond Twitter and beyond anxiety and depression.



EMR-linked dashboards that alerted physicians were more effective in prompting medication orders than just educating doctors, according to a study published in the *Joint Commission Journal on Quality and Patient Safety*. The tech-assisted nudge contributed to an 18 percent increase in needed prescriptions for cardiac patients who would benefit from acid suppression therapy to prevent gastrointestinal bleeding. Looking ahead, the Penn Medicine Center for Health Care Innovation aims to work on similar dashboards to prompt providers to adopt other evidence-based practices.

Honors & Awards

Penn Faculty Comprise 10 Percent of American Academy of Physicians Incoming Class

Six Penn physician-scientists were elected to the Association of American Physicians, making up an impressive ten percent of the 2019 class. This prestigious medical organization recognizes individuals who have contributed to basic and clinical science and applied their findings to advance clinical medicine. The new members from Penn are **Zoltan Arany, MD, PhD**, a professor of Cardiovascular Medicine and director of the Cardiovascular Metabolism Program; **Susan Domchek, MD**, the Basser Professor in Oncology, executive director of the Basser Center for BRCA, and director of the MacDonald Women's Cancer Risk Evaluation Center; **Scott Halpern, MD'03, MSCE'01, PhD'02, MBE'02, MSCE'01**, a professor of Medicine, Medical Ethics & Health Policy, and Epidemiology, and founding director of the Palliative and Advanced Illness Research Center; **David Margolis, MD, MSCE'98, PhD'00**, a professor of Dermatology and Biostatistics and Epidemiology, and director of the Cutaneous Ulcer Program; **Maria Oquendo, MD, PhD**, the Ruth Meltzer Professor of Psychiatry and chair of Psychiatry; and **Drew Weissman, MD, PhD**, a professor of Infectious Diseases.



Arany



Domchek



Halpern



Margolis



Oquendo



Weissman

The honors and awards listed on this page are just a few of the highlights among Penn Medicine's highly lauded leaders, faculty, staff, and trainees. For more honors, see p. 44.

President of the American Board of Emergency Medicine

Jill M. Baren, MD, MS'06, MBA

Professor of Emergency Medicine, Pediatrics, and Medical Ethics

The ABEM seeks to ensure excellent emergency medical care, certify physicians, and provide professional development and education. A member of the Board of Directors since 2012, Baren is now serving a five-year term on the Executive Committee.



AAD's Master Dermatologist and Mentor of the Year

William D. James, MD

Paul R. Gross Professor of Dermatology, Director of Education for Dermatology



James received the American Academy of Dermatology award in recognition of his significant contributions to the field. He was also the first recipient of the academy's William D. James, MD, Mentor of the Year Award—established in his honor—which celebrates excellence in mentoring students, residents, and junior faculty.

Modern Healthcare's 50 Most Influential Clinical Executives

Regina Cunningham, PhD, RN

Chief Executive Officer of the Hospital of the University of Pennsylvania

Cunningham was cited for her dedicated focus on maintaining efficiency—addressing overcrowding in the emergency room, for example—and for undertaking grant research into how to improve clinical trials.



National Academy of Medicine Emerging Leader

Raina Merchant, MD, MSHP'09, GME'10

Associate Professor of Emergency Medicine, Director of the Penn Center for Digital Health



Merchant was one of ten mid-career health care and health policy professionals chosen by the National Academy of Medicine to join the 2019 class of Emerging Leaders of Health and Medicine Scholars. Merchant, who will serve through June 2022, is grateful for this “incredible opportunity for mentorship and collaboration.”

Three Penn Biostatisticians Named ASA Fellows

Three faculty members in the department of Biostatistics, Epidemiology, and Informatics have been named fellows of the American Statistical Association, the field's largest and most prestigious professional organization in the United States. ASA selects fellows based on their contributions to the advancement of statistical science.

Jinbo Chen, PhD

Professor of Biostatistics

Chen was honored for developing innovative statistical methods for biomedical studies with cutting-edge public health applications, exceptional research and mentoring, and generous service to the community.



Rebecca Hubbard, PhD

Associate Professor of Biostatistics

Hubbard was recognized for her contributions to the analysis of electronic health records and study of cancer epidemiology, as well as her ASA service as a leader of the Biometrics section.



Nandita Mitra, PhD

Co-Director of the Center for Causal Inference, Vice Chair of Faculty Professional Development, Chair of the Graduate Group in Biostatistics and Epidemiology, Professor of Biostatistics



Mitra was celebrated for her work developing statistical methods for cost/cost-effectiveness estimation and for developing innovative causal methods for cancer comparative effectiveness studies.

National Academy of Sciences Welcomes Penn Professor

Nancy Speck, PhD

Chair of Cell and Developmental Biology, Co-Director of the Hematopoietic Stem Cell Program at the Institute of Regenerative Medicine, Co-Leader of the Hematologic Malignancies Program at the Abramson Cancer Center, Professor of Cell and Developmental Biology



Speck has been elected to the National Academy of Sciences, considered one of the highest honors a scientist can receive, in recognition of her distinguished original research. One of 100 new members, Speck has cloned and characterized protein mutations found in leukemia in order to understand their role in normal red blood cells.

Penn Paves the Way for Equal, Unbiased LGBTQ Health Care

Penn Medicine has earned recognition as a LGBTQ health care leader from the Human Rights Campaign Foundation. Each of Penn's six hospital entities received top marks for providing an inclusive, welcoming, and compassionate environment for LGBTQ staff, faculty, and patients.

Lancaster General Health and Princeton Health were named LGBTQ Healthcare Equality Leaders, and Chester County Hospital, the Hospital of the University of Pennsylvania, Penn Presbyterian Medical Center, and Pennsylvania Hospital were named Top Performers. These achievements were highlighted in the foundation's 2019 Healthcare Equality Index, which scores institutions based on their equitable care policies.

LETTER



Reflecting on Curriculum and Culture Change from the 1960s

Since attending the 50th reunion of my Penn medical school class in May, I have been thinking about an important part of our institutional history that should have been recognized and celebrated at our reunion. It was not. Our four years as Penn medical students saw long overdue changes in curriculum and community culture begin, changes that would establish the foundation for Penn's current prominence in medical education. [I have prepared a] retrospective narrative about those years [that] draws on two student-edited publications of the time, SCOPE, our yearbook, and ITIS, "a journal of independent student thought," first published in 1967 (and archived in my basement filing cabinet). My hope is that a significant part of our long history does not just fade away when all its living witnesses are gone.

Earl Guthrow, MD'69, PhD'72

Retired endocrinologist

► **Note: An edited version of Guthrow's retrospective narrative has been published online in the digital newsletter for Perelman School of Medicine alumni, *The Pulse*. Read it online at <http://bit.ly/2kQHUox>.**



SECOND NATURE

By Julie Wood

Photos by Peggy Peterson

Kevin Zhang's Graduate Hospital apartment teems with hundreds of plants encased in glass tanks and growing in an assortment of trays. Zhang has taken the idea of a greenhouse and transformed it into a green-apartment, where LED lights hover over plants that flourish in their terrariums, and an extra refrigerator is on hand especially for chilling plants that require colder nights. Zhang balances his time between caring for plants while also caring for patients as a fourth-year student in the MD-PhD program at the University of Pennsylvania. His partner, Sarah Santucci, a third-year medical student, joins him in this shared horticultural hobby.

"I'm still trying to explore my interest in medicine," Santucci says. "But in terms of my interest in plants, that has always been constant."

For Zhang, growing up in Los Angeles, watching his grandmother work in her garden and tend to the tomatoes initially sparked his interest in garden-

ing and growing vegetables. In the third grade, Zhang discovered the world of carnivorous plants while visiting the largest cactus nursery in Illinois with his father, seeing a tiny table filled with the fly-trapping flora surrounded by all the cacti.

Santucci became fascinated by plants when she attended the Philadelphia Flower Show, America's largest indoor flower event, when she was a teenager, driving all the way up with her family from their home in Mississippi. It was there where she first encountered her now-favorite type of plant—orchids. Among her collection of plants, one orchid, referred to as the "Lady of the Night," has grown alongside her throughout her college career and continues to grow to this day.

After growing up from different roots on opposite sides of the country, Zhang and Santucci met through their shared love of botany in college, meeting at Princeton University's undergraduate activities fair.

As the president of the botany club, Zhang was manning the table at the fair, displaying his carnivorous plants. Santucci was instantly drawn to the unique setup. "There's this guy sitting with his tank of plants, and I was like, 'This is the best gimmick for me,'" Santucci remembers.

Zhang was impressed with Santucci's botany knowledge as she approached the club's table. "She actually recognized the plant. Not only did she know the common name, but she knew the scientific name," Zhang says. "I was like

‘Whoa! There’s someone else who genuinely likes plants!’”

Now as medical students at the Perelman School of Medicine, the couple have entered their plants in contests at the annual Philadelphia Flower Show, winning ribbons for their impressive homegrown showcase.

While they tend to the wide variety of plants that they both keep inside Zhang’s apartment, the collection doesn’t end there. Up on the roof of the apartment building during the warmer months, Santucci’s orchids and tropical plants soak up the summer sun.

Zhang keeps his vegetables, American pitcher plants, and Venus fly traps on his roof. It is also where he continues his oldest hobby: growing pumpkins. After first attempting to grow pumpkins in the first grade, Zhang finally grew his first, 20-pound giant pumpkin in high school. Later on, working at the Princeton garden, Zhang managed to grow several pumpkins that each weighed about 100 pounds. “I can’t do that on a roof now, but I still always have mini pumpkins,” he says.

Their methods in raising plants differ, however. Santucci dedicates hours of meticulous care into her plants,



studying each kind and their required care routines. “There’s a lot of science that goes into growing them. I do a lot of research to know the correct growing conditions,” Santucci says.

“I’m more of the mentality where everything’s going to be automated,” Zhang explains. “I have my plants in trays of water so I don’t need to water them every day, and I have lights that will turn on during the day and turn off at night.”

Both Zhang and Santucci agree that the practice of raising plants isn’t a niche hobby; in fact, they’ve noticed it is a common pastime among their classmates and physician mentors.

Zhang suspects he knows why: “It’s the nurturing personality.”

Santucci and Zhang both say they love caring for plants and pets at home as much as for people, reinforcing the “care” side of health care.

Raising plants is also a relaxing pastime that Santucci looks forward to after long hours of clinics. “I think it’s important for people who have medicine-related careers to have a hobby outside of their job,” Santucci says. “One day could be good and another day could be terrible, but having a hobby gives me something stable and always makes me happy.”

Zhang agrees with that idea of plant-life/work balance, but he also enjoys seeing the joy of horticulture overlap with his work. While working at a hospital over the holidays, he recalls, a visitor brought a poinsettia to a patient, creating some horticultural holiday cheer. “Seeing little things like that makes medicine a little more human.” ◻

► **Read this story online with a video at [PennMedicine.org/magazine/secondnature](https://www.pennmedicine.org/magazine/secondnature).**



ABCs of Innovation

By Frank Otto

Big buzzwords in computing and biotechnology fly fast and loose in the headlines about research innovation. A quick glossary spells out the science behind the hype—and shows how Penn Medicine is driving discovery forward with these technologies.

Artificial Intelligence (AI)

noun A form of adaptable computer programming that is seen to approach or resemble the abilities of human intelligence.

In recent years, artificial intelligence (AI) has become one of the most potent tools at the health care industry's disposal. It's used to identify cancerous tumors through pathology images, discover patterns in patient charts to head off potentially deadly infections, and comb social media to predict who might be at risk for depression.

As impressive as AI is, the barrier to entry for its use is pretty high. First, AI software is expensive, which often makes it unreachable to even mid-level health systems, much less individual researchers who have ideas they want to tinker around with. And second, the tools that exist often require advanced technical expertise.

"The problem with AI tools is that 'AI people' build them, so they're usually only usable by those with high levels of training," said Jason Moore, PhD, one of Penn Medicine's leading AI gurus and the head of the Institute for Biomedical Informatics.

Moore said that fellow researchers, including many at Penn Medicine, have asked him about the best AI software and tools for beginners. His answer has always been, "There aren't any."

Now his answer has changed.

Illustrations by Graham Perry



In May, after three years of development, Moore and his team officially launched Penn AI, a completely free AI data analysis tool that was designed to be usable by anyone from the beginner—say, a high school student looking to gain insight on their baseball team—to the seasoned data veteran. An automated machine learning system, Penn AI uses an artificial intelligence engine to work out analyses of datasets with minimal human input using different variables and methods. Users can upload their custom datasets—anything from a sports team’s statistics to a spreadsheet with cancer treatment data—adjust the parameters with guidance from the software’s built-in help information, and let the tool do the rest.

“The feedback has been overwhelmingly positive,” Moore said of Penn AI since its launch. “In addition to comments about its ease of use, we have received a number of requests for new features that we plan to add over the next year.”

Moore and his team are also working with Penn Medicine Information Services to integrate Penn AI with a different

project, PennTURBO, which works to make better connections between relevant clinical data and research efforts.

Moore envisions a (possibly near-) future where AI data analysis is as common as a doctor checking a patient chart. For a clinician-researcher, some of the most time-consuming parts of discovery, from hypothesis-generation to analyzing results, could now be run automatically while on their normal rounds—including complex analyses that were never in their toolbox before.

“I want this to be self-service, clinical AI,” Moore said. “I believe that this tool can make it so that it will soon be routine for a doctor to say, ‘I want to look at the associations between sex, age, smoking and different diseases,’ and then have this tool answer their questions in the time it takes for them to see a few patients.”

► **Penn AI is available online as open source software.**
► **Visit pennai.org to access the source code.**

ABCs of Innovation

Bots

noun (plural) Non-human, AI-powered tools that mimic selected human activities without supervision.

Penny knows the complex pill regimens of chemotherapy backwards and forwards. She can tell you when to take what pill, which combination is coming next, and even help manage the side effects that often crop up.

“People like Penny,” said Lawrence Shulman, MD, a professor of Medicine and the director of Penn Medicine’s Center for Global Cancer Medicine.

It’s true. The 10 patients who texted with Penny all gave her extremely high marks. In addition to their clinical interactions, patients shared news of their day or texted emojis to celebrate sports victories.

Penny isn’t a superstar staffer. She’s a chatbot, an artificial intelligence-run texting platform developed and piloted through Penn Medicine’s Abramson Cancer Center and the Center for Health Care Innovation in collaboration with New York-based startup Patient.ly.

“It’s a personal connection even though it’s a machine. I feel responsible to respond,” said Teresa Sweet, the first patient to begin texting with Penny, back on Christmas in 2017. She feels so connected she makes a point of reassuring the bot if she needs to delay her medications, texting in advance, for example, “I’ll be out for the evening and I won’t be able to take anything until 8.” “I don’t want the thing to worry about me,” she said.

Penny’s job was to help patients with neuroendocrine cancers take chemotherapy pills at home. Over the last decade, there has been an increasing shift toward outpatient therapy. The thought, Shulman explained, is that keeping a patient home makes them more comfortable and assists in their healing. However, the at-home regimen can be difficult to follow. Many times, it involves varying combinations of eight to 10 pills over 10-day periods. It can get confusing fast, and there are other precautions to remember, such as washing hands after handling the pills because they are poisonous. Penny provides regimen reminders and interacts with patients when they’re experiencing side effects to provide tips on overcoming them.

Penny was developed for the two most difficult oral chemotherapy regimens in neuroendocrine cancer treatment, CAP/TEM (capecitabine and temozolomide) and capecitabine, specifically because of how challenging they are.

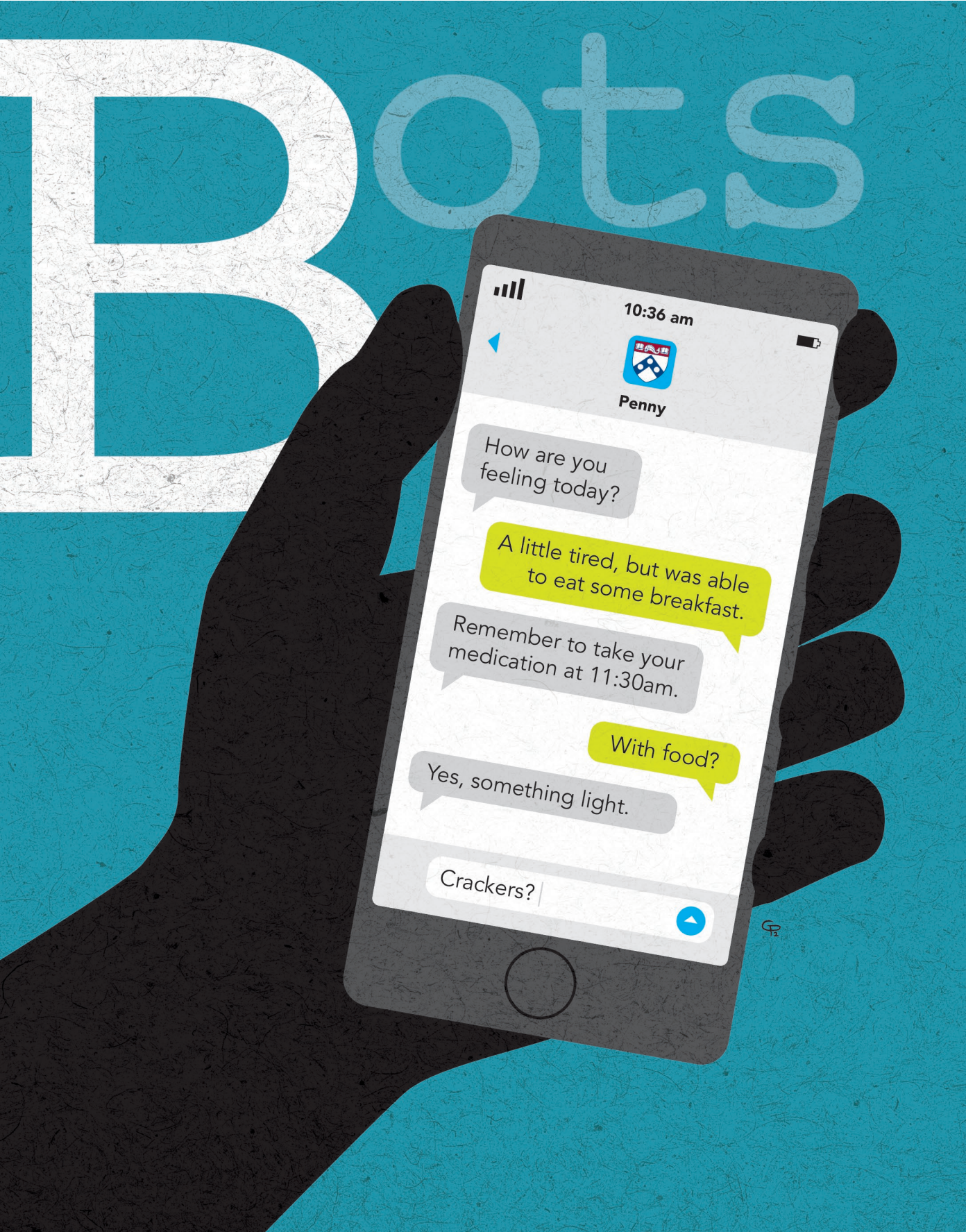
“If we can figure out a bot for these two drugs, we can figure it out for any of them,” said Penny team member Christine Cambareri, PharmD, an outpatient clinical oncology pharmacy specialist.

Because they engage with patients so often—and are built to automatically keep records of these interactions—bots are providing clinicians with more clues of the hiccups can occur in at-home regimens.

“We knew that there were some deficiencies in the home treatment, but we truly didn’t know where they were occurring,” said Beth Mooney, CRNP, MSN, a certified registered nurse practitioner in Gastrointestinal Medicine. “Now we can see where issues are.”

Penny shows promise with several other areas beyond cancer, such as OB/GYN and primary care—all areas where future Penny pilots are under consideration. And, according to David Asch, MD, MBA’89, the executive director of the Center for Health Care Innovation, bots may portend a future path to health care efficiency. Writing this spring in the *New England Journal of Medicine*, Asch and colleagues described the potential use of bots in health care as “facilitated self-service.” In the way that ATMs and cashless banking apps have reduced the need for most interactions with bank tellers, health care bots could be used extensively to free up clinician time.

“Clinical pathways for common medical conditions aim to make care algorithmic,” they wrote, “so it isn’t science fiction to suggest that hypertension could be managed using a bot, with a nurse available for second-line support and a primary care physician serving as the third line.”





ABCs
of Innovation

CRISPR

noun A family of DNA sequences with applications as a genetic engineering tool that uses a sequence of DNA and its associated protein to edit the base pairs of a gene (stands for Clustered Regularly Interspaced Short Palindromic Repeats).

“You take a shot that serves you for the rest of your life. Once and done.”

It sounds like Kiran Musunuru, MD, PhD, MPH, ML, is describing how polio and smallpox have been stopped in their tracks. But what he’s actually talking about is something entirely different: high cholesterol.

“With a single shot, we can permanently turn off cholesterol genes in the liver,” said Musunuru, an associate professor of Cardiovascular Medicine and Genetics. “It’s like taking a statin every day for the rest of your life, but you just have to do this once.”

Such one-and-done therapies are already emerging thanks to newer gene therapies that add a healthy working gene to cells that lack it—with several such therapies developed at Penn. Now CRISPR is widely seen as the tool to exponentially increase the use of these therapies through gene editing. Nimble and inexpensive, instead of just adding a healthy gene into a hole, CRISPR can replace a gene. It uses a guide RNA and an attached protein to seek out and replace matching DNA components. Put simply, the tool cuts and pastes good genes onto bad ones. If a scientist can find the bad genes that lead to disease, CRISPR is a path toward “turning off” that gene and its resultant disease.

Though its proof remains in animal studies, CRISPR’s ease and speed of use have made it a popular tool in laboratories worldwide in the short few years since the discovery of a method for using the Cas9 enzyme as a delivery system for gene editing in 2012. In one study on acute myeloid leukemia, a team led by Saar I. Gill, MD, PhD, an assistant professor of Hematology-Oncology, employed CRISPR to remove certain pieces of DNA from blood cells that CAR T cell therapy “hunters” target and home in on to destroy. The idea is that there will be less collateral damage to normal, healthy cells, resulting in lower toxicity in patients. The technique was proven effective in the lab on rodent and primate models, as well as in human cells.

Musunuru has been working in gene editing for more than 10 years. His work to permanently lower cholesterol in people genetically disposed for high levels of it led to the founding of a start-up, Verve Therapeutics, in May. And while *PCSK9* is the gene commonly targeted for cholesterol, even by drugs currently on the market, Musunuru and his team are focusing on new targets like *ANGPTL3*. About one in 300 people have a variant that naturally turns off this gene. “People with that variant have lower cholesterol levels,

along with lower risk of type 2 diabetes and atherosclerosis,” Musunuru said.

That’s part of the game for researchers using CRISPR: finding a naturally occurring mutation and then chasing it to see whether it is actually linked to a condition and whether it’s viable to use.

For example, Musunuru’s lab has sought out gene variants in heart muscle cells that might be especially well equipped to stand up to a chemotherapy drug called doxorubicin, which has been tied to heart failure in some patients. By taking a pool of heart muscle cells in the lab and delivering CRISPR to them so that each has a different gene turned off, Musunuru’s work identified a number of potential gene editing targets that could factor into clinical trials within the space of a few years.

Musunuru is already using CRISPR to help patients by creating “genetic avatars”: stem cells engineered as a match to their own unique genetic sequences. Comparing these cells to typical stem cells can show whether the patient’s genetic variant is actually the cause of their disease. This knowledge can aid patients and their families in genetic counseling.

“In terms of research, CRISPR has already been transformative,” Musunuru said. “In terms of therapeutic applications, we are still in very early days.”

While Musunuru is still working toward the larger vision of that one-shot CRISPR treatment for high cholesterol, there is no question CRISPR’s clinical days are upon us. Penn Medicine is home to the first clinical trial to use CRISPR to edit human cells outside of China, where early experiments with CRISPR testing in humans have prompted a raft of bioethics debate across the globe. The new study, for patients with multiple myeloma, sarcoma, and melanoma, builds upon Penn’s research leadership as the developer of the first approved CAR T cell therapy, as well as the institution’s support for innovation in applying new technologies. Edward Stadtmauer, MD’83, a professor of Hematology Oncology, is leading the study in which patients’ hunter T cells are modified via CRISPR and then infused back into the body.

To move into the clinic for testing in patients, Stadtmauer’s research team had to progress through a gauntlet of institutional and federal regulatory approval steps that spanned more than two years. Now that the trial is underway, the researchers hope to improve upon early successes using CAR T cells, which have proven highly effective at treating some of the most intractable blood cancers, using this method that can so precisely fine-tune the genetic makeup of immune cells and easily edit multiple genes at once.

Results from Stadtmauer’s CRISPR modified T cell trial are expected to be presented in the coming months. Read this article online for a link to more details at PennMedicine.org/magazine/InnovationABC.

DEVICE ACCELERATOR:

Photos by Peggy Peterson

V1

- Proof of concept
- CD case around anesthesia ventilator pump
- Attached with backpack straps

V2

- Prototype
- Custom 3-D printed valve assembly for existing ventilator pump
- Attached to vest with ski boot straps

HOW A VEST FOR COPD EVOLVED

Through the Penn Medicine Medical Device Accelerator, a physician's back-of-a-napkin sketch may soon help patients breathe easier.

V3

- Clinical prototype
- Completely redesigned pneumatic system
- Additional data sensors
- Belt inspired by a spinal brace

V4

- Streamlined design
- Smallest, lightest, most powerful air pump now integrated with valve assembly
- Nearly ready for commercial production

Michał Swoboda, Chief
Technology Officer,
RightAir, LLC

BREATHING

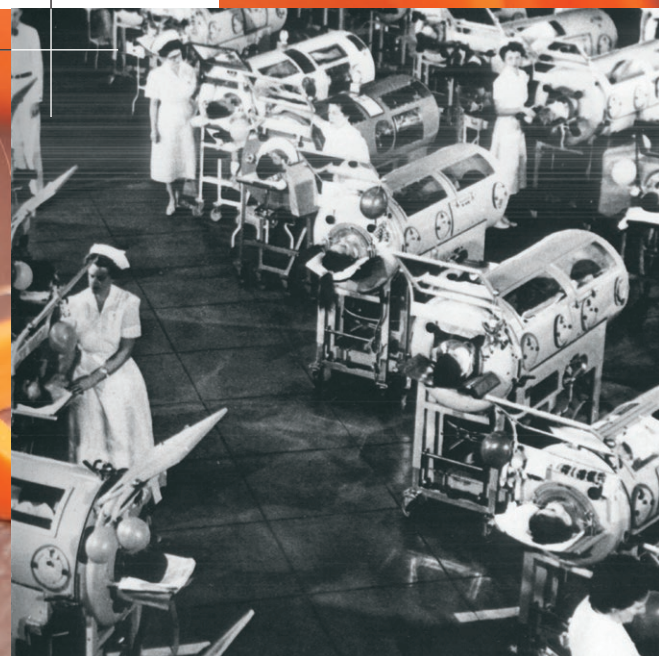
The original idea was an old one. An iron lung was a classic form of mechanical respirator that used both negative and positive air pressure to inflate and deflate the lungs when a person lacked ability to do it for themselves—such as when a patient was paralyzed by polio.

Modern-day patients with COPD, often called emphysema, can breathe on their own, but due to changes in the lungs caused by past smoking, they frequently experience shortness of breath. This symptom is even more pronounced during physical activities. Patients can feel like they are suffocating, even when just walking from room to room. COPD affects 15 million people in the U.S., costing the system approximately \$50 billion per year for their care.

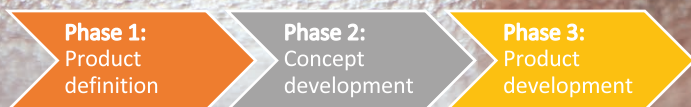
“What if we could make a vest that can decrease the shortness of breath of COPD patients so they can engage in life again?” wondered Jake Brenner, MD, PhD.

Starting with a series of simple sketches, Brenner, a pulmonary critical care physician, aimed to update the functionality of modern respirators based on the same principle as the iron lung. These devices use a front and back turtle-like shell surrounding the chest with an attached pump to apply pressure. Assisted breathing devices currently on the market are generally impractical for patients to wear in their daily lives. Brenner’s device, however, could be worn anywhere.

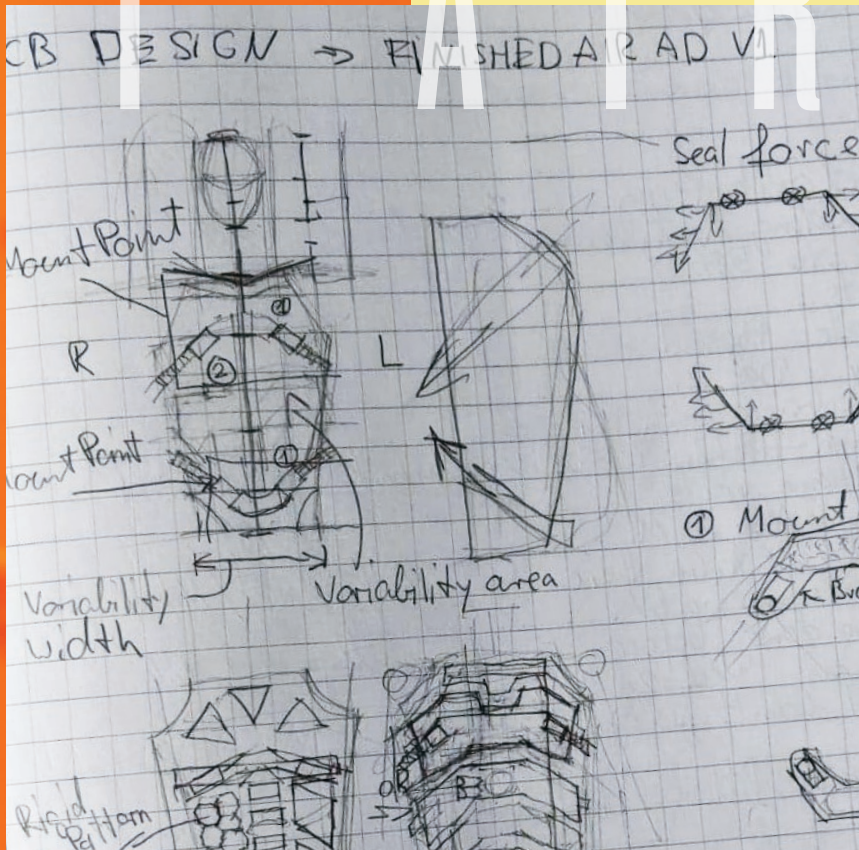
The idea was accepted into Medical Device Accelerator (MDA) program at Penn Medicine in 2017, which provided Brenner with seed funding and collaborators with expertise in engineering and product design to move through a streamlined development process. He formed a company, RightAir, LLC, received additional support from Penn Health-Tech (Penn Medicine and Penn Engineering device-development center) and set up a staff working out of NextFab, a Philadelphia maker space that is a ready-made Santa’s Workshop for inventors.



Medical Device Accelerator Process



H T V A B R



The shell of the first prototype of the Right Air vest mirrored the shape of existing commercial ventilators. Brenner and Swoboda used simple rubber sheeting to produce a seal between the vest and the wearer's body.



A shape form for molding a version of the plastic vest shell was laser cut in the NextFab woodshop of thin slices of wood.



A pump worn on the back creates negative and positive air pressure inside of the shell to pull or push the patient's chest.

Negative pressure: Air passages in the lungs open up to make it easier to inhale.

Positive pressure: Compressing the lungs makes it easier to exhale.

Phase 4:
Verification &
validation

Phase 5:
Design
transfer

Phase 6:
Commercial
transfer

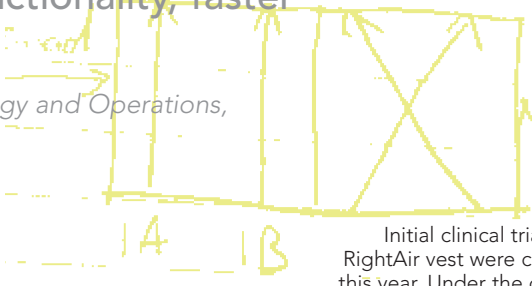
As big area
as possible

tel. voice + chest wall
motion tracking + (CCTF)

“Penn physicians with medical device ideas are first and foremost just that: physicians and researchers. We help them take ideas deeper into the commercialization process to answer more questions about safety and functionality, faster than they could otherwise.”

– Mohit Prajapati, MBA, Director of R&D Strategy and Operations, Medical Device Accelerator Program

Valve Design



Initial clinical trials for the RightAir vest were completed this year. Under the continued guidance of the Medical Device Accelerator, the team is seeking FDA approval in advance of launching sales of the vest as a commercial product.



Marek Swoboda, PhD, CEO of RightAir, LLC, with founder Jake Brenner, MD, PhD



▶ RightAir is just one product among many that the MDA is ushering into practice year after year. Read about a video-guided catheter designed to change minimally invasive brain procedures and gene therapy online at PennMedicine.org/magazine/mda.



Extending the Impact of Innovation *Everywhere*

*By Christina Hernandez Sherwood
Photos by Peggy Peterson*

From texting new moms about blood pressure to sending geriatric patients home from the hospital with packaged meals, innovation in health care involves more than just a change in setting, a change in technology, or a change in care model. It's a system for testing and learning which changes will succeed.



Penn Plastic Surgery had a capacity problem. It's the country's busiest center for "free flap" surgery, in which a patient's tissue, usually from the abdomen, is used to reconstruct the breast after mastectomy. Demand was so high that fewer than half of new patients could be scheduled for appointments within two weeks. That bothered Michael Tecce, DO, a plastic surgery resident who worked as an auditor for five years for international accounting firms analyzing and making process improvement recommendations, before he began his medical training. At the same time, Tecce noticed how frequently postoperative free flap patients returned to the clinic: up to three times to have drains removed from their incision sites and twice more for monthly checkups at which the vast majority were cleared. "Is there a better way for the patient?" Tecce wondered. "Is there a better way for us?"

As Tecce mulled over these questions last winter, he ran into Kathleen Lee, MD, a clinical innovation manager at the Penn Medicine Center for Health

Penn Medicine Home Health nurses including Karen Schwagerl, BSN, RN, CWOCN and Denise Paoline, BSN, RN, CWOCN, were trained to perform surgical drain removals in a pilot program from the Plastic Surgery Division.



Through the Heart Safe Motherhood program, Karimah Ferguson responded to text messages tracking her blood pressure daily when she returned home after giving birth to her baby, Lilliana.

Care Innovation, which shares a floor in the Perelman Center with Plastic Surgery. They chatted over slices of leftover pizza. Before long, the innovation center and Plastic Surgery partnered to study whether, and how, they could ease the burden on free-flap patients—and the strain on Plastic Surgery—by transitioning much of their post-operative care to occur at home, augmented by text-message communication and a care package tailored to their recovery needs. When they pitched a plan to test these ideas, Joseph Serletti, MD, chief of Plastic Surgery, deemed the project “brilliant,” even though it meant losing some clinical control. Serletti signed on as the project’s sponsor. “It’s doing something better for the patient,” he said. “That’s what we should be focused on.”

It was that, and more: From the initial question—can we do this better?—to the resulting pilot project and next steps that are still unfolding, the plan was emblematic of how the Center for Health Care Innovation has accelerated change across Penn Medicine. For nearly a decade, initiatives

launched through the innovation center have yielded multiple benefits in patient outcomes, patient experience, and the cost of care. In many cases, crucially, these projects involve shifting the center of care toward less acute settings, from inpatient to outpatient, and from outpatient to home.

One team found they could keep postpartum women with hypertension safer by using a Penn-developed software platform to check in on their health. Another team discharged geriatric patients earlier—providing more services to keep them safe in their homes to reduce the likelihood they’d be readmitted as inpatients. And the Plastic Surgery team found that removing drains at home could save patients upwards of 20 hours of return visits to the clinic during recovery.

Innovation in health care involves more than just making a change in setting, technology, or care model, though. A lot has to go right in order for health care innovation initiatives to succeed. Not only does the project itself need to work, but it needs to be acceptable to patients, to pass muster

with clinicians, and be financially viable, according to David Asch, MD, MBA'89, executive director of the innovation center. "The innovation process aims to test all of the things that must be true for success to happen."

WHEN A TEXT MESSAGE CAN SAVE A LIFE

In July, Karimah Ferguson, 38, was in the midst of a move from Abington, Pa., to the West Oak Lane Philadelphia home where she planned to raise her newborn daughter, Lilliana. Ferguson had had an uneventful first pregnancy until her 32-week checkup when, before the routine exam was over, she was sent to the hospital with high blood pressure. Diagnosed with preeclampsia, Ferguson delivered Lilliana a week later via emergency C-section at the Hospital of the University of Pennsylvania (HUP).

Even after that, Ferguson was at risk for continued severe high blood pressure, one of the leading causes of maternal mortality. A few years ago, a new mom like Ferguson would have been asked to come back to HUP for a blood pressure

"People think it's innovative if you use Apple watches," he said. "To me, it's innovative if it succeeds."

David Asch, MD, MBA

check after discharge. Yet Penn clinicians were finding it was nearly impossible to get at-risk new mothers to show up. Despite offering follow-up phone calls, flexible scheduling and a walk-in clinic, only about 20 to 30 percent of patients would return, said Adi Hirshberg, MD, an assistant professor of clinical Obstetrics and Gynecology. "Asking women to come back to the clinic was just not working," she said. At the same time, even patients who had their follow up were getting the benefit of only a single blood pressure reading. The timing of their visit didn't necessarily match up with their stroke risk, which is highest for about 10 days after delivery. Clinicians just didn't have the numbers they needed to keep these new mothers safe.

Enter the Innovation Accelerator Program, the innovation center's most intense involvement in transformation initiatives. In 2014, Hirshberg, along with Sindhu K. Srinivas, MD, MSCE'08, director of obstetrical services at HUP and now vice chair for quality and safety in Obstetrics and Gynecology, earned a spot in the program. Their idea: Could they close the gap by sending patients home with a blood pressure cuff and using text-message interactions to make risk monitoring both more consistent and convenient? They called it Heart Safe Motherhood.

Through a series of small, quick pilots—with Hirshberg manually texting patients—the team tested what frequency, timing and wording would work best for the texts. "If we tried to focus on the [technology] platform, we would have looked at all these vendors, checked with legal, gone through all these

processes," said Shivan Mehta, MD'06, MBA'06, MSHP'12, associate chief innovation officer for the center, "and we wouldn't have been able to test what we really cared about." Once they proved what worked, the team scaled up with Way to Health, Penn Medicine's automated software platform for engaging with patients. Way to Health made it easy for patients, who continued to receive a regular text message at the other end—no need to download a dedicated app.

Innovation isn't always about adding more technology or choosing the high tech solution, Asch noted. "People think it's innovative if you use Apple watches," he said. "To me, it's innovative if it succeeds." In fact, the Heart Safe Motherhood team chose to give patients traditional blood pressure cuffs for home monitoring instead of high-tech cuffs that connect wirelessly with Way to Health. The wireless cuffs were clunky and unnecessary, Asch said, and additional complexity tends to result in less participation. "I'd like the lowest tech," he said. "I'd like the easiest solution."

Fast forward to this summer. Once Ferguson was discharged with a blood pressure cuff, she received twice-a-day text messages for about 10 days asking her to check her pressure and reply with the reading. Though she was anxious about what would happen if her reading was high, Ferguson said she appreciated not having to go to the hospital for a check. "I was over seeing doctors after being in the hospital for two weeks and poked and prodded every day," she said. "I was glad to be in my own home."

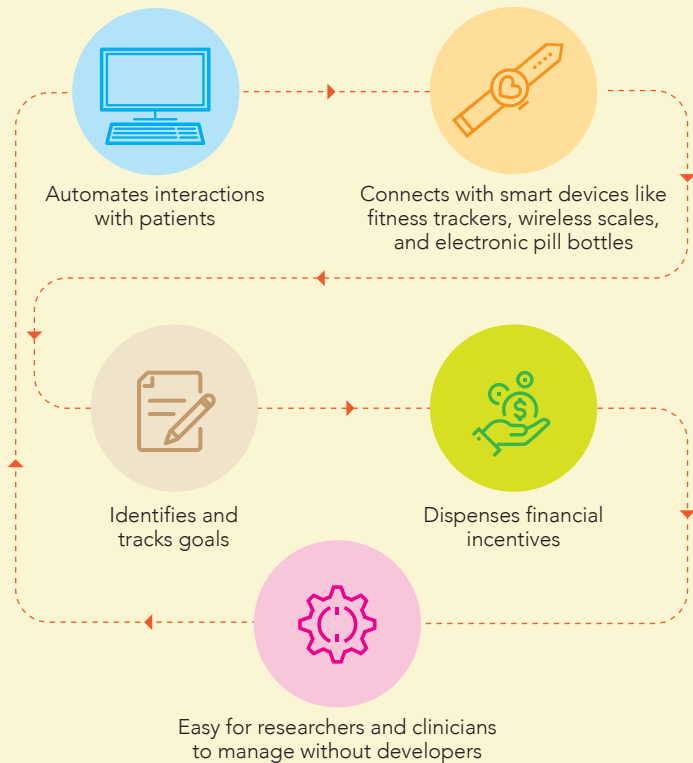
The Way to Health platform automated review of Ferguson's blood pressure numbers. When her numbers were normal, she received a reply letting her know everything was okay. If any had been abnormally high, her care team would be alerted and she would receive instructions about what to do. (Clinicians can also review a patient's full history of blood pressure readings at any time.)

Ferguson wasn't the only patient who found it easier to monitor her blood pressure remotely. Since Heart Safe Motherhood went live in 2017 at HUP, 85 to 90 percent of the more than 2,500 participants reported their blood pressure at least twice. Readmission of postpartum hypertension patients to HUP has decreased by 80 percent, from about five to only one out of every 100 patients. It turned out that even though providers don't get to see their patients in person, Srinivas said, they're "actually more effectively obtaining the data that's needed to act in a timely fashion."

Plus, in stark contrast to the way medical technology can sometimes widen inequality, Heart Safe Motherhood "actually narrowed disparities because they used technology that was very patient centered," Mehta said. Black women are three times more likely to die of preeclampsia than white women, but Heart Safe Motherhood has shown evidence of tightening the gap in follow-up care. While only 33 percent of black patients returned to the office for a blood pressure check after discharge, a whopping 93 percent texted at least one blood pressure reading, Hirshberg, Srinivas and Penn biostatistician Mary D. Sammel, ScD, reported recently in the *American Journal of Obstetrics and Gynecology*.

WAY TO HEALTH

The Penn-developed technology platform was designed to automate and tailor engagement between patients and clinicians and to guide patients toward healthier decisions.



“Although it’s a tech platform, its true engine isn’t tech, but rather practical insight into human behavior,” said Mohan Balachandran, the chief operating officer of Way to Health within the Penn Center for Health Care Innovation. Initially a research tool, Way to Health now integrates with clinical care at Penn Medicine. It may be a crucial catalyst for one of medicine’s largest challenges: automating support for chronic care.

10 years in operation, Way to Health was initially developed as a research tool funded by a stimulus grant.

150 trials or clinical projects have been conducted in nearly all 50 states, with over 65 currently running.

60,000 patients have enrolled in Way to Health projects.

“Advances in health care to date have been very focused on physicians and the science of medicine,” Balachandran said. “Some of the barriers to improving health are social determinants and our behaviors. Way to Health’s intent is the focus on the patient and aid in changing their behavior for the better.”

► For more information, visit waytohealth.org.

Extending the program’s impact is the next step. Heart Safe Motherhood has been the standard of care at HUP since 2017 and at Pennsylvania Hospital since 2018, and the program is gearing up to expand locally, and perhaps across the country. Efforts are underway to determine whether the model can be translated to other medical issues, such as postpartum depression, blood sugar testing, and breastfeeding support.

“We’re not looking for projects that just show early evidence,” Mehta said. “Innovation is the identification, evaluation and, ultimately, implementation and scale of those projects.”

Such innovations in health care are hardly a simple matter of changing technology. The innovation center is continuously learning alongside clinicians that when it comes to revolutionizing health care, one size doesn’t fit all: clinical context matters. The right approach for young mothers isn’t necessarily the right approach for keeping older adults out of the hospital.

WHEN RECASTING ROLES CAN AID RECOVERY

The hospital can be a dangerous place for older adults. Some geriatric patients become delirious or lose functional status. Others develop a secondary complication. All told, about one-fifth of patients 65 and older are readmitted to

the hospital within a month of discharge. “What happens over the course of a five- or seven-day hospital stay could alter the course of that older adult’s life,” said Rebecca Trotta, PhD, RN, director of Nursing Research and Science at HUP. “It’s a highly vulnerable time.”

Trotta worked to establish the role of the geriatric nurse consultant to support older inpatients at HUP in 2016. But to ensure that added support had a lasting impact after the patient’s hospital stay, Trotta wanted to do more. She was inspired by England’s “flipped discharge” model, which involves discharging a geriatric patient immediately after his acute medical problem is resolved and sending an interdisciplinary team—including a nurse, social worker, therapists and nutritionist—to his home to assess what he needs to return to baseline and prevent readmission. She brought her idea to life as part of the innovation center’s 2017 accelerator cohort.

In the accelerator’s first phase, the innovation center worked with Trotta and her team to study the problem of geriatric hospitalizations. “Any time we go into a project, even if people have solutions in mind, we still want to understand more about the problem,” Mehta said. Then the team performed a series of rapid cycle experiments to explore potential solutions in cohorts of 10 to 20 patients. What’s required to coordinate all the activities involved in an earlier

discharge? How do they do so while ensuring the patient has what they need to be safe at home? “We explore different directions and test those concepts very quickly,” Mehta said. “Those learnings can help inform what our actual intervention is.” Finally, the most promising solutions were rolled out in pilots of 50 or more patients to test outcomes.

Trotta’s project, known as SOAR (supporting older adults at risk), kicks off while the patient is still in the hospital. They are followed by the geriatric nurse consultants and receive additional interventions to prevent cognitive and functional complications. On the morning of discharge, geriatric nurse consultants have a handoff phone call with Penn Medicine Home Health to discuss patient needs, instead of relying solely on the electronic health record to share information. The patient is then discharged in the morning—moved up from late afternoon—and leaves with his prescriptions, lunch for himself and his caregivers, and a case of nutritional shakes. “They often don’t have fresh food at home, given they were in the hospital for a few days,” Trotta said. A nurse visits that same day, she said, cutting the time between discharge and a home visit from two days to about three and a half hours while also ensuring the patient has the correct medications in hand days earlier than previously observed. Home health providers use a secure

“There’s so much potential in improving care coordination and thinking about the roles people play. It’s not technology. It’s care design.”

Roy Rosin, MBA

texting app to maintain contact with hospital providers as needed. After the transition home, SOAR continues to support patients, with the help of a geriatric-certified virtual case manager nurse, by ensuring they follow their care plan, attend follow-up medical appointments, and get the supplies they need.

About 120 patients have come through the SOAR pilot at HUP, Trotta said, and as the program has been refined, the readmission rate has decreased from 20 percent to 17 percent. This fall, the SOAR team is moving into a rigorous program evaluation of its playbook (including steps, templates for consistent messaging, and documentation) with the aim of ultimately expanding from the hospital medicine service at HUP to other departments caring for geriatric patients.

While SOAR uses some backend technology, such as text messaging between providers, it’s primarily focused on re-designing providers’ roles. Similarly, IMPaCT, another accelerator alumnus, found success developing a replicable care model that employs community health workers, people who are already known and trusted in their communities, to connect with and provide social support and care naviga-

tion for the sickest and most vulnerable patients. Likewise, Penn Medicine’s Center for Opioid Recovery and Engagement (CORE) leverages certified recovery specialists—in recovery themselves—to provide peer support for people struggling with opioid use. “There’s so much potential for improving care coordination and rethinking the roles people play,” said Roy Rosin, MBA, Penn Medicine’s chief innovation officer. “It’s not just technology. It’s care redesign.”

WHEN LESS TIME IN THE CLINIC MEANS MORE CARE

Karen Towell, 56, of Havertown, Pa., left the hospital after her free-flap breast reconstruction in May with four surgical drains tethered to her incision sites. She also brought home a care package of recovery supplies. It included a sleek bathrobe with a belt for holding surgical drains and a plush seatbelt cover (to protect her surgical site while driving or riding in a car), along with other items.

Towell was one of about 50 patients in the first three months of the pilot program sparked by Plastic Surgery resident Michael Tecce to redesign care following free-flap surgery—a model they called “Care, Reimagined,” or CARE in a stylized, shortened form.

When Tecce first teamed up with clinical innovation manager Kathleen Lee, innovation manager Lauren Hahn, and Plastic Surgery Business Director David Okawa to study the problem, one of their most striking findings was that it took free flap patients an average of four to five hours, including travel, each time they had a drain removed at the office. The drain removal itself lasted three to five seconds.

In the CARE pilot, Towell received text messages about her drain output and a visit from a home health nurse starting the day after she left the hospital. The team alerted home health when Towell’s first drain was ready for removal. (As it turned out, home health nurses visiting free flap patients were perfectly capable of removing drains—they just hadn’t been trained to do so.) The nurse removed Towell’s drain as she relaxed on her living room recliner. “For me to go down to Penn... it would have been my whole day,” Towell said. “Being at home is just so much more comfortable.”

Towell was initially less comfortable responding to the text messages she received about her recovery, however. In a post-surgery haze when the concept was first introduced in the hospital, Towell said she wasn’t sure what to make of the texts she received each morning after she went home. “I was like, ‘Wow, this is so nice, but I don’t know who you are,’” she said. “At first it kind of threw me as being impersonal.”

The innovation center is experimenting with more casual tones for communications sent via automated systems, Asch said, but patient experiences with these remote platforms vary—most patients in the CARE pilot were enthusiastic about the text messages from day one.

Once the text-messaging service was re-explained at an in-person postoperative visit, Towell grasped that even though the check-in questions she received were automated, it was her care team interfacing through Way to Health—not

a robot—responding when she asked more personal questions about her own recovery. The very next day, she sent a text asking if it was safe to start using deodorant again. Towell’s two-month postoperative visit was also handled remotely. Instead of going to the clinic, she answered a series of survey questions and sent photos of her incision sites via a two-day text message check-in beginning on a Monday. On Wednesday, Towell received a text completing her check-in and confirming that she was cleared to return to work.

Transitioning care to the home setting for patients like Towell offered benefits to other patients, too. The CARE model eliminates the need for four out of five follow-up-of-office visits, which frees up a significant number of appointments for new patients, who can now get in faster. Automating the most rote aspects of the text check-ins further frees up clinicians’ time to spend on more personal aspects of patient care. The CARE team has fully automated monitoring of drain outputs and scheduling home health care visits to pull drains at the appropriate times, and is working on automating responses to non-urgent frequently asked questions.

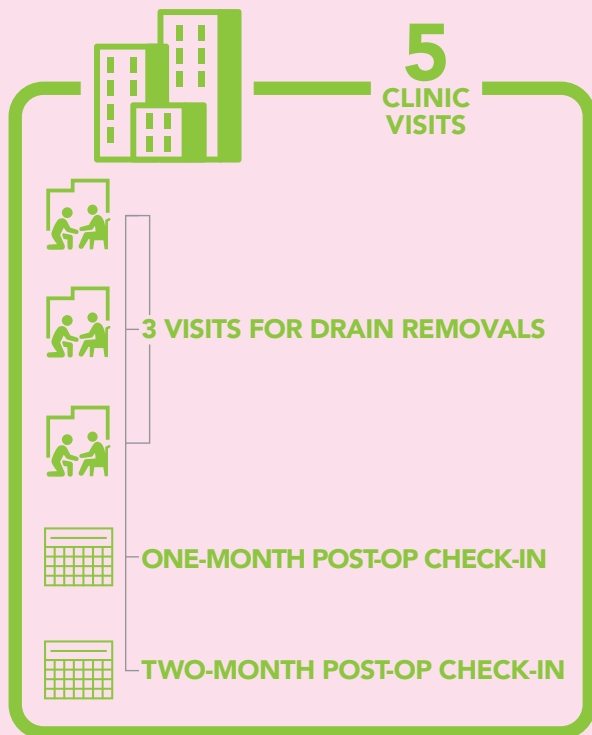
Gaining these kinds of benefits through innovation projects requires constantly refining processes while embedded in a natural clinical context, Rosin said, even though it risks some hiccups along the way. “So many times in clinical medicine, people never get past the white board,” he said. But innovation is about blowing right past the white board. “There’s no way to learn something without doing something. You need to try it.”

It’s also a delicate balance to see patients less frequently in a clinical setting, while maintaining care excellence and a patient-provider relationship. Other Penn innovation projects that are finding success in this area include Advanced Heart Care at Home, which provides IV diuretics to heart failure patients at home, and BreatheBetterTogether, which provides individualized care for patients with chronic obstructive pulmonary disease who are at high risk for hospital readmission.

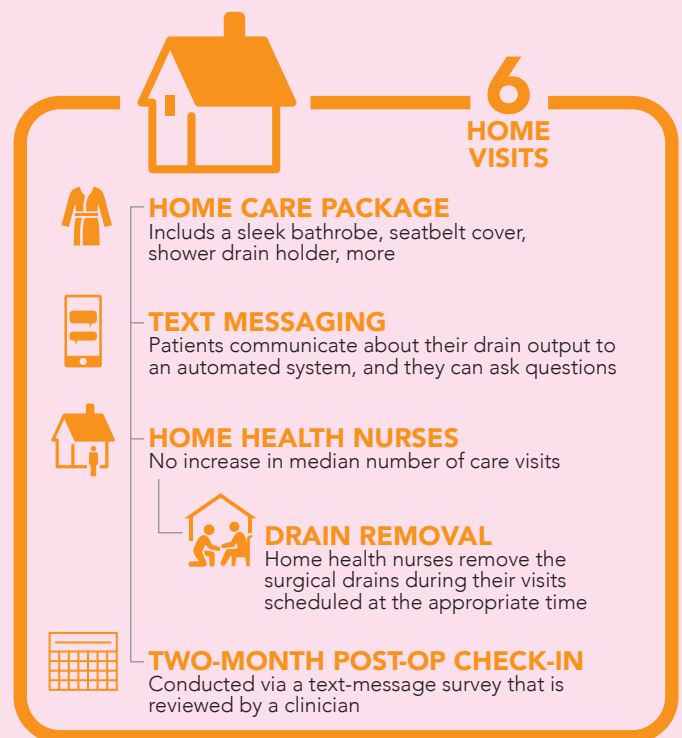
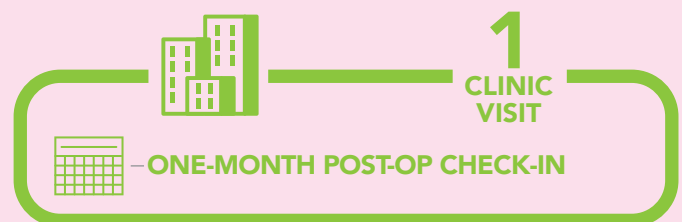
Even though CARE patients aren’t going to the clinic as often, just like new mothers using Heart Safe Motherhood, they’re interacting with Penn Medicine more frequently. In the

After a Free-Flap Breast Reconstruction

TRANSFORMING POST-OPERATIVE CARE...



TO CARE REIMAGINED





Stacy Haley, who was diagnosed with breast cancer and underwent a double mastectomy and free-flap reconstruction at HUP, demonstrates the robe provided in a care package as a tangible sign of the clinical team's ongoing support in her recovery.

old model, a patient received a visit from a home health care provider and a call from the surgery team a few days after discharge. Then, it was crickets until the first drain removal. Now, CARE patients rarely go a day without receiving a text message or seeing a home health nurse. “We’ve pushed all of our contact with the patient to be more personal,” Tecce said, “and earlier in their postoperative care. By connecting with patients through texting and post-operative support garments, we show patients in a tangible way that, even though they are making few in-person office visits, we are still supporting them in their recovery.” The selection of items in the care package was informed by the experience of previous Penn patients who found these items provided comfort in the slow healing process.

Not all innovation projects are designed to shift care away from acute clinical settings. But those that do are built on the premise that the total amount of time patients spend with a health care provider is only a small slice of their lives. Even for the sickest patients with chronic illness, it’s only a few hours each year. It’s what happens during a person’s other

5,000 waking hours—whether they take their medication, if they eat healthy and exercise, whether they smoke, and whether the demands of a new baby make it difficult to get to a clinic—that matters most to their health.

But it is not merely that time spent in clinical settings is limited. It’s also costly and inconvenient for patients who are more comfortable than ever handling the most personal aspects of their lives remotely. “Would you rather write a check made out to cash, go to a bank during banking hours, engage with a teller and get \$50? Or would you rather go to an ATM? Or would you rather skip it entirely and Venmo?” Asch said. “Other businesses have successfully made those transitions from what would be called a more acute site of care. It’s time for health care to get past that.” □

► **Read this story online with related links at [PennMedicine.org/magazine/InnovationEverywhere](https://www.pennmedicine.org/magazine/InnovationEverywhere).**



From Fountain Pen to Big Data

By S.I. Rosenbaum

Photos by Peggy Peterson
and Graham Perry

In the space of one lifetime, medical information technology has transformed radically. Penn's chief medical information officer is living that lifetime.

A fountain pen and an index card were two of the most essential assets in medical information technology fifty years ago.

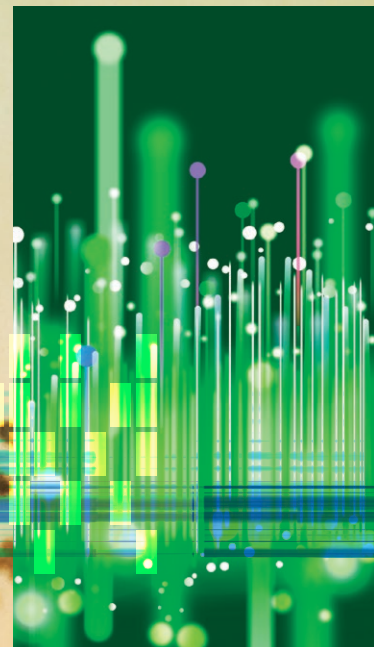
Clarence William Hanson, Jr., MD'55, the director of the Emergency Ward at the Hospital of the University of Pennsylvania, would sit with patients, carefully taking notes on the index card before slipping it into his jacket pocket and proceeding to the exam. Sometimes, his son, Bill played with the fluoroscope nearby. Later, in the evenings, he'd settle in at home with the baseball game on the radio, leafing his way through the index cards and narrating encounter summaries into a dictaphone.

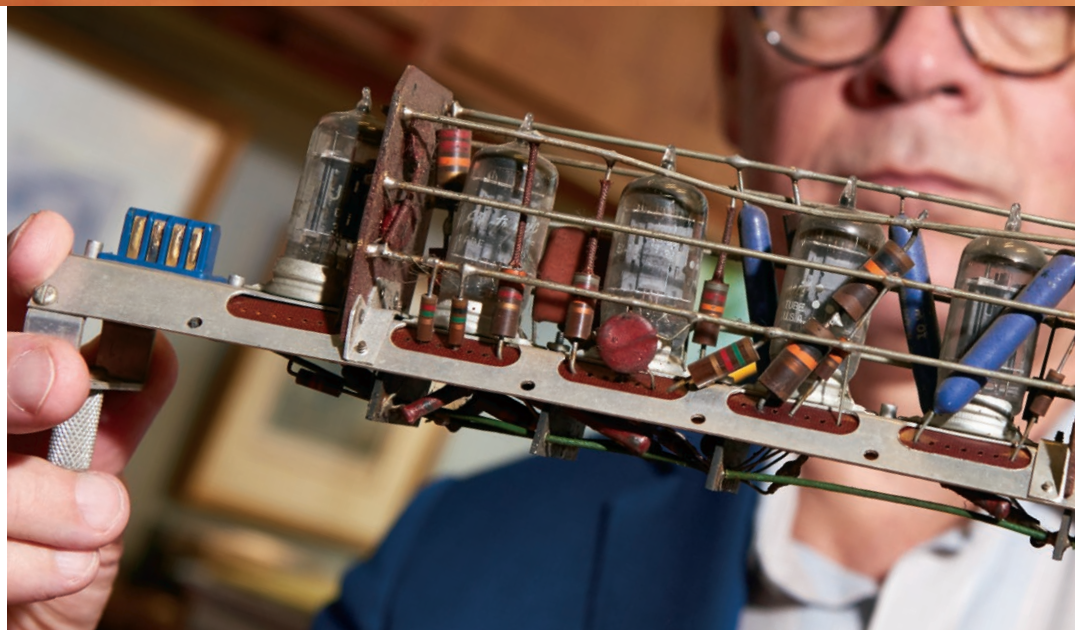
Those tapes then went to his secretary, who plugged them into a transcription machine with headphones and foot pedal. The transcribed patient records then went into a Pendaflex folder and then into a file cabinet.

That was the state of medical information technology when young Bill Hanson was growing up: paper and pen, onion-skin paper.

Today, as Penn's chief medical information officer, C. William Hanson III, MD'83, is on the other side of an information revolution as both a physician and onetime computer coder. He works in a glass office in the Perelman Center for Advanced Medicine, at the heart of a vast network of information—a hive of interconnected computers and smart devices adding up to a system that spans Philadelphia and far beyond.









Medicine has always been about information: gathering it, interpreting it, connecting it to other information. What has changed so far in Hanson's lifetime is not just the tools—the fountain pen and filing cabinet haven't been simply replaced by computer keyboard and database. Medicine, Hanson says, “is in the process of transitioning from a scientifically informed art to what hopefully will be an artistically informed science.”

Hanson is a member of the last generation of people who were self-taught computer programmers and tinkerers. He has witnessed every stage of this rapid evolution—or occasionally just found himself unwittingly adjacent to it, like a medical information Forrest Gump.

Sneakernet and Silicon Valley

One of the first places in Penn's medical enterprise where computer technology was implemented was in financial records.

That's where Hanson wrote some of his first code. He'd learned how to program in high school, so after college and through medical school he wound up working as an “odd jobs guy” under HUP's director of data processing, Rich Viale, PhD. One of Hanson's odd jobs was to write a program that would compare the hospital's ledger of checks written against the bank's ledger of checks cashed.

Both ledgers were digitized, meaning that, at the time, they were stored on magnetic tape. There was one problem: the only way to get the punch tape from the bank to the hospital and back was on foot. So Hanson found himself sprinting the five blocks regularly, creating what old programmers would call a “sneakernet.”

Medicine, Hanson says, “is in the process of transitioning from a scientifically informed art to what hopefully will be an artistically informed science.”

“I was a kid running this business-critical mission, this critical operation, lugging these tapes around in a knapsack between the bank and the hospital,” he says.

But the era of paper punch tape, punched cards, and magnetic tape was almost over, and some were already looking ahead to what might be possible with a new generation of lighter, leaner, more networked machines. As a medical student in 1980, Hanson helped host a talk by one of those visionaries: a former Penn biochemistry student named Larry Weed, who was then teaching medicine at the University of Vermont.

Weed had noticed that hospital records were often illegible and disorganized—as one writer put it, “highly variable in comprehensibility”—and in 1968 had published a paper in the *New England Journal of Medicine* that proposed a new way of consolidating the scattered information. “He was essentially talking about a structured way of recording medical encounters that would be susceptible to computerization,” Hanson says.

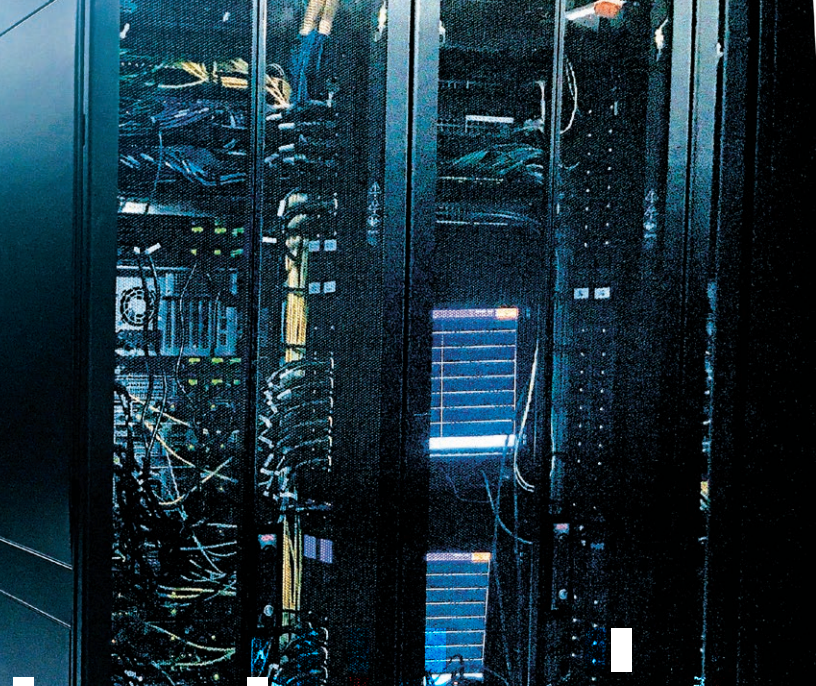
Weed's problem-oriented medical record, or POMR, was a way to keep all the information on a patient together, from one visit to another, so different physicians could check each other's work. He first described what is now known as SOAP (subjective, objective, assessment, plan) note charting. And he envisioned the system as being linked to a database of medical knowledge that could help guide a doctor's decisions.

Meanwhile, across the country in Palo Alto, a company called Apple was working on its version of the invention that would eventually implement Weed's vision: the personal computer.

In 1983, Hanson arrived at Stanford University Hospital for his first residency (in Internal Medicine), but he had no idea how close he was to history.

“The computer revolution was happening blocks away from me that I had no idea of,” he says. “I was oblivious to what was happening with Apple. I was frankly oblivious to what was happening academically at Stanford.”

Ironically, his clinic attending physician was Edward Shortliffe, MD, PhD, who would go on to become one of the pioneers of early medical informatics and artificial intelligence. In 1975 Shortliffe had designed a rule-based computer program, MYCIN, that could assist doctors in diagnosing infectious disease.



MYCIN was never put into practice out of concerns about liability and cost. Still, it was far ahead of its time, and remained a foundational experiment in medical artificial intelligence (AI).

Hanson, the frazzled young resident, knew none of this. To him, Shortliffe was just his clinical attending. “I was sort of aware of the fact that he and his colleagues had developed some software,” he says. But his future career would bring him back into Shortliffe’s orbit.

Shortliffe, for his part, remembers Hanson as a medical student “on the cutting edge in terms of demonstrating that not everybody needed to look like a grey-flannel-suit guy.”

As an attending, Shortliffe knew that Hanson and his peers were absorbing information “firehose style.” But he always tried to drop in some information about what computers and medical informatics could do, just to make sure they were familiar with the concept.

“He left knowing the word, which is a lot more than most doctors in those days,” Shortliffe says.

Tech Hub in the ICU

Even in 1986, operating rooms at HUP were full of technology—and it was smart technology, Hanson realized, as he began his second residency in anesthesia. Oxygen and

anesthesia might flow into a patient, but data flowed back out. “All of these [devices] were, to a degree, computer enabled,” he says. “They had data that they were generating, and that you could access with a computer.”

He wondered what kinds of questions that data might be able to answer.

He started out with a cardiac monitor. By “hacking” the device, extracting and analyzing its data, he was able to write a program that could use that data to predict a patient’s deterioration earlier than a bedside nurse. He was also able to disprove a widespread belief that giving heavy smokers extra oxygen would slow down their breathing, causing CO₂ levels to rise. By checking the data, he found that breathing rates remained the same, and another factor was causing the CO₂ increase.

“I was able to debunk prevailing wisdom and then bring that to a computer model and help explain what was really

going on,” he recalls. “The significance of that is totally current—the idea that you could take something and say, ‘Let’s model this problem with known science and try different inputs and outputs and come up with new explanations and new therapies.’”

HUP wasn’t the only place where doctors were becoming interested in the medical potential of technology. In 1999, two intensive-care doctors at Johns Hopkins Hospital approached Hanson and asked if he wanted to start a company with them. They were looking to apply the emerging field of telemedicine to the ICU, so that a remote intensivist could monitor patients 24 hours a day.

“I was tempted,” Hanson recalls. But he took a counter offer to remain at Penn instead, which afforded him a chance to take a sabbatical in the computer science department at Princeton. “This was the most spectacular opportunity to be a student again, in a place where there was so much intellectual richness,” he says. He continued teaching a course on medical informatics as a visiting professor there even after he returned full-time to Penn.

Some time later, the chief medical officer called him in. “Would you like to be director of a tele-ICU?” he asked.

Penn, it turned out, had decided to contract with a company that would eventually be known as Visicu—the very company Hanson had declined to join a few years earlier. “Poetic justice,” he says. “It’s like we had a bad date and then we end up getting married.”

So Hanson set out to help Penn build one of the very first telemedicine-enabled ICUs.

It was fitting for this happen at Penn, which had already been a pioneer in the field of telemedicine. In the 1940s, Jacob Gershon-Cohen, MD’24, an assistant professor of Radiology at Penn’s Graduate School of Medicine, noticed that newspapers had obtained the ability to transmit photographs across telephone wires using an early version of the fax machine.

Gershon-Cohen found he could use similar technology to send radiological images via telephone from Chester County Hospital back to Philadelphia for analysis by expert radiologists. He called the technique “telegnosis,” and it saved lives: for example, in one case doctors at Einstein Medical Center were able to diagnose intestinal obstruction in a patient at Chester County via an emergency tele-consultation.

He even experimented with “videognosis,” transmitting radiographs using a television camera and a shortwave radio.

So telemedicine was not exactly a new idea—but no one had yet smoothed out the wrinkles in using it to create a constantly-surveilled ICU. At Penn, Visicu’s system set up a remote station where an intensivist could see data from each patient’s bedside monitor, as well as the view from a camera mounted on the wall in the patient’s room. The cameras were moveable and so high-resolution that the

doctor in the remote station could tell how dilated a patient’s pupils were. The station was also equipped with automatic alerts if a patient’s vitals dipped, as well as software that would walk doctors through possible responses.

There was a sharp learning curve for all involved. “It was very challenging bringing Big Brother to look over the shoulders of the people actually in the ICU,” Hanson recalled. As for him, “I didn’t really know how to practice medicine through a camera.”

Initially, the remote station covered two ICUs: the one in HUP, which Hanson ran, and the one at Pennsylvania Hospital. The staff at HUP knew Hanson, and they were already at that time “innovation oriented,” he says. At Pennsylvania Hospital, the transition was rougher. It wasn’t unusual, he

Though initially met with skepticism, the telemedicine-enabled ICU has grown to be adopted as a model nationally, Hanson says—one of computerized medicine’s “first real successes.”

remembers, to find lab coats hung over the cameras.

One night, a patient had to be intubated. As the procedure began, Hanson—watching through the camera—saw that the nurse anesthetist was having some trouble. If he’d been in the room, he would have automatically moved to help her, but he wasn’t in the room. Still, he thought, maybe he could make suggestions, the way he would if he were overseeing a resident.

Visicu had equipped the patients’ rooms with not just a camera, but also a speaker that would allow the remote doctor to talk directly with nurses. So Hanson turned on the microphone and made his suggestions.

He saw the nurse freeze, then look slowly around the room.

“It became apparent to me that she had no idea who I was, or where this voice was coming from,” he says. “This is a perfect metaphor for this new way of doing medical care.”

Slowly, though, it became clear that the extra eyes of the remote intensivist were keeping fragile patients safer. The tele-ICU grew from covering 35 beds to 70. Today, 270 beds at Penn are monitored by a remote intensivist—as part of Penn Connected Care, one of the largest telemedicine programs in the country—and nationwide, Hanson says, roughly 20 percent of ICU beds are monitored remotely.

The telemedicine-enabled ICU is “one of those things that’s initially met with skepticism and it’s grown into being adopted nationally,” he says—one of computerized medicine’s “first real successes.”



Captain of the Sea Change

If telemedicine was disruptive, it had nothing on the electronic health record, or EHR.

The EHR has become central to how doctors practice medicine today. In addition to digitizing a hospital's paper files, they also standardize doctors' case notes, the way Larry Weed had foreseen, and incorporate AI-assisted decision making, the way Ted Shortliffe's MYCIN did. A well-designed EHR can prevent physician error, save money, and improve outcomes; a poorly designed one can burn out doctors and kill patients.

The sea change began in 2010. That year, the federal government established a "meaningful use" incentive program: to be eligible, a hospital had to create an EHR that met government standards by 2014. At Penn, Hanson was tasked to lead the effort as chief medical information officer.

As CMIO, Hanson oversees all the data exchanged with other hospitals and insurance companies and uses that data as a springboard to create better care. He also manages Connected Care—from the tele-ICU to tele-behavioral health—and the development of mobile apps to help patients and doctors keep track of treatment.

But building Penn's EHR—what would eventually become PennChart—has been "job one," he says.

"I won't say it was a baptism by fire," he says. "But we had no predicate."

Across the country, hospitals and medical practices struggled to meet the government's EHR standards. The implementation of EHRs was necessary—medicine was far behind other industries in converting to digital records—but it was also expensive and onerous.

"It's taking a very complicated industry and replumbing it—while you're still operating it," Hanson says. "You can't just shut down the highway; you have to keep taking care of patients."

Not every hospital was able to recoup the cost quickly enough to keep from folding, Hanson says. "Some places were brought to their knees by the implementation of electronic records," he says. "Some places had nine-figure hits to their bottom line."

In 2005, Penn sociologist Ross Koppel, PhD, published a paper pointing out that bad EHRs could cause more problems than they solved. "I said, not that the emperor had no clothes, but that he was pretty friggin' threadbare," Koppel says.

Koppel studied Penn's system for inputting prescriptions. He identified 22 possible sources of user error that could be potentially deadly, writing: "As hospitals and clinicians implement these systems, they must consider the errors [EHRs] may cause, as well as the errors it may prevent."

Even an EHR that didn't create errors could simply annoy doctors—in some cases, causing them to retire rather than face the computer every day. "It's called 'death by a thou-

sand clicks,' Hanson says. Doctors complained that they spent more time satisfying the demands of the EHR than with their patients. "The sound of medicine is not the click of a mouse. It is the human voice," lamented one group of doctors in an op-ed.

Hanson's role as CMIO, he soon found, was similar to a factory foreman—a go-between. "They needed to have someone who on the one hand was interpreting what the IT community was saying to doctors, and on the other hand what doctors were saying to the IT community," he says.

It took four years just to get the EHR up and running; Hanson likens the process to "a snake ingesting a large meal." But now, Penn is concentrating on improving it. Last year, Penn launched an initiative to substantially redesign and enhance the EHR, with the goal of making it more intuitive and user-friendly, like Amazon, Facebook, or Netflix. Hanson's team is working with information services, the EHR transformation team, and the Penn Medicine Center for Health Care Innovation, including the Nudge Unit and the Center for Digital Health, to achieve this goal.

Hanson is looking further ahead. The EHR isn't just a useful clinical tool: like the operating-room devices he hacked years ago, it can yield up a treasury of big data. And with big data comes the possibility of effective AI.

"The number of things you can do with digitized data is proliferating every day, and it's really going to impact medicine writ broad in the coming decades," he says.

An experienced doctor might see hundreds or even thousands of patients with a particular condition over the course of their career. "But an AI can say, metaphorically speaking, 'I have seen a million patients,'" Hanson says. The pattern recognition powers of AI "may contribute to or disrupt entire medical specialties," he adds.

AI can also profile patients to help doctors anticipate their needs—in the same way Amazon analyzes someone's purchases and suggests new books, data from the EHR can allow AI to analyze a patient's history and suggest services they might need in the future. The predictive health care team at Penn Medicine under Hanson's purview for the last several years has already developed algorithms that aid in decreasing readmissions for at-risk heart failure patients and in proactively offering palliative care consultations for patients who are most critically ill.

Hanson is looking forward to seeing where else the technology takes medicine. Wherever that is, it will no doubt be as different from today as his father's pen and notecard.

"I would say the pace of change is intensifying," Hanson says. "We're nowhere near the end of it." ▢

► **Read this story online with related links at PennMedicine.org/magazine/techgeneration.**

Building a Foundation for Greatness: Donors Helping Power the Pavilion

The Pavilion, a leading-edge hospital that is Penn Medicine's vision for the future of patient-centered care, will soon be the newest addition to its world-class medical campus.



Every facet of the Pavilion will be able to adapt to—and lead in—developments in health care delivery. The entire building, down to the wires in the walls, has been designed for maximum flexibility and adaptability—as health care evolves, so, too, will the Pavilion.

As construction on the Pavilion continues, some thoughtful philanthropic partnerships are helping to make this architectural marvel a reality.

The **Dietz & Watson Bridge** will serve as a connector between the Pavilion and the Perelman Center for Advanced Medicine, seamlessly bridging inpatient and outpatient care. Elsewhere through the medical campus, the Dietz & Watson

Foundation is also supporting breast cancer research—fueling progress at the 2-PREVENT Translational Center of Excellence and novel imaging at the **Yetta Deitch Novotny Breast Imaging Center**.

Back at the Pavilion, the **Deena, Arthur, and David Ira Goldstein Family Consultation Room** will provide space for family members and caregivers to gather privately, or to meet with their loved one's care team.

More than just a named space on the Neurosurgery Unit, the **Brennan Family Foundation's** gift will support collaborative research to drive more personalized, effective therapies that address not just a patient's illness, but also their quality of life.

The Board of Women Visitors of the Hospital of the University of Pennsylvania has made a gift to name the



This May, crew members and supporters of Penn's Pavilion celebrated the traditional construction topping-off ceremony by signing the last beam before it was placed.



Pavilion's Emergency Department waiting area—a vitally important gateway and triaging location that will welcome thousands of patients every year to Penn Medicine.

The **Barbara J. and James K. Boese Communication Center** will be more than just a nurses' station. This critical access point, discerningly located to be close to patient rooms, will provide a spot for families to connect with staff.

"The Pavilion represents the very best of Penn Medicine: forward-thinking medical innovation paired with our Quaker spirit of providing the best care for all," says Kevin Mahoney, CEO of the University of Pennsylvania Health System. "It's going to change—and save—lives, and we couldn't be more grateful to our compassionate donors who are helping the Pavilion come together."

"The Pavilion at HUP will be a hospital for 21st century medicine—and beyond. Designed for change and unparalleled patient care, it will deliver comprehensive treatment with a personal touch."

— J. Larry Jameson, MD, PhD
Executive Vice President, University of Pennsylvania for the Health System
Dean, Perelman School of Medicine

THE GIFT THAT KEEPS ON GIVING

Every gift to Penn Medicine and its students makes a difference—especially when they inspire a chain reaction of generosity.

Paying it Forward: A Surgeon Gives Back



When scholarship donor Adil Esmail, MD'96, GME'02, arrived at Penn to enter medical school, it was his first experience away from home. As an undergraduate at UCLA, he had lived with his parents, who had emigrated from Tanzania when Esmail was 12. Fortunately, he remembers fondly, the school was a “highly welcoming” place where he found an encouraging community of colleagues and faculty.

“Everyone at Penn was so kind,” says Esmail, an orthopaedic surgeon who practices in Southern California, where he lives with his wife, two children, and a growing contingent of pets.

“We weren’t treated like students, we were treated like family,” he recalls about his alma mater where he spent ten years—four in medical school, five in an orthopaedic

surgery residency, and one in research on the rotator cuff. “Obviously, everyone was very high achieving, but I never felt a super competitive atmosphere—it was always really supportive.”

The close-knit network he found at Penn also included mentors, such as Marvin Steinberg, MD'58, a foremost expert on the hip who literally wrote the book: *The Hip and Its Disorders*, a seminal resource. Esmail also cites the influence of former Penn faculty member Pedro Beredjiklian, MD. “He was one of my teachers and played an integral role in my decision to become a hand surgeon,” he says.

For Esmail, support also came in the form of scholarship; he was one of Penn Medicine’s first “**Gamble Scholars**,” a recipient of a tuition-free medical education through the 21st Century Scholars Program created by **Anne and Walter Gamble, MD'57**. Like many Gamble Scholars, he became friendly with the generous and unassuming couple, who even attended his wedding.

“Having been so fortunate to receive the scholarship, I always felt the need to represent the honor well,” says Esmail, who believes it helped push him to succeed and earn membership into the Alpha Omega Alpha Honor Medical Society, one of medicine’s most elite distinctions.

“**I saw the scholarship as a loan, not a gift,**” says Esmail, who, in turn, has made a point of giving back to the school, through regular contributions to his Medical Class Scholarship Fund and the Gamble Scholarship Fund. He has also made arrangements in his estate for Penn Medicine, and helped organize his 20th Class Reunion.

The support that Esmail found at Penn, which he calls “one of the best schools anywhere,” made a profound impact on his journey in medicine—an experience he’s glad to help pass on to the next generation.



GivingPages: Crowdfunding Support for the Penn Medicine Causes You Care About



"I feel I am still here to tell the story others may not live to share," says Katherine Miller. "Although my future with this condition is uncertain, I have resolved to bring this issue to as many people's attention as possible."

If there is a particular person or project at Penn Medicine you would like to bolster support for, Penn GivingPages are an easy way to raise impactful research funds—making a real difference for a cause that's important to you.

Located at givingpages.upenn.edu, GivingPages are an online social fundraising tool that lets you describe your cause, demonstrate your goal in easy-to-view graphics, add video, and e-mail your contacts. They are a quick, accessible, and powerful way to further research and care efforts at Penn Medicine while also telling your story—or the story of someone you love.

One patient using GivingPages to tell her story and make an impact is Katherine Miller, who has inspired friends and family to raise more than \$55,000.

At 23, Miller experienced a life-threatening heart rhythm caused by arrhythmogenic right ventricular cardiomyopathy (ARVC). ARVC is

often responsible for sudden cardiac events that take the lives of otherwise active, healthy young people. Francis E. Marchlinski, MD, the Richard T. and Angela Clark President's Distinguished Professor of Cardiology at Penn Medicine, was the one who discovered Miller's ARVC.

Miller, grateful for the care she received at Penn Medicine, used Penn's GivingPages to set a fundraising goal to help Marchlinski and the cardiac electrophysiology team detect ARVC earlier and improve outcomes. (See and contribute to it here: givingpages.upenn.edu/keepthebeat)

Another grateful patient who raised more than \$25,000 through GivingPages is Jonathan Peterson—who, after being diagnosed with stage III head and neck cancer, was successfully treated by Bert W. O'Malley Jr., MD, the Gabriel Tucker Professor and Chair of Otorhinolaryngology: Head and Neck Surgery. To show his gratitude—and to celebrate his 55th birthday—Peterson set up a GivingPage to raise funds for innovative research in head and neck cancer at Penn.

▶ Visit givingpages.upenn.edu to tell your story today.



"I feel incredibly blessed," says Jonathan Peterson. "Blessed by the love of my family and friends and blessed by the resources of a world-class cancer research and care facility like the Abramson Cancer Center, leaders in the research and development of groundbreaking drugs and new therapies and protocols."

Amit Bar-Or, MD, FRCPC, director of the Center for Neuroinflammation and Experimental Therapeutics, chief of Multiple Sclerosis, and the Melissa and Paul Anderson President's Distinguished Professor; **Nina Luning Prak**, MD'96, PhD'96, GME'99, an associate professor of Pathology and Laboratory Medicine; and **Aimee S. Payne**, MD, PhD, the Albert M. Kligman Associate Professor of Dermatology, were awarded a \$4.5 million grant from the National Institute of Allergy and Infectious Diseases. This grant provides five years of support to a new Autoimmunity Center of Excellence, which will research B cells as drivers of life-threatening autoimmune diseases.

Daniel Dempsey, MD, MBA, FACS, chief of Gastrointestinal Surgery, assistant director of Perioperative Services for HUP, and a professor of Surgery, received the Philadelphia County Medical Society's Strittmatter Award—its highest honor. The award is given to a PCMS physician who has made “valuable contributions to the healing arts.”

Gabor Egervari, MD, PhD, a postdoctoral fellow in Cell and Development Biology, has received funding from the Brody Family Medical Trust Fund fellowship for medical research in incurable diseases, given by the Philadelphia Foundation. The fellowship will fund two years of his molecular-level research on alcohol-related gene activity, brain changes, and learning.

Susan S. Ellenberg, PhD, director of the Biostatistics and Data Science Core for the Penn Center for AIDS and a research professor of Biostatistics and Medical Ethics & Health Policy, received the Florence N. David Award from the Committee of Presidents of Statistical Societies. This annual award is given to a female statistician whose contributions and collaborative leadership establish her as a role model for others in the field.

Raquel Gur, MD'80, PhD, director of the Lifespan Brain Institute, co-director of the Translational Neuroscience Center, vice

chair of Research Development, the Karl and Linda Rickels Professor of Psychiatry, and a professor of Radiology; and **Ruben Gur**, PhD, director of the Brain Behavior Laboratory and a professor of Psychiatry, Radiology, and Neurology, were named Outstanding Translational Research Awardees by the Schizophrenia International Research Society. This recognition honors their efforts to revolutionize the approach to emotion and social cognition in health and disease.



Maayan Levy, PhD, an assistant professor of Microbiology, was one of 15 young faculty members to receive \$300,000 in flexible funding from the Searle Scholars Program to support her work for three years. Levy's lab is focused on understanding how intestinal epithelial cells serve as communicators between the gut microbiome and host immunity.

X. Sherry Liu, PhD, an associate professor of Orthopaedic Surgery and Bioengineering and director of the Micro-CT Imaging Core in the McKay Orthopaedic Research Lab, received the Kappa Delta Young Investigator Award from the American Academy of Orthopaedic Surgeons. The award is presented to researchers who have developed “outstanding manuscripts that focus on basic and/or clinical research related to the musculoskeletal system.”

Katherine L. Nathanson, MD'93, deputy director of the Abramson Cancer Center and director of Genetics at the Basser Center for BRCA, has been named the inaugural chair holder of the endowed Pearl Basser Professorship for BRCA-Related Research. In this

role—created with a gift from longtime supporters Shari Basser Potter and Len Potter—Nathanson will strengthen the research efforts of the Basser Center and accelerate new discoveries.



Amol Navathe, MD'10, PhD'08, co-director of the Healthcare Transformation Institute, associate director of the Center for Health Incentives and Behavioral Economics, and an assistant professor of Medical Ethics and Health Policy, has been appointed to the Medicare Payment Advisory Committee by the U.S. Government Accountability Office to analyze access to Medicare and the quality of services.

Ravi Parikh, MD, a fellow in Hematology-Oncology, received the Harry F. Biesel, MD, Endowed Young Investigator Award from the Conquer Cancer Foundation and the American Society of Clinical Oncology to support his research into checkpoint inhibitor therapy.

Trevor Penning, PhD, the Thelma Brown and Henry Charles Molinoff Professor of Pharmacology, a professor of Biochemistry & Biophysics and Obstetrics & Gynecology, and founding director of the Center of Excellence in Environmental Toxicology, was honored with the 2019 Founders' Award by the American Chemical Society's Division of Chemical Toxicology. He was recognized for providing outstanding and sustained service to the society and for his extensive research in the areas of chemical toxicology and environmental science.

Daniel J. Rader, MD, associate director of the Institute for Translational Medicine and

Therapeutics, director of the Preventive Cardiovascular Program, chief of Translational Medicine and Human Genetics, the Seymour Gray Professor of Molecular Medicine, and a professor of Pharmacology, Pediatrics, and Medicine in Genetics, has been named a member of American Academy of Arts and Sciences in honor of his contributions to genetic research related to heart disease prevention.

Li Shen, PhD, a professor of Informatics, was named to the College of Fellows of the American Institute for Medical and Biological Engineering in recognition of his work in developing “bioinformatics strategies for multidimensional brain imaging genomics.”

Robert H. Vonderheide, MD, DPhil, director of the Abramson Cancer Center and the John H. Glick Abramson Cancer Center Professor, earned a Stand Up to Cancer grant. The two-year grant provides \$225,000 to fund his team's research, which combines immunobiology and computational biology to analyze three datasets: short- and long-term pancreatic cancer survivors, primary resected pancreatic cancers, and mKRAS lung and colon cancers.



Kirk Wangenstein, MD, PhD, an assistant professor of Gastroenterology and Genetics, was one of 10 researchers to receive the 2019 Beckman Young Investigator Award from the Arnold and Mabel Beckman Foundation. This award, which comes with a \$600,000 grant, fosters the invention of techniques and materials in the chemical and life sciences. Wangenstein is developing genetic methods to uncover new targets and treatments for MYC-driven liver cancer.

Send your progress notes and photos to:
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Penn Medicine Development
and Alumni Relations
3535 Market Street, Suite 750
Philadelphia, PA 19104-3309
medalum@dev.upenn.edu

1960s

Stephen D. Silberstein, MD'67 has been appointed editor in chief of NeurologyLive, a multimedia platform that provides direct access to practice-changing news and insights in neurology.

1970s

Nolan H. Sigal, MD'77, PhD has joined the board of directors of Aileron Therapeutics, a biopharmaceutical company developing tumor-preventing and suppressing treatments.

Kathy L. Lampl, MD'79 has been appointed vice president of clinical development at LifeMax Laboratories, Inc., a company focused on treating rare diseases with limited therapeutic options.

Kevin H. Mosser, MD'79 has joined SE Healthcare as a senior medical consultant. He most recently served as president and CEO of WellSpan Health in south-central Pennsylvania.

1980s

Alan T. Wright, MD'82 has been appointed to the scientific advisory board of IDbyDNA, a metagenomics tech company. He is the chief medical officer at Roche Diagnostics.

1990s

Gary M. Phillips, MD'92 has been appointed to the board of directors of Zyla Life Sciences. He currently serves as president and CEO of OrphoMed, a biopharmaceutical company focused on gastrointestinal diseases.

Michael DeCastro Cabana, MD'93 has been appointed physician-in-chief at Children's Hospital at the Montefiore Health System, and university chair of Pediatrics at Montefiore and Albert Einstein College of Medicine.

Alan J. Jacobs, MD'95, PhD has been appointed chief medical officer and president of Hemostemix Inc., a biotech company that develops and commercializes blood derived therapeutics.

Tracey E. Cohen, MD'96 has been named the new chief clinical officer at CleanSlate Outpatient Addiction Medicine, which provides treatment for the chronic disease of addiction.

Lawrence M. Rhein, MD'96 has been appointed chairman of Pediatrics at UMass Memorial, the largest medical provider in Central Massachusetts.

Adam G. Arnofsky, MD'98 has been appointed chief of Cardiothoracic Surgery at Englewood Health. He has been director of the hospital's Cardiac Surgery Services since 2009.

2000s

John Leaman, MD'01 has been appointed chief financial officer of Impel NeuroPharma, a biopharmaceutical company that develops products for central nervous system disorders.

George Lin, MD'03, PhD has been appointed director of Dermatopathology and vice-chair of Anatomic Pathology at Albany Medical College.

Gabor Vari, MD'04 has been appointed to the board of directors of Cancer Support Community Los Angeles, a nonprofit cancer support network. He is currently CEO of California Medical Evaluators.

Adam S. Crystal, MD'06, PhD has been appointed chief medical officer at C4 Therapeutics, a developer of therapies that target disease-relevant proteins to stop the spread of disease.

Joneigh Khaldun, MD'06 has been appointed chief medical executive and chief deputy director for health at the Michigan State Department of Health and Human Services.

2010s

Robert Iannone, MD, MSCE, GME'12 has been appointed executive vice president of research and development at Jazz Pharmaceuticals, a biopharmaceutical company and a leader in sleep medicine and oncology research.

OBITUARIES

1940s

Philip P. Thompson, MD'41, a physician; June 19. He began his medical career at the University of Pennsylvania School of Medicine, then completed his residency at Massachusetts General Hospital. He was a medical officer in the U.S. Army, earning both a Bronze Star and a medical infantry badge. Thompson practiced internal medicine and rheumatology at Maine Medical Center for 48 years and self-published a number of books.

Volmar A. Mereschak, MD'45, an obstetrician and gynecologist; March 11. After graduating from the University of Pennsylvania School of Medicine, he continued his training at Grace-New Haven Community Hospital, Kings County Hospital, and Lincoln Hospital. Mereschak served in the U.S. Navy in the South Pacific. He was chief of Obstetrics & Gynecology at Warren Hospital for 34 years, then opened a private practice.

Winfield T. Moyer, MD'47, a pediatrician; April 5. After graduating from the University of Pennsylvania School of Medicine, he continued his medical training at Hartford Hospital. Moyer was a pediatrician for 38 years and served as president of the Manchester Memorial Hospital staff for two years. He also volunteered at his local community wellness center and served on boards at the Lutz Museum and Early Childhood Center.

Frank B. Johnston, BA'39, GME'49, an internist; March 21. He attended both the University of Pennsylvania and Thomas Jefferson University Medical School. He served as a captain (surgeon) in World War II and was stationed in the Pacific. Johnston, who celebrated 101 years, enjoyed a long private practice in medicine.



Samuel A. Youngman, Jr., MD'49, an aerospace medicine specialist; April 4. After graduating from the University of Pennsylvania School of Medicine and establishing his practice, Youngman led a successful career in the U.S. Navy. He was a flight surgeon, was named senior medical officer on the USS Wasp, cared for the Gemini IV astronauts, and held positions in Hawaii, California, the Philippines, Korea, and Saudi Arabia. He later obtained his master's degree in public health and completed a residency in Aerospace Medicine. He also conducted research in Antarctica, where a mountain is now named after him.

1950s

Joseph A. Libbon, Jr., MD'50, a psychiatrist; April 2. He served at a military hospital during World War II, then received his medical degree at the University of Pennsylvania School of Medicine. In 1980, he was named clinical director of a community mental health center at St. Mary's Hospital. Libbon held academic appointments at Tufts University School of Medicine, Boston University School of Medicine, and Albany Medical School.

Victor Birch Rambo, MD'52, GME'58, a physician; March 18.

He graduated from Kodaikanal International School in India, then served in the U.S. Navy. After attending the University of Pennsylvania School of Medicine and completing his surgical training, he practiced in North Carolina. From 1964 to 1992, Rambo and his family served as missionaries in central Africa.

John C. Carson, MD'54, a physician; April 17. After working as a laboratory tech in the U.S. Army, he attended Yale University and the University of Pennsylvania School of Medicine. Carson completed his internship, residency, and fellowship at the Hospital of the University of Pennsylvania (HUP). He practiced cardiology at Scripps Memorial Hospital La Jolla for more than 50 years and served a 48-year tenure as a physician at Lake Mohonk Mountain House.

William C. Gilkey, MD'54, an obstetrician and gynecologist; April 26. He graduated from Westminster College after serving in the U.S. Navy. He attended the University of Pennsylvania School of Medicine, then completed his internship and residency at Henry Ford Hospital. Gilkey worked as an OB/GYN for 40 years and served as president of the Lenawee County Medical Society and the Adrian Board of Education.

William T. Goulburn, MD'54, GM'67, an orthopedic surgeon; March 19. After attending the University of Pennsylvania School of Medicine, he completed his residency at Hartford Hospital and practiced as a general practitioner and obstetrician for eight years. In 1966, Goulburn completed a residency in Orthopedic Surgery at Graduate Hospital, then worked as an orthopedic surgeon for many years in New Jersey.

Gerald K. Schoenfeld, MD'54, an anesthesiologist; March 5. He graduated from Cornell University and received his medical degree from the University of Pennsylvania School of Medicine. After serving in the U.S. Navy as an officer stationed in Japan, Schoenfeld became a professor of anesthesiology at the University of Oklahoma-Tulsa.

Richard G. Lathrop, MD'55, a dermatologist; May 9. He obtained his medical degree from the University of Pennsylvania School of Medicine, then served two years with the U.S. Army Medical Corps. Lathrop completed his residency at the Skin and Cancer Hospital and started his practice in 1962, never missing a day of work in 40 years.



Harold E. Paulus, MD'55, professor emeritus, UCLA; April 5. He earned his medical degree at the University of Pennsylvania School of Medicine, then served in the U.S. Army Medical Corps. He completed his residency and two fellowships at the Wadsworth Hospital Veterans Administration Center in Los Angeles, UCLA Medical Center, and Cedars-Sinai Medical Center. He led a long career in medicine at UCLA Medical Center and earned numerous honors and professional society memberships.

Brooks W. Gilmore, MD'56, a physician; April 5. After attending the University of Pennsylvania School of Medicine and completing his residency at Pennsylvania Hospital, he joined the U.S. Army Medical Corps. Gilmore later returned to Greensboro, where he practiced for more than 50 years. He was named chief of Medicine and president of the medical board at Wesley Long Hospital, and served as an associate clinical professor of Medicine at the University of North Carolina School of Medicine.

Richard A. Blasband, MD'57, a psychiatrist; March 23. He received his medical training at the University of Pennsylvania School of Medicine and Yale Medical School, where he served as chief psychiatric resident. Blasband

practiced bio-psychotherapy for 50 years and served as the president of the American College of Orgonomy. He later established his healing practice—the Center of Functional Research—which he continued until his death.

Clarence M. Gilbert, Jr., C'53, MD'57, a cardiologist; April 17. He attended the University of Pennsylvania for his undergraduate studies, continued his education in the School of Medicine, and completed his medical training at HUP. He served as a captain and staff physician at the Orlando Air Force Base Hospital. Gilbert practiced privately until 1993, and he held an abundance of medical staff, academic, and boards appointments.

Dick Janeway, MD'58, president emeritus, Wake Forest University Health Sciences; March 17. He attended the University of Pennsylvania School of Medicine, then served as a flight surgeon and captain in the U.S. Air Force. In 1966, Janeway joined the faculty of Wake Forest School of Medicine, where he served in roles such as a professor of Neurology, acting chairman of Neurology, dean, vice president for health affairs, and executive vice president for health affairs. He also received the university's highest honor, the Medallion of Merit.

Gilbert Seigworth, MD'58, an obstetrician and gynecologist; April 23. After attending the University of Pennsylvania School of Medicine and completing his medical training, he served in the U.S. Air Force. Seigworth was later named president of the Medical Society for Ideal Hospital, taught at Binghamton University, and wrote several scholarly articles. He and his wife also curated and donated a substantial collection of medical artifacts.

Russell D. Snyder, Jr., MD'58, a pediatric neurologist; May 22. After graduating from the University of Pennsylvania Medical School, he continued his training at Bryn Mawr Hospital and the University of Colorado. He spent two years in the U.S. Army, then accepted a job at the University of New Mexico Medical School. Snyder was also an examiner for the American Board of Psychiatry and Neu-

rology and received a Lifetime Achievement Award from the Child Neurology Society.

John F. Gehret, MD'59, an obstetrician and gynecologist; March 14. He attended Williams College and the University of Pennsylvania School of Medicine. Following his residency at Penn, he began a practice in Wilmington with his father. Gehret practiced from 1963 to 1999, with a brief interruption in 1966 when he was drafted into the U.S. Air Force.

Ralph W. Hamilton, MD'59, a plastic surgeon; April 23. He graduated with honors from the University of Pennsylvania School of Medicine and was later named associate chief of Plastic Surgery at Penn in 1980. He practiced at HUP, Penn Presbyterian Medical Center, and Children's Hospital of Philadelphia (CHOP) until 1996.

Grant Morrow III, MD'59, a pediatrician; May 18. He graduated from the University of Pennsylvania School of Medicine with the Pediatric Prize and completed his training at the University of Colorado Denver General Hospital and CHOP. Morrow worked at HUP and CHOP for 18 years, and at Columbus Children's Hospital for 15 years. He also served in roles at the University of Arizona and Ohio State University College of Medicine.

Morton J. Robinson, BA'53, GME'59, pathology and laboratory medicine; May 21. After earning his medical degree at Jefferson Medical College, he earned a Certificate of Pathology from the University of Pennsylvania. Robinson served as a captain in the U.S. Air Force, then practiced at Mount Sinai Medical Center for nearly 50 years, where he was named chair and director of Pathology and Laboratory Medicine.

1960s

Carl B. Weston, MD'60, a medical director, Agrace Hospice Care; March 20. He graduated from the University of Pennsylvania School of Medicine and completed his residency in Chicago before re-

turning to Wisconsin to practice alongside his father. Over six decades, Weston served in internal medicine and administrative medicine roles in the Jackson Clinic, Meriter Hospital, the University of Wisconsin Medical School, and Agrace Hospice Care.

Jay Jenkins, MD'61, a hematologist; May 19. He attended the University of Pennsylvania School of Medicine, then completed his internship, residency, and fellowship at the University of Pittsburgh Hospital. He served as a captain in the U.S. Air Force, then served on the staff at St. Vincent Hospital, the VA Hospital of Erie, and Hamot Hospital. Morrow co-founded the Regional Cancer Center, where he treated patients for over 20 years.

James P. Tracey, MD'63, a gastroenterologist; March 12. After earning his degree at the University of Pennsylvania School of Medicine, he served in the U.S. Army Medical Corps for three years in Vietnam. After discharge, Tracey returned to Connecticut to establish his affiliation with Norwalk Hospital. He practiced for over 35 years, served as an associate editor for the American Journal of Gastroenterology, and taught at Yale University School of Medicine.

Louis S. Zeiger, MD'67, a nuclear medicine physician; Sept. 14, 2017. He worked as a physicist at the GE Space Science Laboratory before pursuing medicine at the University of Pennsylvania School of Medicine. He made great strides in Nuclear Medicine, an emerging specialty at the time, and served as division chair for Nuclear Medicine at Cooper University Hospital for nearly 30 years.

William W. Resinger, MD'69, a radiologist; May 21. After graduating from the University of Pennsylvania School of Medicine, he spent six years working in his hometown's emergency department. After serving in the U.S. Army National Guard, Resinger relocated to complete his residency at the University of Michigan. He then moved again to Alaska, where he led a nearly 20-year career at Palmer Valley Hospital.

1970s

Stephen M. Sachs, MD'71, a physician; April 16. He was a graduate of Columbia College and the University of Pennsylvania School of Medicine. He was a U.S. Navy veteran and a patriot. Sachs was a partner and physician with Neurological Associates, as well as a passionate supporter of the arts.

1990s



Hester Choi, MD'94, a gastroenterologist; May 2019. She graduated from the University of Pennsylvania School of Medicine and conducted gene therapy research in the lab of James Wilson, MD, PhD. Choi practiced for nearly a decade, focusing on inflammatory bowel disease. In 2018, she enrolled in a master's program in clinical research and planned to obtain her PhD in cancer genomics.

FACULTY

Denis S. Drummond, MD, FRSC, professor emeritus at the University of Pennsylvania School of Medicine; June 18. As a professor and head of Pediatric Orthopedics at the University of Wisconsin School of Medicine and Public Health, Drummond co-invented the Wisconsin compression system to correct scoliosis. He was later named chief of Orthopedics at CHOP and a professor of Orthopedic Surgery at the University of Pennsylvania School of Medicine. He served as president of the Pediatric Orthopedic Society of North America and the Scoliosis Research Society—later receiving the society's Lifetime Achievement Award.

Ralph W. Hamilton, MD. See Class of 1959.

Helping Patients Achieve Their Own Cancer Victories

After beating cancer twice with the help of Penn Medicine surgeons, **Joseph Patrick Rees, G'89**, a veteran of the United States Army, wasn't worried when a lymph node sample tested positive. "I know some statistics, and I'm thinking, one lymph node out of 32 is a pretty good result," he recalls. Rees was referred to David Mintzer, MD, a hematologist and medical oncologist at Penn, for a consultation.



Mintzer was adamant that Rees take the news seriously, so he began chemotherapy treatment over a six-month period. "There's one thing he said to me that I'll always remember: 'You don't work for me. I work for you.' And he proved that to me at every turn," Rees says.

After he was given a clean bill of health, Rees began reflecting on the "first class, leading-edge care" he received and how others may not be as financially fortunate as himself. In 2017, he worked with the Office of Planned Giving to establish the Dr. David Mintzer Patient Comfort Fund at the Abramson Cancer Center of the University of Pennsylvania with an outright gift and a bequest in his will. This fund helps patients financially while they're going through therapies. "I thought about those who don't have the money to cover their treatment, who have special needs, who need rides to and from appointments—I want to make sure people aren't struggling during this stressful time," he says.

By establishing the fund now, Rees has the opportunity to make contributions during his lifetime and experience the joy of seeing his gifts in action. In addition, a future gift will come from his estate. Rees has chosen to make current gifts by utilizing the Charitable IRA Rollover ("Rollover"). The Rollover allows donors who are 70 ½ years or older to support their charity of choice by directly rolling over up to \$100,000 from a traditional IRA account. The Rollover can be applied to your annual Required Minimum Distribution, and the gift is 100 percent tax-free.

"Establishing this fund through gifts now, in addition to my estate, is a way for me to help current and future patients benefit from the same medical attention I received, while also honoring Dr. Mintzer for his exceptional care today," he says.

Planned giving is often described as the final piece of a philanthropic puzzle. Figuring out how this important piece can work best for you, your family, and your philanthropic goals is what we do best. If you are a donor who wants to give through a retirement plan (IRA, 401(k), 403(b), etc.) or through the Charitable IRA Rollover, please contact Christine S. Ewan, JD, Senior Executive Director of Development, at 215-898-9486 or at cewan@upenn.edu.

► For more information, please visit our website at: www.pennmedicine.org/plannedgiving.

RoboDoc

By Julie Wood

Illustration by Graham Perry



What happens when physicians get 3-D vision inside a patient's body while they're performing a procedure?

Brian Park, MD, retrieves a CT scan of a torso on his computer monitor. He moves away from the screen and carefully puts on a headset with lightly tinted lenses aligning with his eyes. Turning to look into his office space through the lens of the headset, he lifts his hand in front of him to make a simple pinching motion. On the screen, the torso rotates. But from Park's point of view through the headset, he is interacting with a floating 3-D CT scan in the room in front of him. This is not just a new way of looking

at medical images; Park is demonstrating a method that is being used and refined in Penn Medicine procedures, one that could change the future of how surgery is practiced. The headset, Microsoft HoloLens, is a wireless portable device designed to use “mixed reality” for learning and collaborating on projects in business settings. Park, an Interventional Radiology fellow at the Hospital of the University of Pennsylvania who has a background in engineering and contributed to the design of the Microsoft Xbox 360 processor, has combined his skills to program new uses for HoloLens in medicine.

Mixed reality projects virtual 3-D models that appear to coexist within a person’s own physical space in real time. Unlike virtual reality, which immerses the viewer in a completely artificial and simulated world, or augmented reality, which simply overlays 2-D images in one’s field of vision, mixed reality offers a fusion of both forms of visual technology. At Penn Medicine, the 3-D models have consisted of virtually constructed bones, organs, and tumors taken from patients’ scans for medical procedures.

Using HoloLens, physicians can manipulate and respond to these models within their virtual workspace as they perform a procedure. “You don’t have to be straining your neck or looking across the room for data,” Park says. Rather than disrupting the course of the procedure to check scans of a patient’s body or examine the progress of a needle being inserted on a screen located away from the patient, the physician can now view this imaging through their headset. “Using HoloLens, you could essentially watch your hands and the patient while you’re looking at the imaging at the same time,” Park explains. “The images are inside of the patient and in 3-D. We can physically see what’s happening at the surface of the patient, but now we can virtually see inside of them, too, right in front of us.”

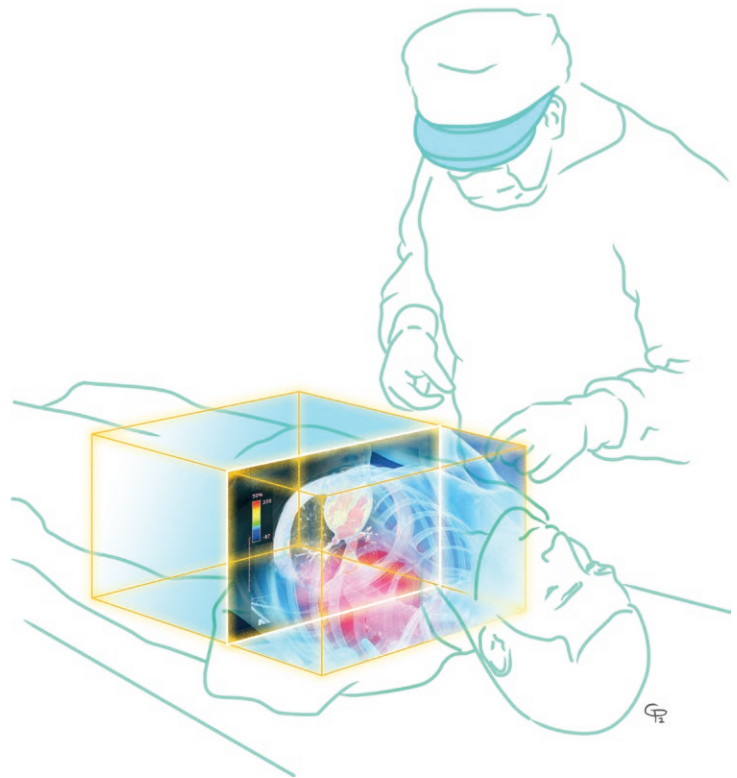
Over the last year at Penn Medicine, HoloLens has been primarily used in ablations performed by Stephen Hunt, MD, PhD, an assistant professor of Radiology—he has used it in several of these procedures to guide the placement of his instruments into the right location to destroy tumors. Penn neurosurgeons have also collaborated to use the device during spinal fixation surgery to direct screw placements into the spine, led by Isaac Chen, MD, an assistant professor of Neurosurgery, and Vivek Buch, MD, a Neurosurgery resident.

Park adds that HoloLens also makes CT-guided procedures more efficient. Rather than conducting multiple small needle adjustments and confirming each adjustment with scans—which also expose the patient to small doses of radiation each time—physicians using HoloLens can see in the

3-D anatomical projection where the needle needs to go and how much it needs to be adjusted to get to the right place. “We sometimes adjust the needle a little too much or not quite enough,” Park explains. “HoloLens can help us adjust the needle just the right amount.”

HoloLens also helps physicians trace the exact line and angle of approach they have drawn on a scan in advance of a procedure for virtual guidance. “You can just use the virtual line as a guide and follow it with your needle,” Park says.

“Visually, it makes physicians more confident with doing the procedures,” Park says. Other hospitals have used HoloLens



simply for practice or preparation prior to a surgery, Park explains, but Penn’s hospitals actually use it during the procedure itself.

HoloLens does have limitations, including limited battery life, making it insufficient for any prolonged operations; however, Penn physicians have typically only used the device for a short period of time during procedures.

The medical applications of HoloLens are also still early in development, but Park says his colleagues are excited about its potential. “It’s not quite there yet,” he says. “But we’re going in the right direction.” □

LEARNING BY ANALOGY

At the Penn Medicine Center for Health Care Innovation, new ideas sometimes come from looking at what other industries do well. They've taken that principle and codified it into a game that helps spark inspiration for anyone trying to transform health care.

▶ Read more about Penn Medicine's Accelerators card game inside on page 2 and online at PennMedicine.org/magazine

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