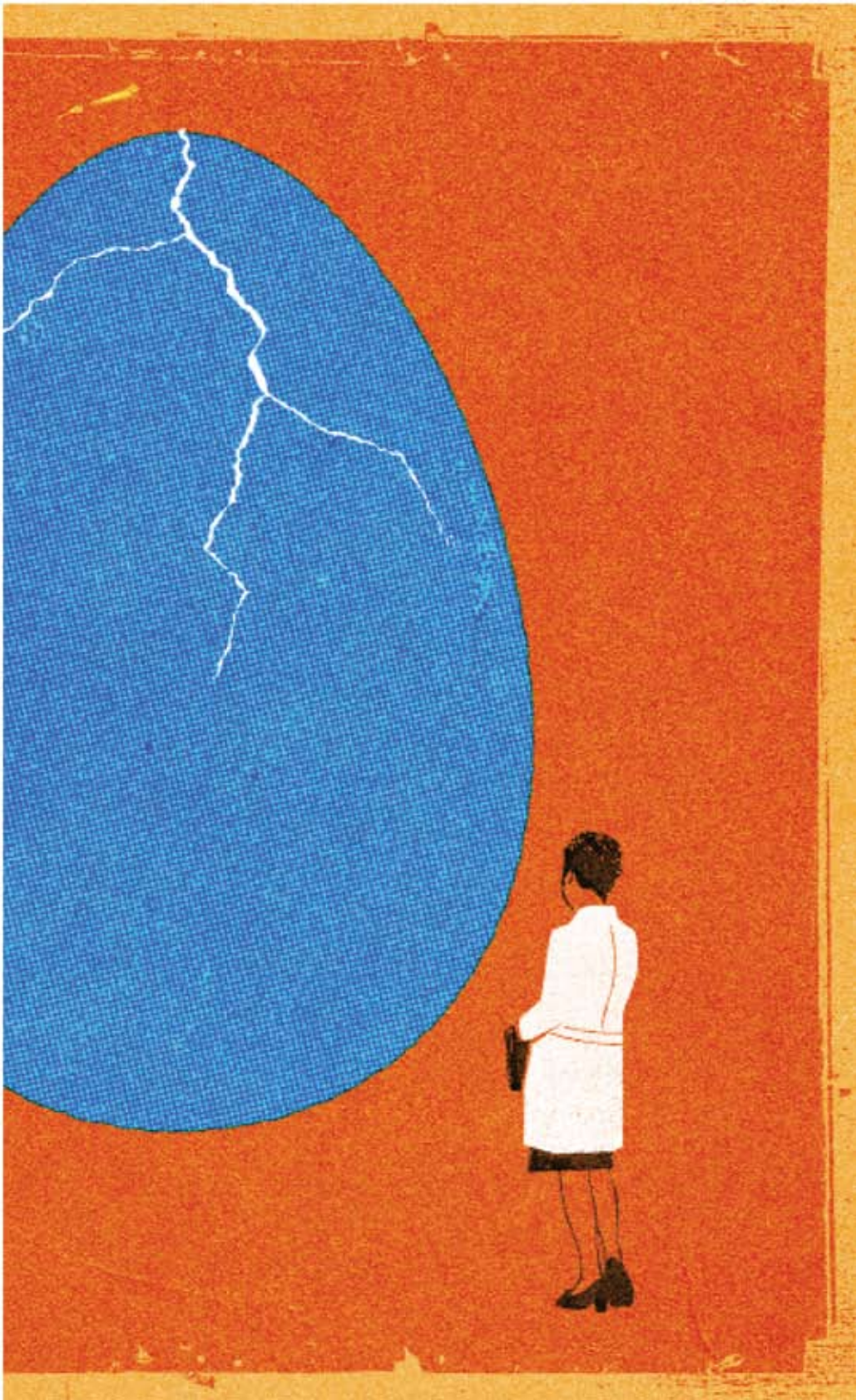
S T A N F O R D M E D I C I N E

Summer 2010



special report

THE TEACHING HOSPITAL

LEADING MEDICINE'S METAMORPHOSIS?

The healing touch

Putting physical back in the physical exam

Green hospitals

Healing meets conservation

Taking the tube

Lab samples latch on to mass transit

No holes barred

Surgery leaves fewer traces

On the record

The U.S. health information czar says: 'Most patients get it.'

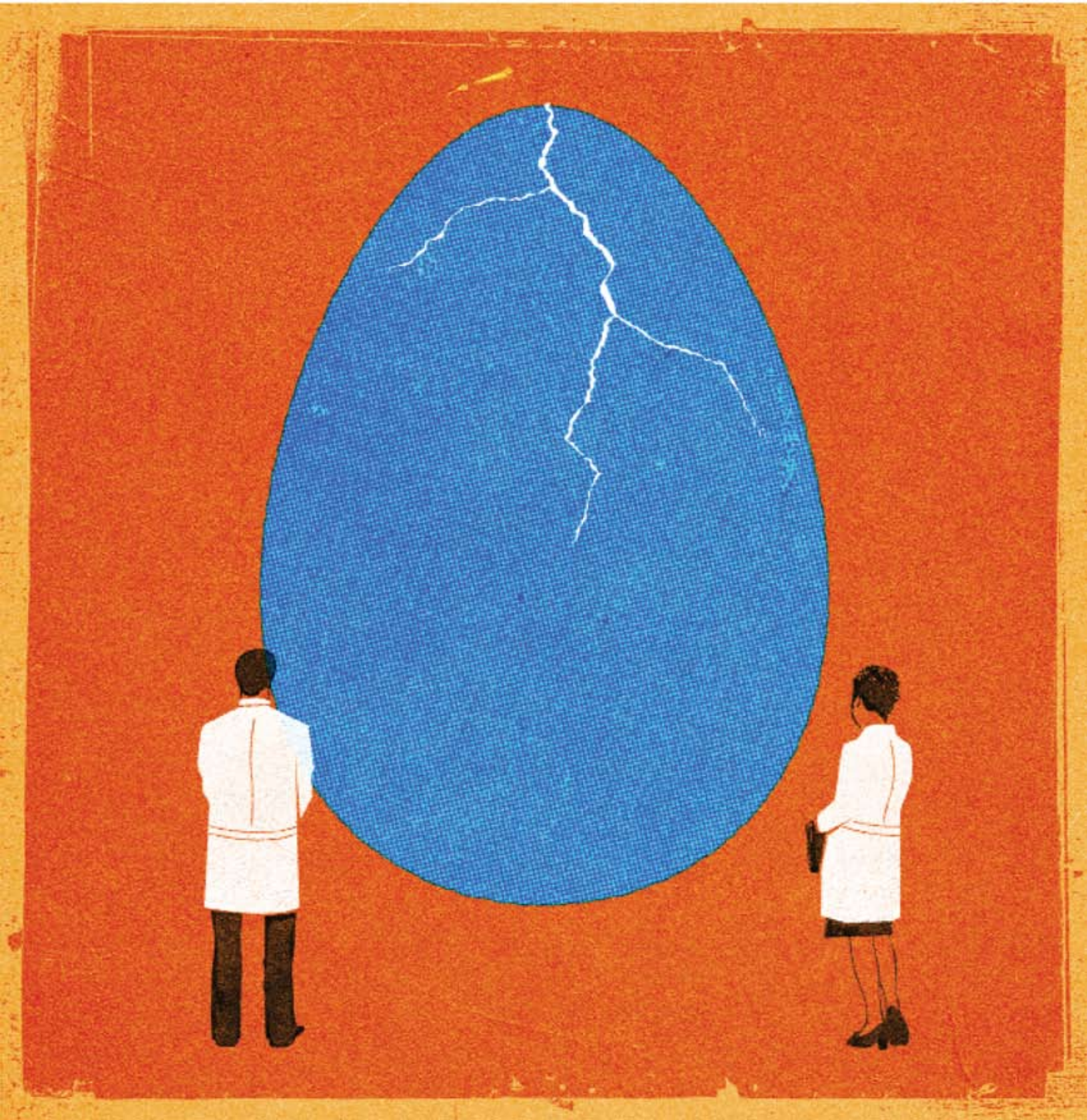
A report from Haiti

One hospital's triumph over tragedy

S T A N F O R D

M E D I C I N E

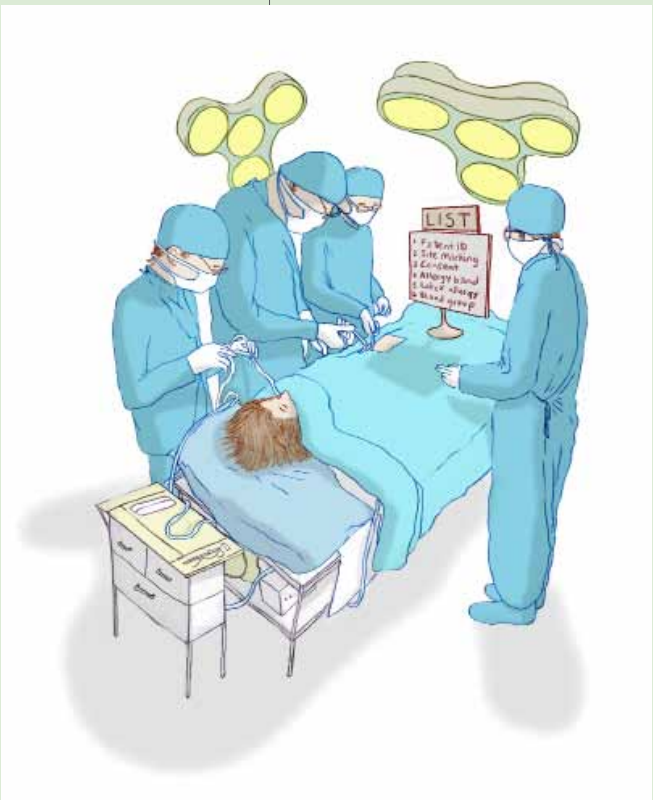
Summer 2010



check please

USING LISTS TO AVOID MEDICAL MISTAKES

On Oct. 30, 1935, the U.S. Air Corps' chief test pilot was at the controls of a prototype of the B-17 bomber, the Flying Fortress. He took off, climbed to 300 feet, then stalled and crashed. The pilot and another man died, and others were seriously injured. • What caused the crash? An oversight. Just one skipped step in the long series of take-off procedures: No one had unlocked the newly installed "gust lock," which kept the craft's movable control flaps in place while it was parked. Pre-flight checklists became the rule. • Today pilots still use checklists. Construction managers for skyscrapers use them too. And now surgeons are beginning to use them to improve patient safety. Checklists may be foreign to the culture of most operating rooms around the world, but that's changing. • It's hard to argue with the logic of checklists. The World Health Organization launched an international push for surgical safety checklists in 2007 and published results of a study trumpeting their value last year. The study of eight hospitals in developed and developing countries, published in the *New England Journal of Medicine*, found that checklists reduced surgical complications by more than one-third.



As a result of the WHO campaign, led by Stanford University alum Atul Gawande, MD, more than 3,400 hospitals and health-care facilities in 120 countries have either pledged to try the checklist or are using it regularly. In the United States, Medicare's decision to stop reimbursing hospitals for preventable errors has stoked interest throughout the country.

Last year, Stanford Hospital became one of the first U.S. hospitals to make a full commitment to the pre-surgery checklist; this year, the hospital extended that requirement to all invasive procedures. Government officials in Canada, the United Kingdom and 19 other countries are also moving toward countrywide checklist use. *The Checklist Manifesto*, a book extolling the use of checklists in medicine, written by Gawande, is a best-seller.

For surgical teams, going through a safety checklist means that before the first incision, the team's members will introduce themselves and confirm the patient's identity, corroborate the procedure's type and location, and check that the patient has received pre-surgical antibiotics to reduce the risk of infection. The team will make sure it has all the equipment it requires — a transplant surgery can involve 400 items — and talk about any special needs for anesthesia or blood. Before taking the patient to recovery, the team will review the procedure and make note of any issues that might cause later problems.

Before the checklist became mandatory at Stanford, some physicians were already using one, says Stanford Hospital's chief of staff Bryan Bohman, MD. "But there were physicians who were very recalcitrant at first. Maybe they'd never had a wrong-site surgery, or thought that it was fine for hospitals in less developed countries but unnecessary here, or dismissed the whole thing because it seems silly to introduce yourself to someone you've worked with for years," he says. "But we're seeing more enthusiasm over time."

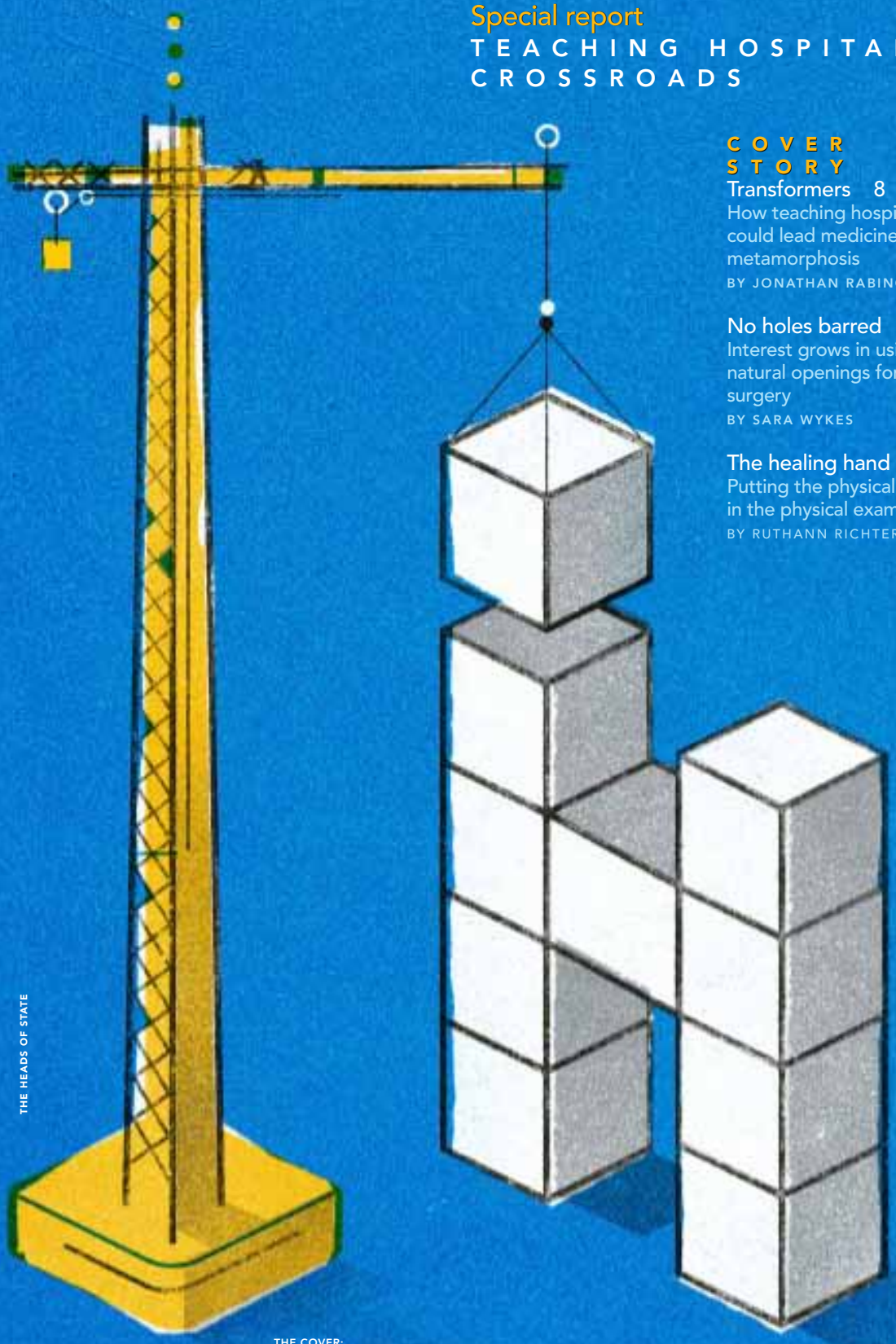
Checklists' results are persuasive, even at Stanford. Clinicians here added a five-step checklist for the insertion of a central line, a catheter that leads through a vein to the heart — something done hundreds of times daily at the hospital. The average infection rate in the United States is around two insertions per 1,000. With the checklist, the infection rate at Stanford dropped to zero. — SARA WYKES

LEIF PARSONS

Volume 27 Number 2
SUMMER 2010

STANFORD MEDICINE

Special report
TEACHING HOSPITALS AT THE CROSSROADS



THE HEADS OF STATE

THE COVER:
Illustration by The Heads of State

letter from the dean

For those who, like myself, believe the health-care system is desperately in need of reform, the passage by Congress of national reform (the Patient Protection and Affordable Care Act) is cause for at least some celebration.

The effort to reform the nation's health-care system, begun in the modern era with Truman and having failed under the leadership of numerous U.S. presidents, has finally come to fruition. After decades of political effort and public debate — sometimes inspiring, sometimes discouragingly uninformed — legislation with major implications for the insurance industry and the public entitlement programs is now the law of the land.

President Obama's signing of the legislation on March 23 marked a new beginning. While the recent legislation, which will unfold over the next five and more years, is broad in its sweep, it does relatively little to control costs or to reform the service delivery side of the equation. So, much work remains to be accomplished.

Ultimately the shape of the nation's health-care system will depend on individual leaders, innovative research and education, and changes in culture that address how we care for patients in the hospital, in ambulatory settings, at home and in their communities. It's an enormous challenge and I believe Stanford's community of scholars, researchers and clinicians has much to contribute.

A new endeavor we are launching this summer holds extraordinary promise for that effort. The Clinical Excellence Research Center, to be directed by acclaimed health-care policy expert Arnold Milstein, MD, aims to accelerate innovations in health-care delivery. Dr. Milstein will lead research teams seeking to discover and refine clinical service innovations that will enhance health, increase patient satisfaction and lower annual per-capita health-care spending.

The teams will take advantage of the prowess of the university at large — they will be composed of faculty from the business, engineering and medical schools as well as Stanford Hospital & Clinics, which is also supporting this new initiative.

Teaching hospitals like ours are in a unique position during this time of transition — ideally positioned to offer solutions, yet particularly embattled by the new economic realities. This issue of *Stanford Medicine* describes some of the struggles and advances taking place at our teaching hospitals, which I believe are in many ways emblematic of the approximately 400 others in the nation. Some highlights in this issue include an examination of how teaching hospitals are responding to change in the system, a conversation with the federal chief of health information technology and our efforts here to reinvigorate the bedside exam.

Despite reform in our country, the health-care system continues to function under extreme tension. As a nation, we still grapple with high costs and the growing recognition that some dimensions of quality of care fall short. Yet the genomic revolution and the work of biomedical and clinical researchers are paving the way for breathtaking advances in medicine. Undeniably, this is a most exciting time to be in medicine. The challenges are daunting; the potential for improving human welfare is dramatic.

LESLIE WILLIAMSON

Ultimately our success will be measured by how we are able to achieve state-of-the-art patient care fueled by innovation and discovery and delivered with high-quality service and as low a cost as possible. I hope our new Clinical Excellence Research Center will help us achieve these important goals.

Sincerely,
Philip A. Pizzo, MD
Dean
Stanford University School of Medicine
Carl and Elizabeth Naumann
Professor, Pediatrics, Microbiology
and Immunology

upfront

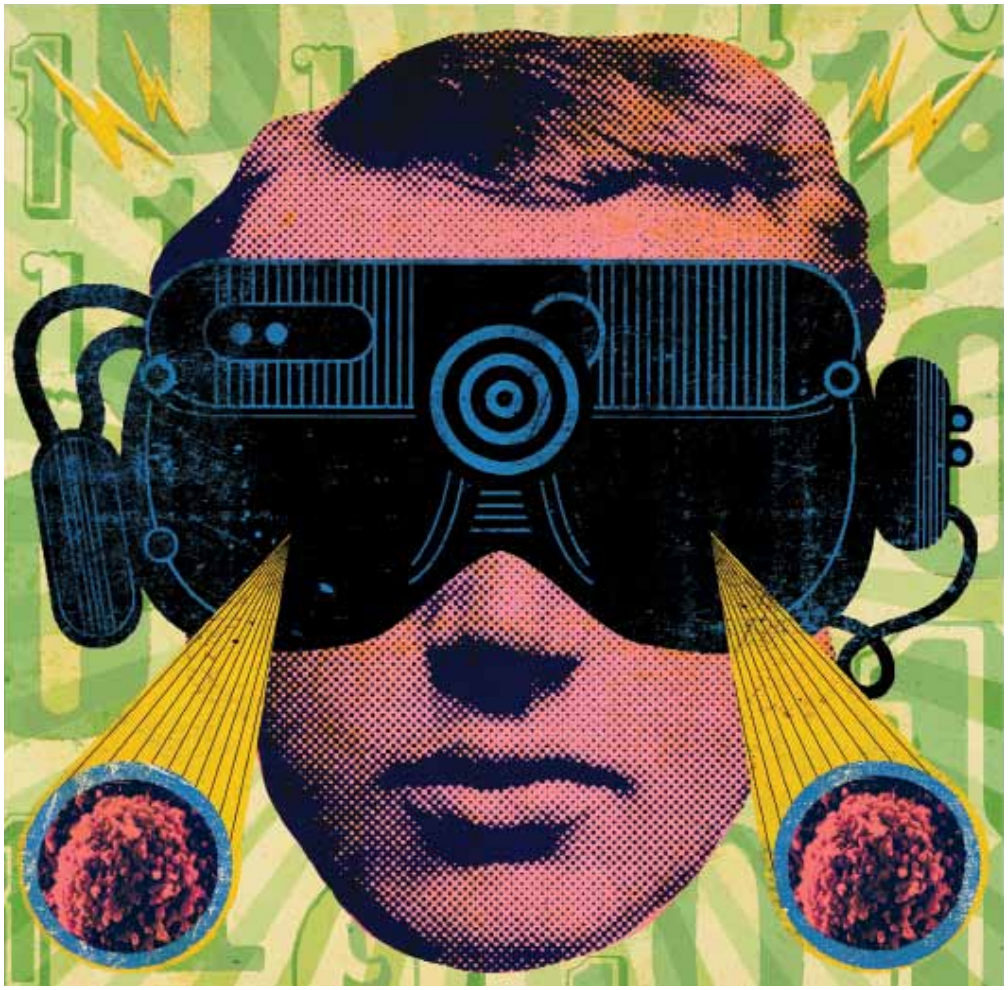
A QUICK LOOK AT THE LATEST DEVELOPMENTS FROM STANFORD UNIVERSITY MEDICAL CENTER

Virtual cell

IN A PURELY LOGISTICAL SENSE, biology can really get in the way of biological research. Cells must be cultured, nurtured and then perturbed according to an experiment's protocol. It can be slow, demanding and expensive work.

While most kinds of scientists and engineers can use computer simulations to speed up their research, there has been no such thing as a virtual cell. Now one is taking shape in the research group of Markus Covert, PhD, assistant professor of bioengineering. In a matter of months, he expects to unveil the first "whole-cell" computer model of an organism.

"To me, this is a dream," says Covert, who got the idea from a *New York Times* article he read 10 years ago suggesting that the ultimate challenge would be to make a computer model of a cell "because that implies biological understanding at a fundamental level."



CHRISTIAN NORTHEAST

The microbe that Covert's team is simulating is *Mycoplasma genitalium*, a sexually transmitted parasite. The nasty bug is a perfect candidate to simulate because of its simplicity. It has only 521 "coding regions," the segments of DNA with complete instructions for doing things such as making proteins. Most of those, about 420, are understood by biologists. As 2010 began, Covert's model accounted for more than 300 coding regions with more joining the model every week.

In other words, about 75 percent of what biologists know about *Mycoplasma genitalium* is now being simulated on Covert's computer. That's already enough to give him two things: confidence about integrating the rest of the coding regions, and a simulation that already works well enough for his group to ask biologically interesting questions about the organ-

ism, such as why it grows so much more slowly than its close relatives.

Success with this model will lay the groundwork for tackling more complicated and biologically important organisms, such as yeast and *E. coli*. Ultimately, Covert's goal is to give biologists the same computational simulation tools that allow peers, such as aircraft designers and nuclear physicists, to perform accurate experiments that are cheaper and quicker (and often safer) than tests with real materials and environments.

"You discover things a lot faster with a computer model than you do without," he says.

Covert's model incorporates many different systems that are at play in a cell, and will therefore give researchers a general platform for investigating a much larger set of questions. In fact, one of Covert's goals is to find out how cells age and why low-calorie intake corresponds to greater health and longevity.

As the *Mycoplasma genitalium* model comes together, Covert's group is also working on creating a graphical interface that provides users with a dashboard view of what's going on in the cell. The collection of graphs and dials and other visual indicators will also give researchers an easy way to tweak parameters, such as removing a coding region to perform experiments.

— DAVID ORENSTEIN

The research is funded by a National Institutes of Health Director's Pioneer Award.

Unbiased ed

THE SCHOOL OF MEDICINE has developed a new model for continuing education for physicians that aims to ensure that corporate donors exert no influence over the courses. Now the school is putting the model to the test, using a large industry grant to develop a new curriculum for continuing medical education classes.

In September 2008, Stanford became the first medical school in the country to place stringent limits on industry support of its CME programs — the courses doctors take to keep their licenses. Nationwide, health-care companies provide about $1 billion a year to support CME.

Stanford's new approach prohibits industry from directing its funding to support specific programs. Instead, the school is exploring educational models that involve industry but would be guided by the needs of physician-learners rather than by commercial interests, says Robert Jackler, MD, the school's associate dean for postgraduate medical education.

"We believe that the education of practicing physicians should be based solely on the best scientific evidence presented in a fair and balanced way," says Jackler, professor and chair of otolaryngology. "Unfortunately what's happened is that the partnership with industry has led CME astray, to the point where the curricula are too often biased toward business interests."

NO STRINGS

Under the new model, Stanford will use a new, $3 million, three-year grant from the pharmaceutical company Pfizer to design and implement a curriculum that uses advanced technologies and teaching methods, including simulated and immersive learning tools. The grant comes with no conditions, and the company will not be involved in either selecting topics or shaping the curriculum.

The overall goal of the program is to improve patient care and outcomes, with a focus on specific patient-care issues identified by Stanford physicians, Jackler says.

"We continue to believe that robust relations between academia and industry are essential to translating knowledge from research to patients. And we believe that academia and industry have much to learn and teach each other," says Philip Pizzo, MD, dean of the medical school. "But the learning and teaching has to be free of marketing or influence and focused on truly improving the lives of the patients we serve and the students and physicians we educate."

The new curriculum is being designed by a group of physicians at Stanford who have a special interest in new educational approaches. It will focus on interactive methods, rather than the traditional CME method of passive, lecture-based courses, Jackler says.

The teaching program will capitalize on Stanford's wide-ranging resources for immersive and simulated learning. These include new facilities at the Li Ka Shing Center for Learning and Knowledge, set to open later this year, where physicians can test different patient scenarios in a fully simulated hospital, among other activities.

Curriculum topics will be chosen based on areas of practice determined by Stanford as having room for improvement, Jackler says. For instance, it may target efforts to reduce surgical infections, improve communication among caregivers, help prevent patient readmissions for heart failure and increase use of palliative care programs. The goal of the teaching program is to produce measurable improvements in patient care. — RUTHANN RICHTER

"Unfortunately, what's happened is that the partnership with industry has led CME astray, to the point where the curricula are too often biased toward business interests."

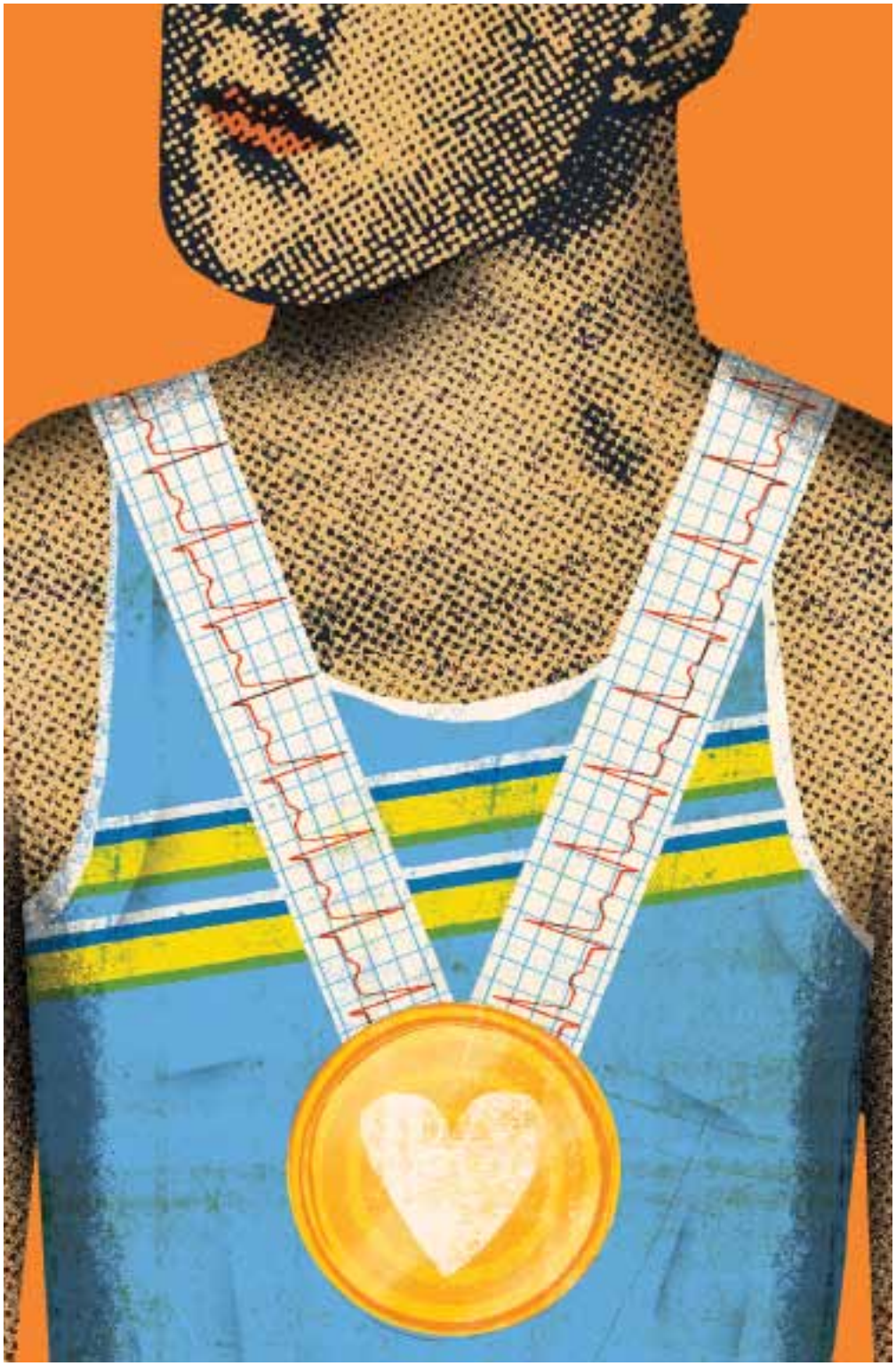
Team screen

IT'S A CLAIM that challenges conventional wisdom in the United States: Screening young athletes for heart abnormalities is a cost-effective way to save lives. Stanford cardiologists came to the conclusion as a result of their study, published in the March 2 *Annals of Internal Medicine*.

Currently in the United States, routine screening to spot diseases that can cause sudden cardiac death is required for many professional athletes but not for those in college or high school. Participation requirements for these younger athletes are usually limited to physicals and medical history. In general, the thinking goes, heart testing — which uses electrocardiogram tests, or ECGs — is a good idea but it's just too expensive, especially when the prevalence of death is so low.

But a study out of Italy, where routine ECG heart screenings of young athletes have been mandatory since 1982, has fueled the debate about the feasibility of such testing in the United States. The study showed that sudden death during competition has decreased nearly 90 percent since testing began.

The Stanford authors based their model on results from the Italian study, while adjusting for U.S. variations in disease prevalence and differences in screening modalities. They also collected data from numerous smaller studies written on the topic.

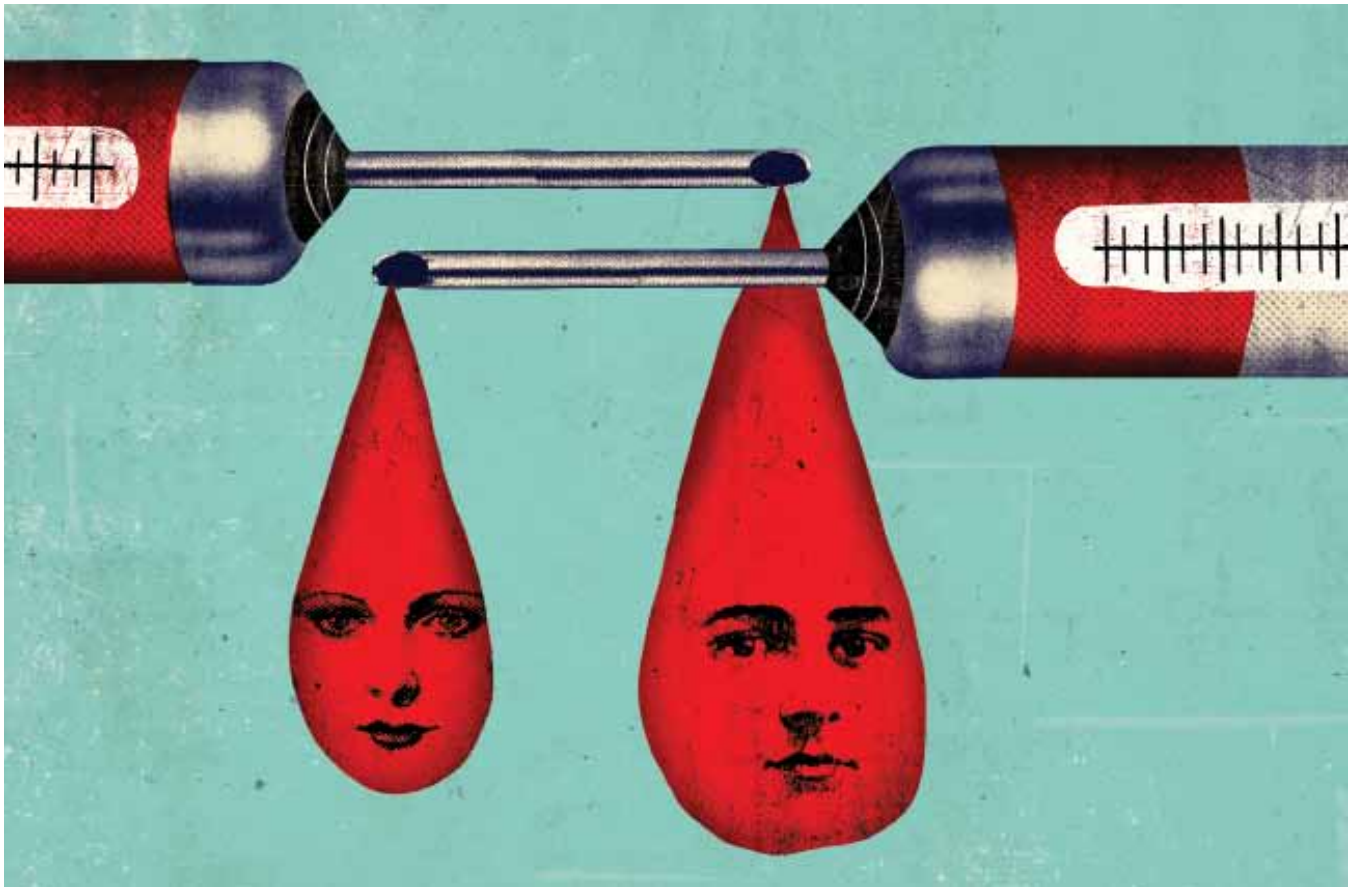


CHRISTIAN NORTHEAST

"We wanted to do a scientific analysis of cost-effectiveness," says senior author Euan Ashley, MD, PhD, assistant professor of cardiovascular medicine and director of the Stanford Hypertrophic Cardiomyopathy Center.

Results showed that adding the ECG to screening at a total cost of $88 per athlete saves 2.1 life-years per 1,000 athletes screened. The total cost included initial testing, follow-up and treatment resulting from screening. From a health economics standpoint, the cost-effectiveness ratio was $42,900 per life-year saved.

"The cost-effectiveness ratio means you spend more money screening, but you also get benefits by reducing deaths," explains co-author Mark Hlatky, MD, professor of health research and policy and of cardiovascular medicine. "Procedures under



$50,000 per life-year added are generally accepted in the United States as cost-effective. Procedures over $100,000 are often not."

Sudden death in athletes is rare. What researchers are looking for, when they examine the athletes' ECG results, are signs of hypertrophic cardiomyopathy, long QT syndrome and other causes of sudden death in young athletes. In the United States, hypertrophic cardiomyopathy is the most common cause of athlete death. An estimated one out of every 500 people in the nation has the condition, the first symptom of which can be death.

— TRACIE WHITE

The study was funded by the Breetwor Foundation and the Stanford Cardiovascular Institute.

MS: Divide and conquer

THE DISCOVERY that there may be two distinct versions of multiple sclerosis has big implications for patients: Their responsiveness to the most popular first-line treatment seems to depend on which version they have.

If larger studies of patients confirm the findings, a simple blood test might someday tell people with multiple sclerosis whether they are likely to respond to the standard therapy, says senior study author Lawrence Steinman, MD, professor of neurology and neurological sciences.

Public health may benefit, too, Steinman says, as the cost savings from predicting which patients will benefit from beta-interferon, a costly bioengineered drug whose global sales come to some $4 billion a year, could be considerable.

In the study, published online March 28 in *Nature Medicine*, Steinman and his colleagues used an animal model of multiple sclerosis called experimental autoimmune encephalitis, or EAE, which prompts the immune system to inappropriately attack the animals' own myelin nerve-cell coatings.

Many nerve cells in mammalian brains and peripheral tissues must convey electrochemical impulses over great distances, and quickly. Long, wirelike projections that transmit these cells' signals to other nerve or muscle cells are coated by myelin, a natural substance whose insulating properties sustain the impulses' strength and increase their speed.

Multiple sclerosis is triggered when, for reasons that are not clear, immune cells called T cells attack the myelin sheathing, causing symptoms including paralysis and blindness.

As for EAE, researchers can induce it using two specific chemicals that T cells secrete into the blood: gamma-interferon and IL-17.

In the new study, Steinman's team induced two similar forms of EAE in mice by directing the myelin-attacking T cells to predominantly secrete either gamma-interferon or IL-17. The researchers found that beta-interferon improved the condition of animals whose EAE had been induced by gamma-interferon-secreting T cells, but exacerbated

CHRISTIAN NORTHEAST

"We actively and directly induced one cell type to become a completely different cell type. These are fully functional neurons. They can do all the principal things that neurons in the brain do."

symptoms in those whose EAE had been induced by IL-17-secreting T cells.

Intrigued, the investigators turned to humans. The Stanford group obtained blood samples taken from 26 multiple-sclerosis patients who had been treated with beta-interferon. They measured IL-17 levels in those samples, and a clear pattern emerged. Measurements of a particular variety of IL-17, called IL-17F, clustered at either very high or very low levels in individual patients' blood. Those with very low detectable blood levels of IL-17F responded well to beta-interferon treatment. But patients with very high IL-17F levels — about one out of three subjects — responded poorly. In fact, says Steinman, there is some evidence that beta-interferon actually worsened these patients' conditions.

Steinman cautions that the results need to be confirmed in larger patient groups, but adds, "I think this has the potential to transform the way we take care of people with multiple sclerosis." He says a simple, already available blood test could spare many patients the inconvenience and side effects of a drug that most likely won't do any good. — BRUCE GOLDMAN

Stanford's Office of Technology Licensing has filed a patent application on the use of the blood test described above. The research was funded by the National Multiple Sclerosis Society.

New neurons

EVEN SUPERMAN needed to retire to a phone booth for a quick change. But now scientists at the School of Medicine have succeeded in the ultimate switch: transforming skin cells into nerve cells, which are much harder to come by. And unexpectedly, the skin cells make the change without first becoming a stem cell — a step long thought to be required for cells to acquire new identities.

The finding could revolutionize the future of human stem cell therapy and recast our understanding of how cells choose and maintain their specialties in the body.

"We actively and directly induced one cell type to become a completely different cell type," says Marius Wernig, MD, assistant professor of pathology. "These are fully functional neurons. They can do all the principal things that neurons in the brain do."

Wernig is the senior author of the research, published online Jan. 27 in *Nature*, which marked the first time that skin cells have been converted into fully functional neurons in a lab dish.

Until recently, it's been thought that cellular specialization was a one-way path: Embryonic stem cells give rise to all the cell types in the body, but as the daughter cells become more specialized, they also become more biologically isolated. A skin cell could no more become a nerve cell than Superman could become Clark Kent in midair.

That view began to change when Dolly the sheep was cloned from an adult cell in 1997, showing that, under certain conditions, a specialized cell could shed these restrictions and act like an embryonic stem cell.

OLD CELLS, NEW TRICKS

A decade later, researchers had made more progress in coaxing adult cells to act like embryonic ones: In 2007, they announced the creation of induced pluripotent stem cells, or iPS cells, from human skin cells by inserting four proteins called transcription factors into their DNA. The cells are called pluripotent because they have the ability, as do embryonic stem cells, to give rise to all other cell types.

Finally, in 2008, researchers showed it was possible in adult mice to reprogram one type of cell in the pancreas to become another pancreatic cell type by adding just three transcription factors.

As a result, Wernig began to wonder whether the pluripotent pit stop was truly necessary.

To test the theory, his team amassed a panel of 19 genes involved in either cell reprogramming or neural development and function. Then they inserted the genes into skin cells from embryonic mice and monitored the cells' responses. After 32 days, some of the former skin cells looked like neural cells and expressed neural proteins.

The researchers winnowed the original pool of 19 genes down to just three, then tested the procedure on skin cells from the tails of adult mice. They found that about 20 percent of the former skin cells transformed into neural cells in less than a week — a vast improvement over the weeks-long iPS process in which only about 1 to 2 percent of the original cells become pluripotent.

"This is much more straightforward than going through iPS cells, and it's likely to be a very viable alternative," Wernig says.

Quickly making neurons from a specific patient may allow researchers to study particular disease processes, such as Parkinson's, in a lab dish, or one day to even manufacture cells for therapy. — KRISTA CONGER

The research was supported by Stanford's Institute for Stem Cell Biology and Regenerative Medicine, the Donald E. and Delia B. Baxter Foundation, William Stinehart Jr. and the Reed Foundation, and the National Institutes of Health.

TEACHING HOSPITALS AT THE CROSSROADS

transformers

HOW TEACHING HOSPITALS COULD LEAD MEDICINE'S METAMORPHOSIS

BY JONATHAN RABINOVITZ

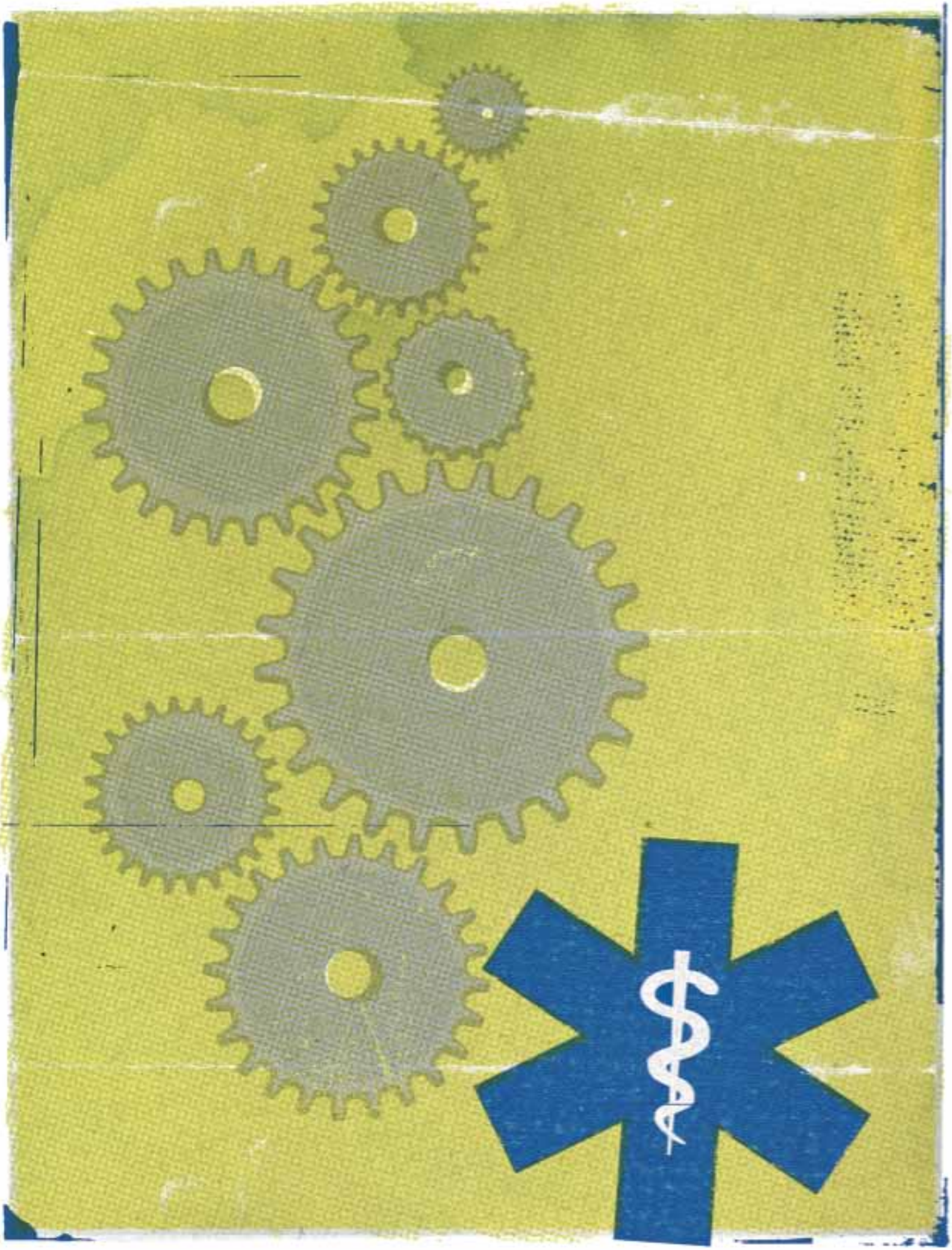
ILLUSTRATION BY THE HEADS OF STATE

An irate doctor wants a blood transfusion for his patient, and he isn't taking no for an answer. • Fielding the request on a cell phone in one of the intensive care units at Stanford Hospital & Clinics, a resident calmly explains to the more senior physician that the latest research — solid, evidence-based medicine — shows that transfusions in cases with mild anemia, such as this one, lead to increased risk of death.

In fact, there's a new national protocol against such transfusions that SHC has just adopted. If the doctor tried to order the blood on SHC's new computerized physician order entry system, it would inform him of the rule to check whether he was sure about the request. But it may take more than computer prompts to change years of habit.

The call takes place as Norman Rizk, MD, leads rounds of the intensive care units, and afterward he commends the resident for standing up for this protocol, even if the physician on the other end of the phone was frustrated. "I'm happy to talk with him about it," adds Rizk, the medical director of the ICUs. "I would hope that such a practice doesn't happen on my watch."

The conversation is another chance for Rizk to drive home a lesson he has been teaching throughout the hospital, and it echoes a point he was talking about earlier in the rounds. "We are using too much blood," he told the residents, citing a sobering statistic: SHC uses 200 percent more blood than one of its most revered peer institutions, Brigham and Women's Hospital in Boston.



Limiting transfusions not only benefits patients' health, Rizk explained, it also is cost-effective: Blood is an expensive and precious resource.

This is a prime example of what Rizk calls the "low-hanging fruit" of clinical effectiveness — practices that can save money while improving care. There are many such opportunities, and SHC is at the forefront of teaching hospitals' efforts nationwide to capitalize on them. To fully realize these benefits, Stanford and other hospitals are changing the way they provide medical care, emphasizing what's referred to in the health-care industry, somewhat simplistically, as "quality." What that means is that hospitals are putting in place a plethora of protocols, based on scientific evidence from definitive studies, and constantly tracking how well these rules are being followed.

Of course, there have always been standards. Still, new information technology and new types of research — coupled with revelations about problems in the way care has been delivered — are transforming the way hospitals practice medicine, making measurement of "quality" central to their missions. For teaching hospitals, that involves a particularly delicate balance between their role as centers for innovative, outside-the-box thinking with this new demand to be more consistent. As a result, they are fostering a different culture — with uniform rules embedded in computerized systems, and management practices that focus attention on efficiency — in place of the ivory tower culture that in another era deferred to whatever the physician-professor deemed best.

Steven Wartman, MD, PhD, president and CEO of the Association of Academic Health Centers, acknowledges the "trend toward more 'corporate' management" in a recent editorial, while cautioning that "the new 'corporate' paradigm not overshadow the fundamental academic ethos and the creativity, intellectual spirit and unique public standing of these institutions." This tension is not new, but there is no longer a debate about whether the corporate paradigm is the way to go — the question is how quickly can it be done.

The push for quality can be traced to a 2001 report issued by the Institute of Medicine, *Crossing the Quality Chasm: A New Health System for the 21st Century*, which drew attention to the gap between what is known to be good, evidence-based health care and the health care that people receive. That gap not only costs lives — two infections that often result from medical missteps, sepsis and pneumonia, kill up to 48,000 Americans per year — but also money for treatment.

Stanford and the other elite teaching hospitals add another wrinkle to the equation. "We can all too easily take for granted when we receive or deliver care, that it is of the highest quality, the most cutting-edge, the most sophisticated available, but is this really true?" says Philip Pizzo, MD, dean of the Stanford University School of Medicine. "The reality is that when a bright light is shined on our personal practice, inadequacies and imperfections are likely to be seen.

"This is especially true when we think we are better than we are: After all, if we are members of the Stanford community, we must be on top of the quality pyramid," he says. "I would argue that once we assume that, we become especially vulnerable to errors and mistakes."

While safety concerns launched the quality movement, what has propelled it further are reports of doctors driving up costs by overusing expensive technology and costly procedures, particularly in hospitals. Virtually everyone in health policy circles agrees that the increases in health-care spending — it now accounts for 17 percent of our gross domestic product — cannot continue, and that the biggest increases have occurred in connection with complex hospital cases. Arguably the most popular solution is to promote evidence-based standards for care.

The new health-reform law adds to the economic pressure on teaching hospitals. It lowers hospital payments under the Medicare program, and it allocates the existing funds in new ways that reward hospitals for higher-quality treatment and greater efficiencies — and penalize those who perform poorly. To be sure, the law expands the number of people who will have insurance, but there won't be enough money or doctors to care for all of them if current habits don't change. There is yet another reason that hospitals are re-engineering how they provide inpatient care: A shift has begun toward reimbursing less for inpatient care and more for outpatient care that keeps people out of hospitals.

"WE CAN ALL TOO EASILY TAKE FOR GRANTED WHEN WE RECEIVE OR DELIVER CARE, THAT IT IS OF THE HIGHEST QUALITY."

"HAVING A GREAT CLINICAL INFORMATION SYSTEM IS CORE TO THE FUTURE SUCCESS OF A PLACE LIKE THIS."

So as Rizk, the senior associate dean for clinical affairs at Stanford medical school, leads his trainees on rounds, they provide a glimpse of the future. Unlike a few years ago, they now have three computers on wheels in tow as they stop outside each patient's room to consult a comprehensive electronic health record; no longer do they need to leaf through a Manhattan-phone-book-sized case file looking — often unsuccessfully — for a test result from a few years ago or an X-ray that was taken a few hours earlier. As appropriate to each case, Rizk gives concise, information-packed lectures on medicine as he has done since joining the Stanford faculty in 1991, but there are some new topics. He talks about the systems for improving efficiency and quality underlying each patient's care, and he talks about money.

The "big bang" was scheduled to take place at the stroke of midnight on April 25, 2008. At least that's what some at SHC were calling it, as they waited for the moment that a new electronic health record system would "go live," culminating two years of intensive planning — rethinking workflows and providing hospital-wide trainings — by more than 300 physicians, nurses and administrative staff members. It was the first stage of an information technology makeover with an estimated cost of some $200 million.

Martha Marsh, the hospital's president and CEO, says she was as nervous as she had ever been in her entire career as dozens of disparate information technology systems throughout the hospital — many that were unable talk to each other — were replaced with one system.

The new EHR would store patients' information electronically and uniformly so that all authorized staff could access it; it would also allow them to place orders. The goal was to let physicians, nurses, pharmacists, lab technicians and others call up a patient's records, view images and test results, and enter instructions, from anywhere at any time. The system would be smart enough to detect possible dosing errors with medication or to call a physician's attention to a measure they might want to take, given the circumstances of a particular case.

What's more, the system would eventually make it possible for an automated process of skimming through the records and crunching data from every patient, measuring in real time how the hospital is performing on metrics, then flagging any potential problems. In the future, it could even drill down and determine which units and which clinicians are not following the advised practices. Ultimately, it could be used to compile databases that could provide the fodder for studies of the effectiveness of different treatments, looking not only at patient outcomes but also at costs.

Marsh had good reason to be nervous about the hospital becoming one of the first to adopt such a comprehensive EHR system. Even with all the precautions, if the hospital hit a snag, clinicians might be without vital computer support for precious hours. She had no doubt, though, that it was worth the risk. "Having a great clinical information system is core to the future success of a place like this," says Marsh. "It won't make you successful on its own, but you can't measure the data needed to implement clinical protocols and guidelines without it.

"There are a million quality steps that the system can enable you to do, which you would be hard-pressed to do in its absence," she adds.

The EHR and other new information technologies are the linchpin of the effort under way at Stanford and other hospitals to — first and foremost — make objective improvements in quality, then capitalize on instances that also reduce costs. The idea is to establish a set of best practices and embed them in the hospital's information systems, which will encourage their use — a mix that is hoped to be strong tonic for the nations' hospitals, which have been rife with medical errors and inefficiencies. President Barack Obama and Congress have allocated $20 billion to help health-care providers implement this technology. And the new health-care law adds to the need for such systems by increasing the demands on hospitals and other providers to produce reams of data about their performance.

Marsh understood that the EHR would not succeed unless the hospital organization was streamlined to produce and respond to the new information systems. Under her leadership, the hospital has applied the principles of Six Sigma,

(Motorola's statistics-based strategy to improve its workflows) and lean manufacturing (Toyota's model for efficiently producing quality cars) to its own operations and services.

Soon after becoming the hospital's CEO in 2002, before the EHR project was launched, Marsh began to bring in new sets of management skills, people who understood management-science principles and could apply them to a health-care institution. She needed, for instance, to create a position that would oversee quality improvement and medical information, and recruited Kevin Tabb, MD, president of clinical data services for GE Healthcare Information Technologies, for the job. She needed expertise in process redesign, and brought in first Sridhar Seshadri, PhD, also from General Electric, for a new vice president's post, then added chief operating officer Dan Ginsburg, a senior vice president at Massachusetts General Hospital and a Harvard Business School graduate who had led efforts to redesign care in the network that included MGH. In his previous job, Ginbsurg had, to give one small example, reorganized how patients were seen at a proton beam facility, increasing the number of visits to 37 each day from 29 — without adding staff or hours of operation. "It often sounds totally obvious," Ginsburg told the *Boston Globe*, "but until you do it, things won't change." Those sorts of redesigns were launched throughout Stanford Hospital before the initial launch of the new clinical information system and continue today.

On that night in April two years ago, the first stage of the EHR transition went relatively smoothly. There were (and continue to be) headaches — doctors and nurses routinely complain, for instance, about trouble finding things within a patient's EHR — but right out of the gates, some tasks, such as ordering CT scans, became easier. Doctors can also access the system from home to follow up on patients; one even logged in from Florida on that first day. Over the next two years, the EHR was rolled out in the outpatient clinics and expanded to include billing and other business functions. In January, SHC became one of seven health-care institutions to be recognized for having achieved the highest level of clinical information integration by HIMSS Analytics, a wholly owned, nonprofit subsidiary of the Healthcare Information and Management Systems Society.

"Everybody is going to have to do this," says Tabb, now SHC's chief medical officer. "We're very proud because we did it quickly, we did it well and we're using it well, but it's still very new." And he is quick to point out that the hospital is still working on how to weave the technology into everyday practice and how to keep it up to date with the latest changes in medicine. Indeed, the true benefits of SHC's system have yet to be realized.

Rizk, for instance, wants to be able to see whether the many protocols being adopted in the ICUs are affecting the mortality rate. That should soon be possible, as the system is now running a program that evaluates the expected mortality of every patient admitted to the ICUs, using a national database of ICU patients. It will then report how the results at Stanford compare with those prognoses. Similarly, Rizk wants to track how several of the most expensive and commonly prescribed drugs in the ICUs are being used in the hope of being able to find a less expensive alternative.

"The truth is all that we've done is put in place a set of tools," says Rizk. "We can't make the changes we need to make without these tools, but we need to learn how to use them."

For the last half of the 20th century, teaching hospitals flourished as a result of what some term a "virtuous cycle." The fundamental premise was that they provide the latest, most advanced care not available at their non-academic counterparts, while also carrying out two other missions: They train doctors and conduct research. When things were going smoothly, the academic and the clinical efforts complemented each other: The scientific advances and educational enterprise brought new and greater expertise to the clinical care, and, in turn, the clinical care provided opportunities for study and training.

But the funding that once fueled this juggernaut — government monies for research, education and advanced inpatient care — is less available, and academic health centers are looking to streamline the engine using the tools of EHR, quality improvement and other elements that underlie the new health reform law. Stanford and other teaching hospitals remain committed to giving the most advanced care, but they must find a way to thrive in tighter fiscal times. They need to use their academic strengths to become more efficient.

To understand the situation, take a look at Stanford Hospital, the flagship of one of the nation's leading academic health centers. It is renowned for taking in the complex cases, known as tertiary and quaternary care, that community hospitals are not equipped to handle: It provides heart, liver, bone marrow and other organ transplants; the latest surgical and drug therapies for stroke; new minimally invasive ways to repair heart damage; and experimental treatments for cancer, among other things. Stanford and other teaching hospitals also disproportionately provide vital emergency services and shoulder much of the care of the neediest. While the major teaching hospitals affiliated with the American Association of Medical Colleges constitute 6 percent of the nation's hospitals, they account for 41 percent of all charity care, 60 percent of level-1 trauma centers and 50 percent of all transplant services.

"IT'S CLEAR THAT BUSINESS AS USUAL — AND CERTAINLY ONE BASED SIMPLY ON GROWTH — IS NOT SUSTAINABLE."

As a result of these services and their distinct missions, teaching hospitals tend to be more expensive than their non-teaching brethren. "The cost is by definition higher," explains Pizzo. "For a variety of reasons, there are more people involved in the provision of care — trainees, students, residents, fellows. All that adds to the cost and, in some ways, decreases the efficiency of the operation."

Those higher costs weren't necessarily a problem in the recent past. Revenue from the clinical operation subsidized training and research, but the balance is now in jeopardy. The growing complexity of care has led to growing numbers of trainees — for instance, the Stanford University Medical Center (which includes other units in addition to the hospital) went from 607 residents in 2001 to 900 residents in 2009 — and many of those new positions aren't covered by federal graduate medical education funds. SHC last year had to devote about $30 million from clinical revenues to cover the cost of training residents. At the same time, the amount spent on medical research by the federal government, when adjusted for inflation, declined during the administration of President George W. Bush, and it's doubtful, given the poor economy, that the new administration will bring back the boom in funding that characterized previous decades. "This has made the dependency on support from clinical income, generated largely at teaching hospitals, more critical at many academic medical centers," says Pizzo. "It's clear that business as usual — and certainly one based simply on growth — is not sustainable."

One way that teaching hospitals are likely to adapt is by putting more emphasis on research into what's known as "comparative effectiveness." It involves doing studies that compare drugs, medical devices, tests, surgeries or ways to deliver health care and then using the evidence from that research to guide care provided by physicians and hospitals. The goal is to provide the basis for new standards and protocols that will not only improve quality, but also cost-effectiveness and efficiency.

Although you might think that the treatment you receive has been carefully evaluated, all too often it has not. "When you shop for a new car, phone or camera, you have lots of information about your choices," explains the U.S. Agency for Healthcare Research and Quality on its website. "But when it comes to choosing the right medicine or the best health-care treatment, clear and dependable information can be very hard to find."

There are new funds for this type of research. Congress allocated $1 billion last year for such studies, and the health-care reform law takes it one step further, establishing a permanent trust fund that guarantees a steady stream of support for this type of research. At Stanford, in addition to medical school faculty already doing comparative-effectiveness studies, the medical school in collaboration with Stanford Hospital & Clinics is establishing a new Center for Clinical Excellence Research, under the direction of one of the nation's leading quality-improvement experts, Arnold Milstein, MD, to boost its efforts. Other academic health centers are ramping up their work in this area as well.

In the meantime, as SHC transforms its model of care, Rizk's rounds are one of the spots where the rubber meets the road. Like many other Stanford clinical leaders, he has changed his teaching so that he weaves information about cost of care and the need for standardized systems into his discussion of almost every patient on his rounds. And he wants to make his students particularly aware of the guidelines for caring for patients at the end of their lives, which, by one estimate, accounts for $1 of every $3 of spending in the Medicare program.

Indeed, the critical care curriculum for residents lists among its goals and objectives that "residents should be capable of deciding about the utility and appropriateness of this advanced but invasive and expensive care in the overall treatment of patients." This effort to teach about cost is accompanied by new lessons on end-of-life issues and palliative care, the principles and techniques of managing the ICU, ethical and legal aspects of critical care, and developing and implementing quality improvement through data analysis and careful observation of the ICU's workings. Such changes

are in keeping with guidelines from the Accreditation Council for Graduate Medical Education, which now requires that considerations of cost awareness, risk-benefit analysis and quality improvement be integrated into training programs.

So at each patient's door, Rizk makes sure that the young doctors follow a set routine and ask the nurse for that room to join the meeting, a system set in place to guarantee that nurses are updated on their cases' status and that doctors ask nurses about what they've observed. (From 2002 through 2006, about 60 percent of "sentinel events" — medical deaths and major injuries of unknown cause — stemmed from communication failures, ranging from doctor-nurse miscues to misinterpreted written instructions, according to a report from the Joint Commission, a nonprofit group that accredits health-care organizations.)

When one of his residents waits until the last moment to put antiseptic gel on her hands before seeing a patient, Rizk gently warns that had she forgotten, he would have handed her a red card, with boldface type saying, "CLEAN HANDS SAVE LIVES," a practice that is being tracked, measured and reported in many of the biweekly e-mail reports on various quality metrics that are sent to select hospital leaders. (Research from Johns Hopkins University shows that ICUs that do hand-cleaning 100 percent of time bring their infection rate near zero.)

And while Congress dropped the political hot potato of how to handle end-of-life care, Rizk reviews with his residents the steps established under the hospital's palliative care program to manage the cases in which intensive measures are being taken to stave off death, with little benefit to quality of life. (One of four hospitals now has a palliative care program, and the number has more than doubled since 1999, in response to studies showing that medical care for patients with advanced illness is characterized by inadequately treated physical distress and poor communication between caregivers and patients and their families.)

During rounds, Rizk comes to an elderly patient whose kidneys are failing, whose lungs are falling apart and who is overwhelmed with a host of other problems. Rizk and the residents have tried a panoply of drugs and treatments over the last few days, but her condition has worsened. One resident advocates continuing with such aggressive treatment to prolong the patient's life.

"Does she know that she is likely to die in two weeks?" Rizk asks quietly. In fact, the patient is now in a coma. To continue dialysis and other highly intrusive and complex measures, Rizk says, is going to add to the patient's suffering without, as studies show, prolonging her life or improving its quality. It also would be expensive.

There are now systems in place to guide how to proceed, and Rizk refers to them. There will be a meeting of ethicists, caseworkers, nurses, doctors to evaluate the patient's options, a practice the hospital instituted a few years ago with its launch of a palliative care program.

Rizk explains to the trainees that he wants to be able to work with a family member who understands the choices, and he asks about the relative who was just at the bedside. "Do you know who the surrogate is in this case?" he quizzes them, noting that the answer has very practical consequences. "In the state of California, the doctor gets to pick who the surrogate will be," he says. "That's why I'm asking if this relative is going to be able to handle making a decision." This is not the sort of detail that would've been discussed a decade ago.

Rizk requests that one of the residents set up a meeting with the family. It won't be an easy conversation to have. In many cases, for instance, patients or their families are demanding unnecessary tests and measures, and if Medicare or a physician suggests otherwise — even citing evidence of their ineffectiveness — the initial response could well be an angry one.

But those attitudes can be changed. At least that is what Rizk and other medical practitioners are hoping. While these decisions have a huge effect on cost, the discussions are not about money. "That's not relevant," says Rizk. "We're trying to establish what is best for the patient," he says, explaining that people often make the mistake of thinking that the best treatment is the most expensive. "If they know you care," he says, "they'll listen to what you have to say.

At hospitals these days, "quality" has become a mantra, but, of course, hospitals have always been trying to provide quality. Indeed, when Rizk was appointed head of the ICUs in 1997, then-chief of staff Lawrence Shuer, MD, said Rizk's mission was to "foster quality care at a time when we have had to be creative in reducing costs."

Now in health-care circles, "quality" means standardization based on evidence-based protocols, and in the last few years, the number of protocols has multiplied. There are guidelines for running ventilators and modulating blood sugars, and there are control measures for infections, for sedation, for nutrition and for care of patients who suffer cardiac arrest. The hospital board of trustees now has a committee specifically to review how well quality measures are being followed. Rizk chairs another twice-monthly meeting for the ICUs to consider new protocols and to assess how they're working. In fact, there is now a backlog of protocols waiting to be posted on the hospital's intranet, he says, noting that while it would be good to have them up more quickly, it is also a sign of the

"IF THEY KNOW YOU CARE, THEY'LL LISTEN TO WHAT YOU HAVE TO SAY."

tremendous appetite for enacting evidence-based medicine.

Equally important is the transparency that hospitals are practicing in conjunction with these protocols. Hospitals' performances on certain practices are being regularly tracked and shared not just within the hospital, but also with the public. There are already a number of websites that post this information and allow a visitor to compare hospitals with each other. And the new health-care law is going to make it possible to compare physicians and look at hospital costs. "Whether we do it or not, someone is going to be measuring our quality," says Marsh. "That's the new world we're in: Public accountability has become really important."

This transparency appears to be driving hospitals to change.

The Joint Commission hospital accreditation group reported in January that hospital performance nationwide improved continuously between 2002 and 2008 on 12 quality measures, which reflect the best evidence-based treatments for heart attack, heart failure and pneumonia — practices demonstrated by scientific evidence to lead to the best outcomes. The magnitude of national improvement on these measures ranged from 4.9 percent to 58.8 percent.

At Stanford specifically, the hospital last year scored above the norm on most measures. For instance, 100 percent of its patients appropriately received post-operative medication to prevent blood clots as compared with 88 percent for hospitals nationally. Another example is how 98 percent of its patients were properly given the heart medication known as beta blockers in conjunction with surgery as compared with 87 percent for hospitals nationally.

Indeed, from 2006 through the start of 2009, SHC rose from the middle of the pack of 100 hospitals to the top 93rd percentile on compliance in the two dozen or so core quality measures of the care of patients with heart attacks, heart failure, pneumonia and surgical conditions. When these numbers dropped a bit in mid-2009, hospital officials quickly pinpointed where the effort had suffered a slight decline — appropriate use of beta blockers in acute myocardial infarction patients and the consistent ordering of blood cultures for pneumonia patients were two examples — and the number quickly climbed back up.

These changes in quality performance have yet to substantially affect health-care spending, but there's reason to believe that they will as the health reform provisions are enacted over the next decade. The health-care sector has lagged behind other sectors in adopting the latest information technology — and it takes time for investments in this realm to have an effect. So health-care providers are just beginning to see the increased productivity they can reap from reengineering their operations. The bottom line: Teaching hospitals will be leveraging technology and management science to get more health out of each dollar spent, and that means a more careful marshalling of resources.

And that is why Rizk is, among other things, so interested in blood.

Earlier this year, Rizk met with hospital leaders to explain how SHC was using twice as much blood products as several of its very best peer institutions, which apparently had adopted the new transfusion protocol more quickly. The group agreed that SHC's computer system should give a pop-up educational message when someone orders blood for a patient who doesn't meet the guidelines. Those at the meeting opted for a note that would be more of a gentle nudge than an edict from on high.

Of course, some physicians may be in such a rush that they gloss over the message. Others may have someone else enter the order for them and never see the message at all. Undoubtedly, doctors will need to be engaged on a more direct, personal basis. Even then, some may bridle at the rule regardless of how gingerly it's raised, seeing it as an example of "cookie cutter" or "cookbook" medicine.

Still, if the numbers don't improve, Rizk says, more scrutiny could bring about change. The hospital is now keeping track of blood use. The new electronic health record could make it possible to quickly analyze which units are ordering the most and then drill down to determine which physicians are the biggest users. They then could focus the message on those who most need to hear it.

"It's not the right treatment," says Rizk, "and it's a waste of money to be buying all this blood." **SM**

Jonathan Rabinovitz is at jrabin@stanford.edu

TEACHING
HOSPITALS AT
THE CROSSROADS

no holes

barred

INTEREST GROWS IN USING NATURAL OPENINGS FOR SURGERY

Seventy-five-year-old Joe Cherry woke up on a Friday at his home in Florida with a severe headache. By the end of the day, he was in the emergency room.

"I didn't know much of anything for the next two or three days," he says. Cherry's son, Mike, a Stanford genetics professor who had flown out to be with his father, began feeding MRI images to Stanford Hospital physicians, including professor of neurosurgery Griff Harsh, MD, surgical director of the Stanford Pituitary Center, and associate professor of neurosurgery and medicine Laurence Katznelson, MD, the center's medical director. What they saw was a tumor at the base of Cherry's skull, below the pituitary gland. Nearby was a deposit of blood. Cherry's eyesight was in jeopardy.

No surgeon goes near the brain without a keen awareness of what inadvertent damage can do. The pituitary is one of the body's master control organs, surrounded by critical neurological structures. Drilling a hole into Cherry's skull was out of the question. Instead, Cherry's tumor would be reached and removed through his nose.

Yes, his nose. Increasingly, surgeons pipe brain tumors out nostrils, remove appendixes through patients' mouths, and conduct gastric bypasses by way of the belly button. These surgeries seem weird and amazing — but probably won't much longer. The popularity of surgeries via pre-existing openings and tiny incisions is rising, taking the trend begun decades ago toward minimal-access surgery to the ultimate extreme.

As with traditional minimal-access surgery, physicians use long tubular instruments called endoscopes to avoid cutting large incisions through skin, bone and muscle. The endoscopes allow physicians to slip tiny surgical tools in and out of the body; an attached camera transmits video images to a screen showing what's happening inside.

The first endoscopic gallbladder removal, in 1987, started the trend. Now the technique is used for nearly all of the hundreds of thousands of gallbladder removals annually in the United States, as well as the majority of certain other common operations, including appendectomy, colon polyp removal and hernia repair, according to the Center for Minimally Invasive Surgery at the University of Minnesota. Soon minimal-access procedures will constitute as much as 65 percent of surgeries, the center projects.

The benefits of surgery without large incisions easily explain the increase in these procedures' popularity over the last 30 years. Instead of a big scar, they leave a small one. Instead of lots of pain medication, there can be far less. Smaller incisions also reduce infection and speed recovery — there is literally less to heal and, overall, the body is less traumatized. Some procedures that once required hospitalization can now be done as day surgery, and patients can more quickly get back to their normal lives. When even one day in the hospital can cost several thousand dollars, avoiding stays can mean large savings.

BY SARA WYKES

ILLUSTRATION BY LEIF PARSONS

Using natural orifices for surgery has another advantage — an internal incision instead of an external incision. Whatever scar is left behind will not be visible from the outside. Some physicians say that internal incisions heal more quickly than external. And, with some surgeries, like Cherry's, entering the body through one of its existing openings is literally the only way to get in without life-altering damage.

Documenting how common this small-scale surgery has become depends on definitions. Endoscopic surgeries are performed by the hundreds of thousands each year. At least 90 percent of the average year's 700,000 gallbladder removals were done with a laparoscope — an endoscope that enters the abdomen. Catheter access, which annually aids hundreds of stroke, tumor and cardiac patients, is available at major medical centers like Stanford. Within each of these groupings, however, are leading-edge procedures — like removing an appendix through the mouth or a gallbladder through the vagina — that are available at only a handful of facilities.

FOR PATIENTS LIKE CHERRY AND MANY OTHERS, the microsurgical instruments developed for minimal-access surgery, combined with advanced imaging technology that gives physicians the assistance of real-time video as they work, have made life-saving surgeries possible. Stroke, aneurysms and skull base tumors can now be reached and treated effectively with a minimum of disruption, whether entry begins at the nose or the femoral artery, in the thigh. Physicians can send tools through the mouth to get to the voice box for a far more effective removal of tumors there. Other body openings physicians have begun using include the vagina, rectum and urethra. Stanford surgeon Sanjeev Dutta, MD, is pioneering another minimal-access avenue — traveling through the body underneath the skin.

The innovative use of access routes, in particular through the nose, is influencing how physicians work together, blurring traditional lines of territory and technique. When neurosurgeons Harsh and Katznelson operated on Cherry, a third surgeon was part of the team — rhinologist Peter Hwang, MD, director of the Stanford Sinus Center. Stanford neurosurgeon Robert Dodd, MD, PhD, often pairs with interventional radiologists to repair ruptured blood vessels in the brain, working through a barely visible incision in the leg. As a collaborative team, Harsh says, specialists in surgery, oncology, radiation, ophthalmology and otolaryngology can accomplish what they could not as individuals.

The demands of minimal-access surgery also have begun influencing hospital design. New hospitals will no longer have places called operating rooms. They will have a flexible hybrid called an interventional platform: a space with movable partitions that meets the standards for open incision surgery and has space to hold the equipment to allow both surgical and catheter interventions. The new hybrid room is large enough to hold collaborative teams of clinicians for procedures that combine both specialties. This spring, Stanford Hospital inaugurated its first hybrid, specially fitted for neurological diagnosis and treatment. Plans for a new Stanford Hospital building call for an entire floor of interventional platform space.

Enthusiasm for surgery via small incisions is so great that medical training, research, tools and hospital infrastructure are only now starting to catch up. Despite advances, the instruments for these surgeries are still not as small, strong or flexible as physicians say they should be — problems that programs like Stanford's surgical innovations fellowship for surgical trainees are trying to solve. The program teaches surgeons how to invent and bring new surgical devices to market.

When neurosurgeon Harsh goes into narrow vessels or arteries to reach pituitary tumors, the two fine tips of the forceps tool must be equally narrow. And those fine tips are so delicate, he says, they can lose precision just by passing through the body. The tools' maneuverability also needs improvement. Turning corners with a catheter in the human body is not like moving a stick through dry sand.

The early laparoscopic tools were like chopsticks, says Stanford's chief of general surgery, Tom Krummel, MD, "long, straight sticks that couldn't do very much." The tools are better now but have a way to go. "Now what we have are relatively small in diameter — about the thickness of a swizzle stick — and they incorporate radio frequency, ultrasound and dividing tools. Until we get better tools — to suture, to grasp — we are limited in what we can do." Some device manufacturers are interested in the next generation of minimal-access surgery's special requirements,

"NOBODY TAUGHT ME ANATOMY FROM THAT ANGLE. I HAD TO REORIENT MYSELF."

he says, "but the tool kit we need hasn't yet materialized."

Refining these tools may come far faster than surgeons can be trained, or retrained, with the special skills required to use them — and to compensate for the loss of big field view and tactile information. Data show that the more experienced a physician is in this type of procedure, the better the outcome.

For surgeons trained in open surgery, it's a completely new view of anatomy. Dutta, an associate professor of surgery, does minimal-access neck surgery. "Nobody taught me anatomy from that angle. I had to reorient myself," he says. "Even experienced surgeons can get lost." Getting that training can be a challenge: While research hospitals like Stanford provide training in minimal-access surgery, opportunities for learning the techniques are not nearly as widespread as for traditional, open surgery.

The new techniques are also physically strenuous. With shoulders up and arms out, holding and maneuvering long instruments with eyes fixed on a video screen, sometimes for hours, surgeons are feeling the pain. A recent survey of its members by the Society of American Gastrointestinal and Endoscopic Surgeons found a stunning 86.9 percent reporting physical complaints attributed to minimal-access procedures.

The ultimate question is how well these minimal-access techniques stack up against open surgery. In fact, the shift toward more minimal-access surgeries is happening before researchers have gathered compelling evidence supporting their value. "The way technology is now," says clinical associate professor of surgery James Lau, MD, a recent arrival to Stanford Hospital's bariatric surgery program, "you get the process and the technology way before you get the literature."

Very simply, Krummel says, "he risk increases as we make smaller and smaller holes for more complicated approaches, and we don't yet have an adequate track record of success and safety."

These new approaches are, after all, just another step in treatment evolution, says minimal-access surgery specialist John Morton, MD, and need to be carefully evaluated for appropriateness. "There is a continuum, from big to little to no incision," says Morton, an associate professor of surgery. "Not every single approach is going to meet every single problem."

Cherry never hesitated about his procedure to remove the pituitary tumor. Harsh explained the procedure to him in great detail, he says, "what they were going to do and how they were going to take the tumor out. I knew the nose was the direct route. Of course, I was very eager to get this thing out of my head and I had total confidence. I even asked another one of my doctors, Peter Hwang, 'Why should I believe you can do this job? He said, 'Because I've done thousands of others successfully.'"

Cherry had also expected pain. "You would think that when you have surgery and they go in and start cutting that you would have pain. I had no pain at all. Everything was a real success. I've just been doing terrific."

His surgery, he says, "was a life saver." **SM**

Sara Wykes is at swykes@stanfordmed.org

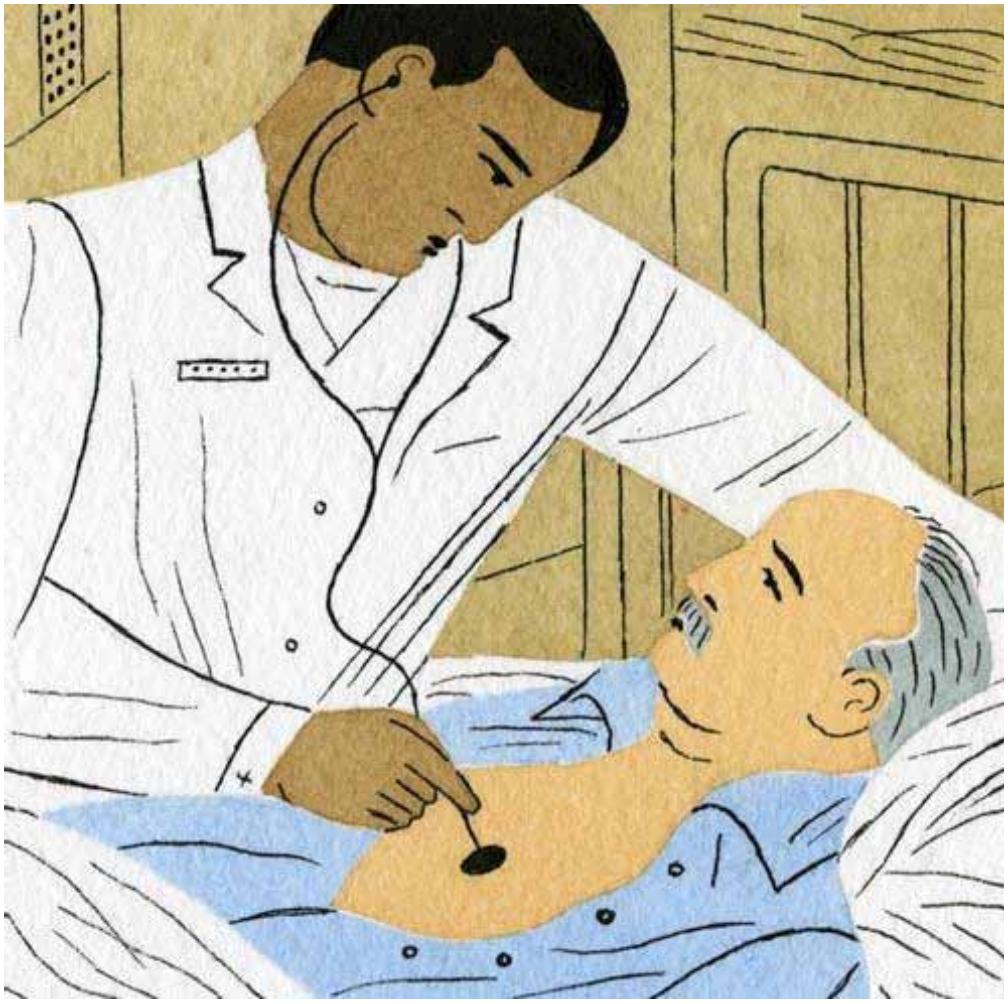
Invisible surgery

A few of its guises

AT STANFORD, teams of interventional radiologists, surgeons and other specialists in a range of disciplines are expanding the possibilities for surgery through small incisions — or by way of natural orifices.

A few examples:

- Stanford surgeon **JOHN MORTON, MD,** who has done minimal-access procedures for years using three or four small incisions, has begun using a single incision — in the belly button — for certain gastric bypass surgeries. The associate professor of surgery says it's not easy to tie knots on the inside, but the payoff for patients is a quick recovery. Patients are often able to go home the next day and are up and about a few days later.
- **SANJEEV DUTTA, MD,** is a Stanford and Lucile Packard Children's Hospital surgeon who uses the armpit as an entrance point, making an incision just deep enough to let him slip tiny surgical tools under the skin to reach the neck. Once there, he can remove thyroid and parathyroid glands, cysts and other lesions. Dutta has also used the subcutaneous route to move from an incision in the scalp to a cyst on a patient's forehead. Neck surgery in particular can leave some of the most stigmatizing scars, he says, "and if I can safely and effectively do things I need to do while addressing that kind of concern, I'm obligated to do that."
- Stanford otolaryngology surgeon **JAYAKAR NAYAK, MD, PHD,** calls the nose a central terminal that makes several areas accessible without the kind of long incisions down the side of the face once needed for procedures such as reducing eye pressure caused by the autoimmune disorder Graves' disease. The new scope of transnasal surgery means treatment for a wider variety of tumors and infections. And even though the nose houses bacteria, incisions in its interior have proven to have a lower infection rate than any skin incision. He says the next destination by nasal entry could be the spine.



the healing hand

PUTTING THE PHYSICAL

BY
RUTHANN RICHTER
ILLUSTRATION
BY BRIAN CRONIN

"What do you notice about this patient?" Abraham Verghese, MD, asks the four trainees as he nudges them closer to the bed. The patient, a 44-year-old woman, smoothes her blondish hair and adjusts her hospital gown to cover herself.

Well, her sclera [whites of her eyes] look a bit yellow, one volunteers. Verghese, a professor of medicine, nods. He gently picks up the patient's hand and points to her palm and how it bears a curious pattern — islands of intense redness on a background of pale white skin. "That's palmar erythema," he says. He leads the student to feel a distinct raised and thickened tendon in the palm. It is called

Dupuytren's contracture, and it occurs in patients with liver disease. Now he feels the patient's pulse and remarks how it is forceful — indeed, it can be felt not just with the fingertips but simply by holding the wrist in one's hand as if trying to pull the patient up. It is a "bounding" pulse, a sign of a wide pulse pressure that can occur with liver dysfunction. These are common observations, Verghese tells me later, and though students may know about them in theory, they may not have recognized them in practice.

The professor, with the patient's permission, exposes the skin just under her collarbones, revealing curious red, star-shaped markings. These are spider angiomas, fanning out like the threads of a spider web. The students lean in to glimpse

BACK IN THE PHYSICAL EXAM

the unusual blood vessel patterns, which they've never seen before. These and a host of other findings are the classic signs of liver disease, says Verghese, the senior associate chair for the theory and practice of medicine.

"It would be unfortunate to use technology to tell us something that's clear on the first blush," he tells the trainees. "That's why this bedside practice is useful to us. It helps us ask better questions of the tests we order."

These bedside teaching sessions, which he conducts with students every Wednesday, are part of a department-wide effort, spearheaded by Verghese, to resuscitate the vanishing art of the bedside exam. As doctors increasingly rely on imaging and other new technologies, they have strayed from the practice of diagnosing disease on the basis of a physical exam.

What has been lost in the process is not only the time-honored, meaningful ritual of the doctor-patient encounter, which itself can be reassuring and therapeutic for the patient, but also critical information about the patient's condition, which is available at once, often days before a test (if ordered) reveals the same result.

Verghese, who considers the body a text of sorts, and considers the skilled exam a form of basic medical literacy, has made it his mission to revive this kind of literacy nationwide. He credits Ralph Horwitz, MD, professor and chair of the Department of Medicine, who recruited him to Stanford three years ago, for giving momentum to the effort to help reshape the way medicine is practiced.

"We order tests so easily because, as my colleague [health economist] Alan Garber, MD, PhD, has said, our health-care system feels like the 'menu without prices' — we can order filet mignon every night. No one really stops to consider what a test costs or who is paying," Verghese says. Reversing the trend is a daunting challenge, but he believes no effort is more important for medicine's future.

"We make huge errors of oversight because certain conditions are staring us in the face — and we miss them," he says.

VEERING AWAY FROM THE BASICS

There was a time not so long ago when the doctor's senses — hearing, vision, touch and even smell and taste — as well as skill at gleaning a patient's history were the anchors of the diagnostic tool kit. Clinicians relied on simple gadgets they could carry, such as reflex hammers and stethoscopes.

The movement away from the history and exam emerged

"I view the bedside exam as ritual, and rituals are
The person becomes vulnerable and

in the 1970s with the rise in advanced imaging techniques, such as ultrasound, CT and MRI scanning, and echocardiograms to detect heart problems.

"I began practicing in an era when we didn't have a CT scan. If a patient came to the ER with abdominal pain, a bedside exam was vital for determining whether they had appendicitis or some other condition," says Charlotte Jacobs, MD, emeritus professor of medicine and former senior associate dean of education and student affairs.

Now, a patient with abdominal pain may be shipped off to a CT scanner, which may — or may not — yield information of value. But often it is only the hand examining the patient that reveals where the patient is most tender and where the attention needs to be directed. The expensive new tools aren't useful in every case, and for CT scans and some other imaging techniques, there's risk from radiation exposure to consider.

After his arrival in 2007, Verghese, with Horwitz, introduced the Stanford 25, an immensely popular "grand experiment" in which trainees in internal medicine get focused instruction on 25 essential exam skills *[see page 24]*. He also organized a national conference, the first Symposium on the Bedside Exam, at Stanford last fall, bringing together some 40 master clinicians from around the country who are interested in rejuvenating bedside skills.

Speaking nationally on reviving the bedside exam, he has struck a chord. More than 1,000 physician educators attended a talk on the subject at the annual meeting of the Association of American Medical Colleges in November 2009.

"I was mobbed by people wanting more details," he says. "The irony is that these skills have been around for at least 100 years. The problem is that they have fallen into disuse."

The physical exam skills of American clinicians are deteriorating, the result of powerful converging forces.

"It has nothing to do with the lack of interest or this idea that it's not useful. It has to do with how medical problems are defined," says Steve McGee, MD, a professor of medicine at the University of Washington who attended the Stanford conference and is among those advocating for change. "Our understanding of clinical problems has become more and more scientific, and patient problems have become subdivided more and more, so that what people look for is the objective data to decide what category to put people in," adds McGee, author of the widely cited textbook, *Evidence-Based Physical Diagnosis*.

Verghese says the physical examination skills of today's internists have declined in part because their proficiency isn't required for certification to practice. The American Board of Internal Medicine's exam is multiple-choice, and applicants are never grilled on their clinical skills. So internists can treat patients without ever proving that they know how to find a spleen or check the reflex in an ankle, he says.

"The public would be scandalized if pilots were allowed to fly without ever having been in the air with a seasoned examiner; medicine's standards should be no lower," he wrote in a December 2008 perspective in the *New England Journal of Medicine*.

And then there's the problem that might be at the root of it all: In former days, doctors simply had more time to spend with patients.

"We're asked to do more and more in the same amount of time," says David Simel, MD, vice chair of the Department of Medicine at Duke University and chief of medicine at the Durham-VA Medical Center. "It has had a negative impact on the ritual. Our ability to just sit there and listen to a patient is limited."

With so many competing time demands, it is a daily challenge to make the physical exam a priority, says Tyler Johnson, MD, an intern at the Palo Alto Veterans Affairs Health Care System.

"My experience as an intern is that you're so busy, it's so much easier to fall back on a lab value," Johnson acknowledges. "In the process, you lose the power that comes with the physical exam."

Mastering the art of the bedside exam requires practice, repetition and feedback, all of which take time.

"It really takes years of practice to become an expert, at least 10 years of meaningful practice," says Simel. "Compare it to sports, where coaches can go through it over and over and can review the game playback. We don't get the opportunity to do that in medicine."

HANDS-OFF MEDICINE'S RISKS

Drummond Rennie, MD, a professor of medicine at UC-San Francisco and deputy editor of the *Journal of the American Medical Association*, takes a particularly dim view of Americans' increasing reliance on technology.

about transformation.
invests great authority in another." ABRAHAM VERGHESE, MD

LENNY GONZALEZ

"There is an emphasis on tests in this country which is staggering," Rennie says. "The American public has fallen in love with tests, no matter how harmful, useless and expensive."

Rennie maintains that doctors in Great Britain, Australia, New Zealand and some other countries do a far better job of the physical exam because they don't look to test results for all the answers.

"There is a marked difference in emphasis and the immediate consequence is that if you downgrade the history and the physical you can make spectacular mistakes and you never get to know the patient," Rennie says.

McGee agrees that a lot of mistakes are made because of lack of attention to physical detail. For instance, some doctors confuse signs of heart failure with pneumonia in hospitalized patients, particularly if they rely on X-ray results that show airspaces in the lungs filled with fluid, an ambiguous finding. The patient with heart failure, however, would have other signs that would show up on careful examination, such as elevated neck veins, an extra heart sound, a rapid heart rate or weight gain, he says.

Many useful and simple hands-on diagnostic practices have fallen by the wayside, says former education dean Jacobs. For instance, a thyroid tumor can be detected by gently feeling the gland in the throat, yet a lot of primary care physicians don't do this simple exam anymore, she says. Similarly, a rectal exam may detect a colon cancer, yet some doctors have abandoned this low-tech procedure in patients who have had a colonoscopy, which is done only every five to 10 years.

As an oncologist, Jacobs also teaches trainees the importance of a careful lymph node exam in cancer patients. If a cancer patient has enlarged, firm lymph nodes, an experienced clinician could measure the nodes, note their location and examine the patient regularly to gauge the patient's response to therapy.

"There are a number of oncologists who don't bother to do that, and it's foolhardy," Jacobs says. "They just order a CT scan once a month. I see patients in consultation from the outside, and in the reports on what happened on examination, all I get is a stack of CT scans, no physical exams."

One of her particular pet peeves, she says, is the failure of physicians to use an ophthalmoscope to examine the eyes of a cancer patient with signs and symptoms of a cancer that has spread to the brain. A look at the disc in the back of the eyes will tell the clinician if there is an increase in pressure in the brain, a sign of the cancer's spread.

"Trainees will sheepishly say they don't know how to do the exam," Jacobs says. "They last did it in medical school. The excuse is that they're going to do a scan anyway."

THE IMPORTANCE OF TOUCH

In moving away from the bedside exam, clinicians not only lose valuable information but they also miss out on what some physicians view as an important transaction with the patient.

"I view the bedside exam as ritual, and rituals are about transformation," says Verghese. "The person becomes vulnerable and invests great authority in another. The patient disrobes and allows touching — that is a very significant ritual. If the other person's skills are not up to the investment of authority, nothing happens."

Touch alone and the focused physical attention of the clinician can aid in the healing process, says Daniel Sedehi, MD, chief resident in internal medicine at Stanford.

"For the patients, physical contact — the laying on of hands — has therapeutic benefit, for psychosocial and physical rea-

WEB EXTRA: HEAR AN INTERVIEW WITH ABRAHAM VERGHESE ON HANDS-ON MEDICINE AT STANMED.STANFORD.EDU/2010SUMMER

The Stanford 25 EXAM TECHNIQUES EVERY DOCTOR SHOULD KNOW

ON A THURSDAY MORNING, about 40 internal medicine trainees gather in a Stanford Hospital room to learn what a hand can reveal about a person's health. It is the monthly Stanford 25 session, one in a series of workshops teaching 25 essential techniques for examining patients.

"My worst nightmare is a patient with a diagnosable, treatable disease that I missed because of sloppy technique," Abraham Verghese, MD, professor of medicine, says in opening the session.

Verghese, the Department of Medicine's senior associate chair for the theory and practice of medicine, designed the Stanford 25 with first-year residents (interns) in mind. He hopes that they will perfect a repertoire of hands-on diagnostic skills they can pass along to next year's crop of interns when they become their immediate supervisors. But the Stanford 25 sessions have proved popular with second- and third-year residents as well, and the room is full. All trainees have been taught these techniques or know them in theory, but the sessions emphasize hands-on practice.

Each gathering, part of the required curriculum, focuses on a single diagnostic technique and what it can reveal. Verghese uses real patients, standardized patients (actors), and occasionally, as in the session this morning, trainees practice on each other. He also uses simulators, in particular for rectal and scrotal exams, and is enthusiastic about a newly ordered cardiopulmonary simulator — a mannequin displaying normal and abnormal heart impulses and sounds.

VERGHESE ON THE TECHNIQUES:

1. Funduscopic exam: Using an ophthalmoscope to examine the fundus (the retina, vessels and nerves in the back of the eye) can help assess the condition of blood vessels throughout the body, diagnose neurologic problems and provide clues to systemic diseases from heart valve infection to AIDS.

2. Pupillary responses: This session covers how the pupils constrict and dilate to light and respond to distant and near vision, as well as the best ways to elicit these findings. The responses can indicate trauma to the eye, and neurological disease and other conditions.

3. Thyroid exam: Palpating the neck to feel the thyroid gland can help diagnose thyroid disease. A nodule can indicate thyroid cancer. Without thorough training, people often feel too high on the neck or place their fingers at an angle that precludes feeling a nodule.

4. Neck veins: Because the jugular veins in the neck go directly to the heart, they can indicate cardiovascular problems. Seeing the neck veins and discerning their pulses takes a practiced eye, good patient positioning, good light and patience. Once it's seen, the pulse level can be measured and abnormalities identified that can diagnose cardiac conditions such as tricuspid incompetence and complete heart block.

5. Lung: Percussing (tapping) on the chest and sounding out the lung's boundaries are useful for detecting fluid or pneumonia, particularly in areas without access to radiology equipment and blood testing.

6. Point of maximal impulse and parasternal heave: The PMI is a dime-sized area of the chest, just left of the breast bone, where the beating of the heart can be felt. Heart and lung problems, such as hypertension or cardiomyopathy, create unique PMIs. The parasternal heave is an impulse originating in the heart or large vessels that can be felt with the heel of the hand resting on the left sternum. Though these are crude and simple maneuvers, they reveal much about the heart and can help physicians ask better questions of echocardiograms they order.

7. Liver: This session covers percussion to approximate liver size as well as techniques to feel the liver edge and to feel its surface for nodules and masses. It includes feeling for tenderness in the gallbladder region and signs of gallbladder inflammation.

8. Palpation, percussion of spleen: The spleen is notoriously difficult to feel, yet it is embarrassing to miss an enlarged spleen. When enlarged it is almost always abnormal: It can be a sign of infection, tumor or liver disease. Positioning both the patient and the examiner properly is critical for success.

9. Common gait abnormalities: A person's walk can indicate nervous system and musculoskeletal problems. The long hospital corridors provide a great opportunity to observe gait abnormalities common in patients with a stroke or with Parkinson's disease, or peripheral neuropathy (damage to nerves outside the brain and spinal cord) and multiple other conditions.

10. Ankle jerk: This is a natural reflex, a brisk forward movement of the foot, which occurs when a hammer strikes the Achilles tendon above the heel. An absent reflex might suggest nerve damage, but often a reflex is labeled absent only because of incorrect technique (in a bedridden patient in particular). The ankle reflex is almost a metaphor for the Stanford 25. Being able to elicit this reflex generally means the examiner can elicit the other reflexes, which are easier to bring out.

11. Stigmata of liver disease: The paradox of liver dysfunction is that its signs are found outside the abdomen. These so-called stigmata include spider angiomas (dilated capillaries) on the cheeks, parotid gland enlargement, diminished armpit hair, breast enlargement in a male, islands of redness on the palms and myriad other findings.

12. Internal capsule stroke: An area deep in the brain called the internal capsule is one of the most common sites of stroke. The condition produces a plethora of neurological signs that can be demonstrated, involving cranial nerves, muscles, sensation, reflexes and gait. In this session, the student runs through a series of maneuvers from head to foot that help identify the location of the stroke.

13. Knee exam: The knee is often affected by disease and by trauma. Well-validated means exist for establishing the presence of fluid in the knee and testing for tears in a meniscus or ligament — each test involves a specific physical manipulation, which requires practice.

14. Cardiac second sounds/splitting: The healthy adult has two normal heart sounds (the familiar lub dub), produced when heart valves close.

The second sound is actually composed of two separate sounds produced by closure of the aortic valve and the pulmonary valve. Though they close together they become asynchronous after a deep breath. Many variations on this theme — exaggerated splitting or paradoxical splitting or fixed splitting — can speak to specific conditions such as bundle branch blocks or atrial septal defect to name two.

15. Involuntary movements: These range from tremors to much more complex movements. In this exercise, students learn to identify and characterize the types of tremors as well as other involuntary movements termed chorea, athetosis and several more.

16. Hand: Many diseases show signs in the hand, from Down's syndrome (evidenced by an extra crease in the palm) to certain cancers. The nail is affected by disorders ranging from cystic fibrosis to lung cancer. In this session, students learn to read the hand for everything from nerve disorders to specific finger deformities that in turn predict systemic disease.

17. Tongue: Visually inspecting the tongue for swelling, unusual color or texture can reveal signs of oral cancer, nutritional deficiencies or infection, such as HIV.

18. Shoulder: Like the knee, the shoulder joint is commonly affected by injury and aging. A series of observations and maneuvers can lead the clinician to strongly suspect a specific diagnosis, such as rotator cuff syndrome or even joint dislocation.

19. Blood pressure assessment: Accurate blood pressure measurement is dependent on correct use of the right-sized cuff in the right manner. In addition, the sounds heard when the cuff is deflated can indicate conditions such as fluid buildup around the heart.

20. Cervical lymph node assessment: Enlarged lymph nodes in the neck are easily overlooked. Their size and presence can indicate cancer as well as responses to therapy.

21. Ascites: Ascites is the buildup of free fluid in the abdomen, around the organs. Ascites is often associated with liver disease, such as cirrhosis, but also develops in heart failure and ovarian cancers. A technique involving percussion detects fluid.

22. Rectal exam: Many cancers of the colon are in the rectum, and a good many of these are within reach of the examining finger. In addition the rectal exam is a precious way to feel the prostate and other pelvic pathology.

23. Evaluation of scrotal mass: A mass, or lump, in the testicle is a possible symptom of infectious disease, tumor or hernia.

24. Cerebellar testing: The cerebellum is an area of the brain that plays an important role in motor control and coordination. Disease of the cerebellum produces a whole list of abnormalities from speech ("scanning speech") to gait changes, to abnormal reflexes. In this exercise, the physicians are taught to run patients through a list of tests and maneuvers to assess cerebellar function. ("Finger to nose," "finger to finger," "heel to shin" and "rapid alternating movements" are some of the maneuvers taught.)

25. Bedside ultrasound: Use of portable ultrasound at the bedside can identify fluid in the lung, free blood in the belly and determine if the patient is dehydrated or fluid-overloaded by studying a central vein. The technology in this area is rapidly evolving and an ultrasound might one day be among the contents of the white coat pocket.

sons," Sedehi says. "My belief is that the physical exam allows patients to relieve some of their stress. If they're not talking to and seeing their physician, they're kind of left in the dark. I think our culture has been that people expect the physician to examine them. Without that, the emotions may run wild."

He says that most trainees chose the practice of medicine so they could experience that important human bond — not spend their time staring at a computer screen or a radiology film.

"I don't think the majority of people entering internal medicine are going into it so they can look at an image," Sedehi says. "They want to learn how to use all their senses in working with a patient. That's what is exciting. I think those skills have fallen out of favor because ordering tests is functionally easier and the time limits us. In the pursuit of efficiency you shouldn't forget to be human."

THE SCIENCE OF THE PHYSICAL

Part of the process in reviving the physical exam is determining what aspects of the exam are useful and what are not. As an editor at *JAMA*, Rennie instigated a series called "The Rational Clinical Exam," which examines various patient scenarios in a systematic way, based on history and the medical literature, to validate what works. The journal has published more than 80 articles in the series, now available as a book.

"I think the series has pushed educators to think a little more about what they teach in the physical exam," Simel, his co-author, says. "So rather than teaching the entire physical exam from head to toe, we are using it to figure out what sorts of things you must do and what things are worthless."

Verghese says he also plans to build a web-based repository of clinician anecdotes about common mistakes and signs missed during the exam process. This could serve as a physician guide to potential pitfalls. It was one of the ideas that emerged from the fall symposium at Stanford.

"We agreed there is a whole litany of errors we're not catching — subtle errors," he says.

While advocates say there is clearly an interest on the part of clinicians and educators in rejuvenating the bedside exam, Jacobs says there are a number of factors that could help bring about change. Physicians must be comfortable doing all aspects of the exam, and that takes repetitive training. If they see colleagues regularly using their clinical skills, that will reinforce the value of hands-on practices among peers, she says. Physicians also will be more likely to perform a bedside exam if it is linked to reimbursement, she says. And public expectation may play a role, as people begin pressuring their doctors to give them a careful physical exam, she says.

"There is nothing like public pressure to bring about change." **SM**

Ruthann Richter is at richter1@stanford.edu

TAKE THE TUBE

Mass transit for lab samples

In a hospital the size of Stanford, where a quarter-mile's distance might separate a tissue specimen from its destination lab, making good time means better medicine. That's why every day, 7,000 times a day, the hospital's staff turns to pneumatic tubes — technology that was cutting edge when first introduced in the 19th century — for a transport network that the Internet and all the latest Silicon Valley

BY SARA WYKES
PHOTOGRAPHS BY
NORBERT VON DER GROEBEN

STANFORD HOSPITAL'S CHIEF ENGINEER, LEANDER ROBINSON, STANDS NEAR THE BLOWERS THAT POWER THE PNEUMATIC TUBE SYSTEM, FOUR MILES OF TUBING SNAKING BEHIND THE BUILDING'S WALLS. RIGHT: TRANSFER UNITS THAT DIRECT THE TUBES TO THE VARIOUS STATIONS.

wizardry still can't match: A tubular system to transport a lab sample across the medical center in the blink of an eye.

In four miles of tubing laced behind walls from basement to rooftop, Stanford Hospital & Clinic's pneumatic tube system shuttles foot-long containers carrying everything from blood to medication.

"Approximately 70 percent of the information on a patient's chart is lab data," says David Myrick, quality coordinator for the hospital's clinical labs. "We conduct about 8 million tests a year, serving thousands of patients. We are going full blast, 24-7, at the highest level of testing. The tube system is part of a complex chain of events that ultimately give doctors the essential lab results they need to make decisions about our patients."

The value of these pneumatic tube networks is not unique to Stanford — they are in use at hospitals nationwide — but SHC's system, which also serves the adjacent Lucile Packard Children's Hospital, is one of the largest in the country. Its architecture is a sophisticated design of switching points, waiting areas, sending and receiving points. It hosts 124 stations (every nursing unit has its own); 141 transfer units to prevent crashes; 99 inter-zone connectors to facilitate the most efficient routing, and 29 blowers, the heartbeat of the air-driven system. To help alert employees to the arrival of containers, the system has more than three dozen combinations of chiming tones.

Stanford's leaders are planning a new hospital, which they project will be up and running by the end of the decade. When it opens, its tube system will be tied in to the old system to create what will likely be the largest pneumatic tube system in the world — approximately eight miles long and an additional 50 to 75 stations. It will have technology to enable six containers to be sent express within one transport zone. Now, just one at a time can be sent in that fashion. That multiple express capacity will be especially needed for the hospital's transfusion service, which often sends blood and blood plasma when the need is urgent.

Such pneumatic tube systems date back to the early 19th century, when they drove the workings of postal services, department stores and other commercial businesses whose physical size demanded something faster than standard human pace. But those versions were usually designed to move paper. As computers and then the Internet made it possible to deliver data electronically without paper, tube systems lost their value for many industries.

BUT THE TECHNOLOGY ENDURES — AND THRIVES — IN HOSPITALS, THANKS IN PART to more recent improvements in the delivery system. Originally, the tubes would arrive with a thud, a hard landing that could damage sensitive lab samples. Then in the late 1980s engineers figured out a way to control airflow to slow down the containers for a soft landing at their destination station.

At Stanford Hospital, before 1993, a team of about 20 people had the job of transporting the multitudes of tissue, medications and documents. However, the increasing size of the hospital, and the addition of two adjacent buildings,

LAB ASSISTANT NAPOLEON GACUSANA IN STANFORD HOSPITAL'S PRE-ANALYTICAL DEPARTMENT PULLS OUT A FRESHLY DELIVERED BLOOD SAMPLE. RIGHT: ROBINSON HOLDS AN OPEN CYLINDER THAT'S EMPTY AND READY FOR NEW CARGO.

the Blake Wilbur Building and Packard Children's Hospital, made the tube system option the most modern solution. "We like the human touch," says chief of staff Bryan Bohman, MD, "but we don't like the human foot speed."

Depending on the diameter of a tube, cylinders can reach speeds of up to 25 feet per second, about 18 miles per hour, far faster than any human could ever manage.

It was also a question of best use of employee time, if, as often happened, a courier wasn't available when a specimen needed to get to the lab. Having a nurse leave a patient's bedside for a minutes-long run to the lab made no sense.

Reliable speed is crucial when the system carries blood products, some of which are temperature-sensitive and, by regulations, must be discarded if not properly maintained. The tube system, says lab operation services manager Gay Routh, "is vital, very vital. I don't know what we'd do without the tube system, especially when it comes to tests like those that happen in surgery. When arterial blood gases are sent from the operating room, we need to return results in a very short period of time, so physicians know if they need to change settings on a monitor. Years ago, before the tubes, we would get a phone call and we'd have to send somebody. It definitely slowed our turnaround time."

The hospital's chief engineer, Leander Robinson, commands the system from a small basement office, where computer monitors light up every time someone puts a container in a chute, types in a numerical address and presses the "send" button. The screen displays a tiny icon that reflects the container's travel through various switches and transfers, but it moves so quickly it's actually hard to track its passage. Even during the heaviest flow through the system, between noon and 2 p.m., a container can cover the longest start-to-finish distance — 1,500 feet — in less than three minutes.

The system has a complete set of checks and balances, sensing where containers are needed and sending them. Some departments, such as the operating rooms, have dedicated lines that guarantee them a straight shot to the lab. "Blood products get first priority," says Lee Chua, blood transfusion services manager.

THE SYSTEM DOES OCCASIONALLY FALTER, BUT IT IS OPERATIVE 98.8 PERCENT OF THE TIME, Robinson says. And no cylinder has ever gotten stuck in a tube, he says.

Robinson has software that monitors the system, charting its use station by station and watching especially those times when someone sends a cylinder "stat" — the highest priority coding.

It's also a work in constant progress; the hospital continues to evolve and locations can change. "The tube is everywhere," Robinson says, "and the directories ever-changing."

The system "is amazing," says assistant patient care manager Pam Ponti, who sends and receives cylinders that affect surgical care. "I don't know exactly how it knows where to go, I'm just happy that it does."

Recently, the hospital's tube system emerged as an object of interest to a newly formed group called Atlas Obscura. Dedicated to drawing attention to the world's unusual sights, both natural and man-made, the group asked the hospital if it would participate in tours of these sights as part of the first Atlas Obscura Day, on March 20.

More than 3,000 people signed up to tour 80 locations in 20 countries. Many more people couldn't be accommodated, including 45 who didn't sign up fast enough to be among the lucky 13 to take the tour of Stanford Hospital's now-famous tube system. **SM**

Sara Wykes is at swykes@stanfordmed.org

WEB EXTRA: SEE A VIDEO OF A JOURNEY THROUGH THE TUBES AT STANMED.STANFORD.EDU/2010SUMMER

CODE GREEN

New hospitals blend healing and conservation

BY DIANE ROGERS
ILLUSTRATION BY CHRISTIAN NORTHEAST

In an alcove a few feet away from an operating room, the surgeon covers his hair with a surgical cap and pulls a surgical mask over his nose and mouth. He uses a pick to clean under his closely trimmed nails, though they look clean already.

Then the washing begins. He gets the water flowing just right — gentle enough to avoid splashing, but hard enough to sweep away microbes and debris. He's careful to keep his hands above elbow level so the dirty water runs away from his fingertips throughout the washing. He wets his hands and forearms with a sponge and antiseptic, 30 seconds per arm. He brushes his nails, 30 seconds per hand. Then he washes both arms for two minutes each, scrubs between his fingers and scrubs his palms with his fingertips. He rinses his arms and hands, turns off the tap using his elbows, and allows his hands and arms to drip dry, keeping his hands above his elbows. With drying and gowning still to come, he's only halfway through scrubbing in — a routine that hasn't changed in its essentials for over a century.

Meanwhile in a conference room on another floor, hospital administrators are in the midst of their own version of scrubbing in. They're scrutinizing every aspect of the construction and operation of a new facility so they can build and run it as cleanly as possible. Electricity demands and carbon emissions will be reduced by maximizing natural light and adjusting ventilation and temperature throughout the day; air quality will be high because of new nontoxic carpeting and upholstery; wastewater will be treated to arrive at the sewage plant free of drugs and other chemicals. The administrators aim to reduce the hospital's waste, shrink

its carbon footprint, cut resource consumption and eliminate pollution. In effect, they're scrubbing the whole hospital.

As similar scenarios play out in hospitals throughout the country, it's clear that the $40 billion health-care construction industry is not only booming today — it's going green. Like Stanford Hospital & Clinics, which opened in 1959, hundreds of hospitals built after World War II have come to the end of their 50-year life spans. Like Stanford and the adjacent Lucile Packard Children's Hospital, they're being rebuilt in a far more environmentally conscious era.

Their leaders are learning that factoring in protections for the environment is complicated and expensive — but can save money in the long run. And the communities surrounding them won't stand for anything less.

"What is different from 10 years ago is that the general public and local governments are now aware of and tuned into environmental impact," says George Tingwald, MD, director of medical planning for the Stanford Hospital renewal project. The new building, designed by Rafael Viñoly Architects, is projected to open before the end of the decade.

"Going green is not only the right thing to do, or the fashionable thing to do today — sometimes it's the law," says Tingwald. "Costs for certain green technologies have decreased, so it's easier to go green, but more important, governments are mandating green design."

In Palo Alto, for example, a city ordinance requires that new construction projects of greater than 5,000 square feet meet LEED "silver" requirements. LEED is the Leadership in Energy and Environmental Design rating program of the U.S. Green Building Council, and silver is its third-ranked category. Stanford has set LEED silver equivalence as its goal, Tingwald adds.

Hospitals are different

COMPARED WITH OTHER INDUSTRIES, HEALTH CARE HAS BEEN SLOW TO CLIMB ABOARD the green-building bandwagon, says Robin Guenther, lead architect for the Packard Children's Hospital expansion project. That's because hospitals operate in "a restrictive, highly regulated, risk-averse environment," says Guenther, a nationally recognized sustainable-hospital design expert and a principal at the design firm Perkins+Will.

Even two or three years ago, says Walter Vernon, president of the San Francisco engineering design firm Mazzetti & Associates, "you had to work pretty hard to convince health-care owners that they needed to think about green-building issues."

But today? "Going green has gone mainstream," says Vernon, whose company is engineering both the Stanford Hospital and Packard projects.

While the greenness of most commercial buildings is determined by their impact on the outdoor environment, hospitals are held to a higher standard: They are expected to tread lightly outdoors *and* to promote a healing environment indoors. "A green hospital includes everything from siting and design to the construction and operations of buildings. It's about everything that occurs in and around the buildings," notes Anna Gilmore Hall, executive director of Practice Greenhealth, a nonprofit membership organization representing more than 1,000 hospitals in North America.

It's a big job for hospitals. The energy costs of keeping lights and computers on 24/7, maintaining the humidity and temperature in operating suites, running negative-air pressure rooms for patients who need to be isolated, cooling ginormous specimen fridges — you get the picture. Not to mention toxic waste, like the lead in radiation shielding, disposal of pharmaceuticals, as well as the challenge of keeping clean without caustic chemicals in cleaners and pesticides. (In 2007, Stanford Hospital switched to cleaning chemicals cer-

tified by the ecolabeling organization Green Seal.)

The U.S. health-care industry consumes $6.5 billion worth of energy each year, making it the second most energy-intensive building sector (food service is No. 1). Hospitals are often communities' largest users of water and are major generators of waste. All of this activity contributes to the production of climate-changing greenhouse gases.

Sustainability in practice

GUENTHER HAS BEEN IN THE BUSINESS OF "GREEN HEALTH CARE" SINCE ITS INCEPTION, IN THE MID-1990S, when she was asked to design a bone marrow transplant unit for Mount Sinai Medical Center in New York. "The laminar air-flow manufacturer rejected every material I wanted to use on the basis of unwanted particulate off-gassing," she recalls. "I thought, 'Wow! If these materials are really bad for patients whose immune systems are compromised, they can't be good for other patients, either.' And that led me on this whole investigation into the materials that we surround ourselves with." Ultimately she wrote, with co-author Gail Vittori, the key reference text for the field, *Sustainable Healthcare Architecture* (John Wiley & Sons Inc., 2008).

With Guenther as lead architect for the Packard renewal and Vernon as head engineer for both the Packard and Stanford Hospital projects, it would be difficult to find a more committed green-building team. Together with Vittori, they helped develop the *Green Guide for Health Care*, a best-practices guide for improving energy and water efficiency and using safer materials, and they oversee the guide's online forum. They know the key elements that have to be addressed in every successful sustainable project: site planning, energy, water, materials and indoor environmental quality. And they could teach The Greening of Health Care 101.

Starting about 10 years ago, Guenther notes, community hospitals in environmentally progressive communities, like Boulder Community Hospital in Boulder, Colo., and religious-based health-care organizations, like St. Mary's/Duluth Clinics in Duluth, Minn., began to take the lead in the greening of health-care facilities. By installing a new high-efficiency, low-emission boiler, the Boulder hospital reduced nitrogen oxide emissions by 70 percent, carbon monoxide emissions by 50 percent and fuel consumption by 20 percent over standard boilers.

In many projects, hospital administrators with environmental commitments initiated pollution prevention and green building efforts, for instance low-VOC (volatile organic compounds) paints, recycled denim for insulation and PVC-free carpeting. CEOs often cited a personal reason or a cathartic experience for their interest. "For example, Kaiser Permanente, an early adopter, traces its interest to a talk Rachel Carson, author of *Silent Spring*, gave executives just before she died from breast cancer," Guenther says.

Designers and architects also started asking broad questions that prompted hospital administrators to consider greening not only construction but also overall operations. Could new urban buildings be sited near mass transit systems so that patients, family members and staff could get to the hospital more easily? What could be done to reduce the volume and toxicity of medical wastes? What could be done to lower hospital staff exposures to cleaners and pesticides? Could hospitals use locally grown food? Could cafeteria managers purchase beef that is antibiotic-free, as well as milk and yogurt without synthetic growth hormones?

The American Medical Association has long advocated the elimination of antibiotics in meat production, largely because of developing antibiotic resistance. But hospitals — not the AMA — buy meat. And when they make "green" purchases, the market responds. "Why do green hospitals matter?" Guenther asks. "Because the health-care sector is the largest service sector of the U.S. economy, a huge employer and touches most Americans' lives. When health care models green building or healthier food choices, or advocates for public transit, patients and staff notice."

Models of green health-care facilities include Brigham and Women's Hospital's Shapiro Cardiovascular Center. Opened in 2008, it is the first hospital building in New England to achieve silver LEED certification. The Shapiro design team set out to emphasize indoor air quality and energy efficiency. State-of-the-art air filtration helps reduce the incidence of hospital-acquired infections. New floor cleaners are resulting in fewer respiratory problems among staff — an important change since health-care workers account for more than 40 percent of occupationally related, adult-onset asthma. Latex gloves have been eliminated, more efficient landscaping has reduced water use by 50 percent and more than 90 percent of construction debris was recycled. More than 75 percent of the center's interior is exposed to natural light, which some studies indicate accelerates healing.

Healing influence

NUMEROUS STUDIES OVER THE PAST DECADE HAVE SHOWN THAT SUNLIGHT IN PATIENT ROOMS is associated with reduced pain, stress and depression. Views of nature similarly strengthen patient recovery, shorten hospital stays and reduce levels of

pain and stress. For example, a study in *Psychosomatic Medicine* of 89 spinal surgery patients concluded that exposure to sunlight led to recovery with less stress, pain and need for pain medication (Jeffrey Walch et al., Jan./Feb. 2005).

Another green model, Dell Children's Medical Center of Central Texas, has earned the top-ranked platinum LEED certification. In addition to using local materials for construction, the Dell design team built an onsite power-generation facility, recycled 92 percent of construction debris, reclaimed an environmentally damaged site, or "brown field," significantly reduced potable water use and planted only native grasses. Spotlighting the intimate link between outdoor environment and indoor, healing environment, the hospital has seven courtyards for patients, family members and staff to meander through. The designers refer to them as "the lungs of the building."

Guenther is particularly pleased with the way the new building in the Packard Children's Hospital project will connect to the outside environment. The proposed design features a two-story glass lobby that faces one of many gardens. The current site, dominated by asphalt parking surfaces, would be converted into almost four additional acres of landscaped green space. "Recovering what is termed in the industry a 'gray field,' or a previously developed site that has been stripped of its capacity to support ecosystems, and turning it back into a 'green field' is a huge achievement," Guenther says. "It can handle storm water better, and it's just going to function better, supporting life on every level." Plans also call for using condensate water — the liquid that is formed by dehumidifying indoor air — to irrigate all of the landscaping, along with rainwater that is collected in an underground 90,000-gallon cistern.

"Having green buildings doesn't mean that suddenly the operating rooms are going to be warm because we're saving energy, or that there won't be enough light to see," Guenther adds. "Sustainability does not equal deprivation. It's actually about being smarter in resource use."

Ask Walter Vernon about the coolest new green technologies that are going into the two hospital projects, and he's liable to slip into geek speak about IAQ, or indoor air quality. According to the Environmental Protection Agency, indoor air pollution is one of the top five environmental risks to public health. Hospitals traditionally have relied on ventilation systems that cool down air, then warm it back up, and finally mix it up to dilute the amount of airborne, transmissible organisms. Vernon's displacement system eliminates the need to cool and reheat air. "We basically introduce air at the floor level, at a low velocity, and as it rises up, it displaces warmer room air and carries out any bugs with it." If Vernon's new system meets expectations, the potential energy savings could be dramatic.

"SUSTAINABILITY DOES NOT EQUAL DEPRIVATION. IT'S ACTUALLY ABOUT BEING SMARTER IN RESOURCE USE."

Vernon's firm has also completed a greenhouse-gas inventory for Stanford Hospital, measuring and recording all the emissions for the hospital and its related buildings. "It's not a required procedure, so Stanford is very progressive in the sense that they even did this," he says. "What we found was that Stanford's current greenhouse-gas footprint is already far less than that of competing hospitals, because the Palo Alto Municipal Utility District has been so progressive in its use of renewable generation sources."

In the current design phase for the two hospital projects, hundreds of decisions about operating systems and materials are still to be made. For example, floors in most hospitals of the past were made of VCT, vinyl composition tile, which contains toxic chemicals, and which required chemical-laden cleaners, waxes and strippers filled with heavy metals. "Everyone in the hospital likes those clean, shiny floors, but VCT is not sustainable," Tingwald says. "We've looked at rubber floors, which you can't polish, and at linoleum, which is not as durable over time. These are the kinds of challenges we're facing, where there's no replacement product on the market at the moment that's as good and durable. We may either have to compromise, or delay our selection until better products become available."

Guenther takes a slightly different position. "Hospitals are finding that more sustainable materials and systems can be introduced with surprising results. For example, rubber floors may not be shiny, but clinicians prefer their softness underfoot, and appreciate the noise reduction," she says.

CONTINUES ON PAGE 48

“Kaiser Permanente reports less plant

The nation's health information technology

DAVID BLUMENTHAL, MD, *the national coordinator for health information technology, has spent a lot of his career thinking about health policy. He's on leave from Harvard Medical School, where he's a professor of medicine and health policy. Now, with health-care reform settled, the next big hurdle in the health arena for the Obama administration is implementing electronic health records, commonly known as EHRs.*

There's a lot of debate about what exactly EHRs will achieve. Proponents say they will usher in a new era of patient-centeredness and shared decision-making between patient and physician. They're touted as delivering better disease management and improving care for people with chronic disorders. And then there's the financial savings, estimated to be between $33 billion and $77 billion over 10 years. Critics think that the financial savings and dreams of delivering better health care are illusory at best. They contend that EHRs will give the consumer less efficiency, greater costs and inconsistent quality of care.

So medical school executive communications director Paul Costello took those questions to the top and asked Blumenthal: What about the critics? What are physicians saying about EHRs? And what's it like taking on such a huge task while under a political microscope? Are careers in public service worth the public scrutiny?

"It's obviously a challenge to build a new program of this size with this ambition," says Blumenthal. "But it's also exciting. Public service is a valuable career for young people — one that I hope more and more young people will consider, both young physicians and other people interested in health."

COSTELLO: Why is health care behind so many businesses in using technology to improve service and efficiency?

BLUMENTHAL: There are a lot of reasons. One is that the incentives are not lined up to reward performance. People get paid just as well for delivering care that is inefficient or unsafe as they do for care that is efficient and safe. The money doesn't drop to the bottom line the way it does in a business setting. Another important reason is that electronic health records are complicated. Health care is complicated. It's a team sport, where information is critical — and that information is often fragmented and diverse and needs to be brought together from many sources at the same time in order to develop a good treatment plan.

COSTELLO: Why should patients care whether their physician uses electronic health records? What do you tell them?

BLUMENTHAL: Well, I tell them that they're going to get better care. And I can illustrate it with stories from my own experience as a clinician using an electronic health system, where it's prevented me from giving medications that my patients were allergic to, prevented me from doing tests that were duplicative, given me access to information that makes it possible to answer patients' questions at the time they want the information, given me vital information when I'm on call for other physicians, and given me the information I need to make better decisions about their care in emergency situations. I think most patients get it. I mean, I don't think you have to convince patients that this is valuable. Some are worried about whether the value will come along with threats to

their privacy. But the value, I think, is readily apparent to most patients.

COSTELLO: Yet some are worried. Last year 59 percent of respondents in a Kaiser/Harvard survey said they're not confident that electronic health records will remain confidential. How is the federal government addressing this?

BLUMENTHAL: We've adopted standards for the privacy and security of electronic health records, against which they can be certified. So that's a first step. And one of the proposed certification criteria is that all providers actually test the security of their electronic health systems. We'll continue to work on the standards and certification criteria over the coming years, because we're just at the beginning of this process.

COSTELLO: The Bush administration set 2014 as the year electronic health records would be available for Americans. Is that still the timetable?

BLUMENTHAL: We want to accomplish as much as we can, as soon as we can. We believe we will make a huge amount of progress over the next three to four years — under the influence of incentives we're offering, but also because I think the congressional action and the administration's work have made it clear to professionals and to hospital managers that this transition is inevitable. It's part of being up to date. It's part of being at the top of your game. It's part of being capable as providers of care. So, we are going to make, I think, a great deal of progress. I think it's achievable.

COSTELLO: I wonder if you'd talk a minute about the need for a skilled work force that understands the use of health-information technology.

BLUMENTHAL: We need people who can help doctors become meaningful users. We're not talking about installing records. We're talking about helping physicians take advantage of records, get the benefits of them. And that's where I think our biggest gap is. And the same is true for nurses and for other health professionals. So, that's why we're funding the training of such a work force under our legislation. I expect that if meaningful use takes hold, and if value-based payment takes hold, there will be a private-sector market for that kind of a trained work force.

COSTELLO: Clearly, with sophisticated health technology, there will be a lot more health data to evaluate. This will undoubtedly ramp up comparative-effectiveness research. But, as we saw not long ago with the outrage over draft federal guidelines reducing screening for breast cancer, there's a huge gap between gut reactions and what the hard data actually suggest. Do you envision a lot more struggles like this?

BLUMENTHAL: I think as we get better evidence, we'll get better care. There may be periods of controversy as we digest that evidence. I think that's healthy. A vigorous public debate is the way we spread information in this country.

COSTELLO: When you travel around the United States, what are physicians telling you? What's on their minds?

BLUMENTHAL: Physicians want to take the best care they can of their patients. They want to be the best they can be. They feel that there are a number of obstacles they have to overcome to do that. They have a perverse payment system with the wrong incentives. They have an enormous number of conflicting requirements, from private insurance companies, from employers, from the government. I think what they want is simplification, a reduction in hassles, a reduction in administrative burdens, a reduction in the complexity of the payment system and support in caring for patients in meaningful ways. We think that the electronic health record can give them many of those benefits. **SM**

Interview condensed and edited by Rosanne Spector

JONATHAN KANNAIR

WEB EXTRA: HEAR THE INTERVIEW AT STANMED.STANFORD.EDU/2010SUMMER

VALLEY OF HOPE

A report from one of Haiti's few working hospitals

BY TRACIE WHITE

ILLUSTRATIONS BY STAN FELLOWS

"Is this your first visit to Haiti?" the attending doctor, Cynthia Racine, asked me. A Haitian-born, U.S.-trained physiatrist who works at a hospital in Brooklyn, Racine arrived as a volunteer at Hospital Albert Schweitzer two weeks after the earthquake. "And today is your first time in the hospital?" She raised her eyebrows. This isn't like the hospitals you are used to, those eyebrows said.

I took a deep breath, swatted at a mosquito and followed her into the wards.

It was early on a February morning, a month and a half after the devastation of the 7.0 magnitude earthquake. Already the tropical heat was blasting and a wet blanket of humidity hung in the air.

I'd arrived in Haiti the night before to report on this small 80-bed hospital in the Artibonite Valley, relieved to have missed the horrors of Port-au-Prince in the days following the quake, the dead bodies left to rot in the heat, the looting. My flight was only the second to arrive from New York after the re-opening of the airport. The cracks were still visible in the airport walls, the tarmac crowded with military and U.N. trucks and the white tents of aid agencies.

After a three-hour bumpy truck ride past the capital's tent cities and into the barren terrain of the Haitian countryside, I arrived at the town of Deschapelles, and this 54-year-old hospital started by the Mellon family of Pittsburgh with wealth from the family business, Gulf Oil.

Word got out quickly that the hospital was undamaged after the quake. In two days, its patient load swelled from 80 to 800. Within weeks, thousands of refugees had come to the Artibonite Valley to stay. By the time of my visit, the patient load had dropped but was still twice the hospital's normal capacity.

We wound our way through the wards — through post-op, then pre-op, then the neonatal ward and, finally, pediatrics — each a small room crowded with patients and their families. People cooked meals in the corridors; through the hospital windows you could see them doing the laundry in an outdoor courtyard, draping dresses and sheets to dry over dusty bushes.

A young man seated on a stretcher in the hallway lifted his amputated leg high for the doctor to examine as we walked past. He looked calmly from the oozing open wound to the doctor, who shook her head, no. He was not ready to leave yet.

I took another deep breath.

The earthquake victims were scattered between the burn victims — mainly children who had fallen on the open fires that many Haitians cook over. The hospital's other patients included a man who had lost toes from diabetes, a malnourished child hugging stick-thin legs, a motorcycle accident victim with a broken neck who spasmed uncontrollably.

Only the complicated earthquake cases still remained — those with the deepest wounds, the crushed bones, the severed spines. The amputees whose stumps hadn't healed well.

As we continued winding our way through the wards, it was the strength of the Haitian people that struck me most. The single mother of five singing soft lullabies to her baby boy in her arms, sitting by her 19-year-old daughter lying in a bed paralyzed. A 5-year-old boy helping his horribly burned 2-year-old sister move her arms and legs in circles for physical therapy.

The air grew heavier and my knees weakened as I struggled to catch my breath.

At the end of the hallway, an adolescent boy near my son's age allowed the physical therapist to move his burned arm up and down, up and down. He smiled bravely to hide the guttural moans of pain that filled the room. And I turned away to hide my tears.

I'd been told repeatedly the Haitians were a resilient people. They're survivors. Two days after the quake, the hospital ran out of pain relievers. Within a week the antibiotics were gone. Limbs were amputated with no pain relievers at all. And still, no one complained.

"They've had so much thrown at them, they just get up and go," Racine told me with a shrug as she moved on to the next patient.

The operating rooms had finally thinned out. The amputations were over. The stunned and somewhat giddy staff, sleep-deprived and deeply moved, had a moment to pause and plan.

What next?

ONE NIGHT AFTER MY TOUR, at the end of another long day, I found the managing director of the hospital, Ian Rawson, at home at his dining table in front of a sewing machine. Reading glasses balanced on the tip of his nose, he squinted down at the curtain he was hemming, a curtain that would give amputees privacy while being fitted with their new prostheses.

Providing limbs to amputees had become a new focus for the hospital. So at the end of a long workday, he pulled out the sewing machine and threaded a needle.

For weeks after the earthquake, Rawson's day started before dawn and stretched late into the night. Reporters and aid workers, volunteer surgeons from Harvard, anesthesiologists from MIT, Project Hope workers and physical therapists from around the world had rotated through his home, next to the hospital. The work had slowed somewhat when I arrived, and finally near the latter part of February, he had some time to reflect.

"We've redefined ourselves as a result of this tragedy," says Rawson, referring to the hospital and its staff of 15 doctors and 50 nurses. "None of us who were in the middle of this will ever forget it."

In the weeks and months following the quake, as a panicked country buried its dead and tried to care for its injured, a plan to save Haiti had begun to emerge, resting on the policy buzzword "decentralization." With the capital city of 3 million in a country of just 8 million virtually destroyed, Haiti's survival depended on building the infrastructure of the countryside, agreed both the Haitian government and the international community.

As just one small hospital, in one small, poverty-stricken valley, the task of opening its arms to the rest of the country appeared daunting. As one of only four surgical hospitals functioning in the entire country, Hospital Albert Schweitzer was struggling.

But Rawson remained hopeful. "We're not rebuilding Haiti," he says over and over during my weeklong visit, repeating the words he'd heard many times at meetings of aid organizations and government officials. "We're building Haiti."

"IT WAS PRETTY CLEAR TO US, THIS WAS THE PLACE THAT NEEDED HEALTH CARE THE MOST."

I KNEW A LITTLE ABOUT THE HOSPITAL'S HISTORY WHEN I ARRIVED IN HAITI, ABOUT ITS REPUTATION for stability and excellence in a country where the health-care system has little of both. These qualities inspired the Stanford community to donate $370,000 to the hospital following the quake.

"The hospital has been there for 50 years," says Michele Barry, MD, Stanford medical school's senior associate dean for global health, who fondly remembered a residency early in her career there. "It will be there for 50 more years."

But I wanted to hear the story firsthand.

Seated on the couch in his home, Rawson told me the story. His mother and stepfather, Gwen and Larimer "Larry" Mellon were so inspired by a 1947 *Life* magazine article on the medical missionary to Africa, Albert Schweitzer, and his philosophy of "reverence for life" that they became disciples of a sort. After searching for the place in the world where they could relieve the most suffering, they leased an abandoned Standard Fruit Co. banana plantation from the Haitian government and began building Hospital Albert Schweitzer while Larry finished medical school at Tulane University. Medical school, which Larry started at 39, was part of the plan. And Gwen studied to become a laboratory technician.

The family had traveled to the Yucatan and Peru searching for the right place for their hospital. But the overwhelming need for health care in the Artibonite Valley, a patient base of 185,000 with not a single doctor, drew them in instantly. They founded the hospital 54 years ago, years before Paul Farmer — made famous by Tracy Kidder's book *Mountains Beyond Mountains* — founded his own small hospital just a few hours north.

"It was pretty clear to us, this was the place that needed health care the most," says Rawson, 70, who first traveled to Haiti with his family when he was 10 years old. Three years ago, he retired to the area with his wife, Lucy, after a career as a senior manager at Allegheny General Hospital in Pittsburgh. His mission in retirement: to continue his family's legacy.

"My mother would say, 'Haiti chose us,'" says Rawson, who has a PhD in medical anthropology from the University of Pittsburgh and served as president of the Hospital Council of Western Pennsylvania.

The hospital has made a tremendous difference in the valley. The Mellons' emphasis on community-based primary care has resulted in a virtual eradication of tetanus. Typhoid has been greatly reduced. The valley is now almost free of blindness caused by vitamin A deficiency and outbreaks of measles. Life expectancy has increased from 30 to 53 years. Diarrhea, pneumonia, AIDS and TB are no longer death sentences. Daily it continues its battle with malaria, malnutrition and typhoid, saving countless lives. It's seen patients through hurricane devastation, AIDS epidemics and outbreaks of antibiotic-resistant tuberculosis.

But still, the hospital had never seen anything like the disaster headed its way Jan. 12.

RAWSON WAS DRIVING HAITI'S BACK ROADS, HEADED HOME TO DESCHAPELLES ON JAN. 12 WHEN THE EARTHQUAKE STRUCK AT 4:53 P.M.

"Suddenly the car veered to the left side of the road and went into a ditch," says Rawson. "I thought I'd broken a tie rod or had a senior moment." The country folk started pouring out of their homes, wailing and waving their arms, a blur of brightly colored clothes. Rawson realized then that there'd been an earthquake, a *tremblement de terre*, but he had no concept of just how bad. He drove on.

When he arrived home, he first checked the hospital for structural damage. Everything was intact. But the cell phone towers were down, and he has no TV, so it would be hours before news of the devastation and loss of life 60 miles away in Port-au-Prince began to trickle in.

At 8 p.m., the pickup trucks, the colorful *tap taps* that serve as taxis, started arriving, continuing through the night and into the next day and the next. Families and neighbors loaded their injured into the backs of these trucks and drove the three hours north from Port-au-Prince to the Artibonite Valley.

They used the front doors of their destroyed homes as stretchers and prayed the injured would survive the journey. But sometimes it was too much, and cries would arise from the family at the shock of the loss of their loved ones.

"In the back of the truck are one or two people, their legs or arms covered in bandages or clothes," Rawson wrote in a blog he started the day of the quake. "Security staff rush out to the truck with a backboard or a gurney and bring the patient inside to be triaged by the emergency team."

With the arrival of each new truck, the reality of the devastation caused by the quake began to sink in. The radio news reported that the National Palace had collapsed, that hundreds of thousands might be dead, that hospitals had crumbled, that the international airport was closed and medical crews from around the world were desperately trying to get into Haiti to help.

It took one week to run through three months' worth of supplies. As the days passed, Rawson's blog grew increasingly desperate. The injured waited in line for surgery for days, weeks sometimes, but didn't complain. When a patient began to smell like rotting meat, the gangrene had set in, and he or she was moved ahead in line.

Jan. 13: "Two school buses filled with patients just came to the door," Rawson wrote. "We sent to St. Marc to buy a dozen more beds and mattresses in the market. We are all exhausted. I haven't left the hospital for two days except to take a shower and change. And I have been lucky — others have just stayed through."

Jan. 17: "Overnight, several patients have died, of a combination of their injuries and sepsis," Rawson wrote. "We have run out of antibiotics. We have never had enough pain medicine, and the usually stoic patients are now succumbing to days of unrelieved pain…."

Jan. 18: "Many of our patients have been in our hallways now for days, patiently waiting for help. We have become good friends and I appreciate their forbearance when I explain why they have not yet had their much-needed surgeries. Their pain is becoming more intense, but they always respond with a smile."

SEVERAL DAYS AFTER MY ARRIVAL IN HAITI, I crowded into the back seat of Rawson's car with the members of a newly formed mobile rehabilitation team from his hospital to travel to Farmer's hospital, Zanmi Lasante, two and a half hours farther north, in the town of Cange. With estimates of the number of amputees in Haiti reaching as high as 4,000, prosthetics care and rehabilitation services were in great demand.

Just a week earlier, Hospital Albert Schweitzer had become the site of a prosthesis factory and rehabilitation lab. Prosthesis producer Hanger Orthopedic Group Inc. had set up the factory at its own expense, shipping in 13,000 pounds of fabrication equipment and machinery. Hospital Albert Schweitzer was prepared to teach amputees from across the country to walk again.

When Farmer called Rawson about the need for prostheses for his patients, a mobile team was set up — a perfect example of the future coordination of services that Haiti will need more of in the future, Rawson says. Hospital Albert Schweitzer's prosthetics team would serve the patients at Zanmi Lasante as well.

The miles of open countryside rolled past: women with baskets of fruit and laundry balanced on their heads, children bathing naked in streams, huts with corrugated metal roofs, donkeys, goats. Vendors along the roadsides sold rocks and charcoal and sugar cane laid out in neatly organized piles. Pickup trucks, top heavy with passengers and loaded down with luggage and an occasional strapped-on mattress, passed by as refugees from Port-au-Prince headed out of town looking for homes out in the country.

Almost every family in the Artibonite Valley was housing friends or relatives newly homeless from Port-au-Prince, Rawson told me.

The limited infrastructure that once existed in Port-au-Prince completely disappears in the countryside. There are

I'D SEEN THE FIRST AMPUTEE FITTED WITH A PROSTHESIS KICKING A SOCCER BALL AROUND THE REHABILITATION LAB THE NIGHT BEFORE.

no public services. No waste-removal systems, no running water, no electricity. As in most of the country, garbage is piled up, squirted with gasoline and lit on fire. As the miles rolled by, the concept of "decentralizing" Haiti grew more overwhelming to me.

Why would all those Haitians who had once escaped the poverty of the countryside, migrating to Port-au-Prince for the opportunities of city life, return to the country to live for good? How could a government criticized for its inability to run its own country be able to build new homes and schools and clinics out here?

In *Mountains Beyond Mountains*, I'd read Kidder's description of Farmer's hospital, an oasis of hope in perhaps an even more destitute spot than the Artibonite Valley. But when we drove into the town, it looked just like one more forlorn stretch of the highway, the hospital hidden behind a high wall.

This was the rehab team's first trip to Zanmi Lasante. Jay Tew, a prosthetist, newly arrived from Lafayette, La., who works for Hanger, and Sean Cleaver, a physical therapist on Hospital Albert Schweitzer's staff, originally from Canada, planned to measure the limbs of five amputees and form five plaster casts to take back to the prosthetics workshop. From each cast, a technician would make a mold to create a plastic socket — the part of the prosthesis that fits over the stump. Last, a technician at a workbench would assemble the limb, complete with tennis shoe or flip flop or work boot attached.

Eventually, the patients from Zanmi Lasante would travel to Hospital Albert Schweitzer to be fitted with their custom-made prostheses, and the physical therapists would teach them to walk again.

I'd seen the first amputee fitted with a prosthesis kicking a soccer ball around the rehabilitation lab the night before amid the cheers and laughter of amputees waiting their turn.

"Does it hurt?" Tew asked a 16-year-old girl in a tube top, both her legs amputated below the knee. He was pulling a white prosthetic sock over her stump in preparation for making the cast. Cleaver knelt next to the two of them, translating Tew's southern twang into the native Creole.

She nodded yes, her eyes wide with fear.

Within a month, back at home, I'd see this same girl on an MSNBC news show, walking around the hospital, laughing and joking with Tew, proudly showing off her two new legs.

A MONTH AFTER I RETURN HOME FROM HAITI, I'M JOGGING ON A TREADMILL staring out at the lush rolling hillsides of Northern California through pouring rain. When my cell phone rings, a halting voice comes through:

"This is Jean, remember me?" It's an aspiring priest from Zanmi Lasante who lost his arm in the earthquake, trapped for 24 hours beneath rubble. He'd told me in halting English of his fear that he'd never become a priest because he could no longer raise both arms to properly celebrate the Catholic mass.

CONTINUES ON PAGE 49

"I'm going to France," he says, through static. "A bishop is paying my way. Don't forget about me. Please send money." Then the line goes dead.

Images of Haiti run through my mind. Sidewalk markets in Port-au-Prince built upon piles of rubble between block after block of tent cities. Haitians selling pineapples, cell phones, charcoal. A young boy skinning a pig in a gulley by an open-air market in Deschapelles. Schoolchildren in neat uniforms crowding around my camera. Truckloads of Haitians fleeing the capital searching for a place to live.

The boy with burns in the hospital, smiling through his pain.

Hospital Albert Schweitzer has undergone a transformation in the months since the earthquake. It's fitted nearly 300 amputees with new prostheses. On average, 35 percent of its patient base regularly comes from outside the Artibonite Valley. As one of the only functioning surgical hospitals in Haiti, it plays a key role in coordinating services, and its leaders talk to Ministry of Health officials and various hospital administrators on a daily basis. The goal of decentralization is still a good one, Rawson believes.

"The world has changed for us," says Rawson. "There are new attempts to integrate health-care services across the country. We're being called upon to do things we've never done before."

But what he wants people to know most about the earthquake was the incredible perseverance of the Haitian people, Rawson says.

"What I remember mostly of those weeks after the quake are the faces of the patients. Moving them to the operating room. Helping to clean them. To get them ready for surgery. To look into their faces and to see how little people here complain about their obvious pain and anguish. Every patient has gone through difficulties in their lives. They learn they can get through it. That the pain will pass. It's absolutely incredible."

Media reports in the United States about Haiti have dropped off dramatically in the five months since the quake. The fevers and nausea that followed me home have completely disappeared. I woke up once in the middle of the night, the week after I returned, tears on my cheeks. But now I sleep just fine. Perhaps I complain a bit less, and appreciate my life a bit more. I hope so.

"When will you be coming back?" the staff asked me when I left the hospital. It's the same question they ask everyone who visits for the first time, full of good intentions, then returns home to hot water, overstocked grocery stores and weekly garbage service — never to return. **SM**

Tracie White is at traciew@stanford.edu

catching air

A DEADLY DISEASE, A PROBLEMATIC HEALTH-CARE SYSTEM, A HAPPY ENDING

BY BRUCE GOLDMAN
PHOTOGRAPHS BY LENNY GONZALEZ

In health care there are many heroes and few villains. Working together, patients, health-care providers, researchers and insurers can overcome what would have seemed impossible odds. Yet, while their interests largely coincide — in a good doctor-patient relationship, they are identical — aspects of the alliance can come into conflict. The experiences of Americans with rare, deadly diseases illustrate the greatest strengths of the complex super-organism that is our health-care system, as well as its vulnerabilities. Here's the story of one doctor-patient team that prevailed.

One Saturday in 2004,

KAREN LINDEMANN, 38, took a BART train into San Francisco to see a musical production and collapsed halfway up the steps from the station. "I thought I was going to die right there," she says. "I finally crawled up the rest of the stairs and made it to the theater right across the street and watched *The Lion King*. That was probably the dumbest thing I ever did in my life."

Lindemann hadn't been feeling well for years, but no doctor could nail down the nature of her problem. She would finally find out that Monday, and the news wouldn't be good. She was going to learn she had a rare condition called pulmonary arterial hypertension, or PAH, which destroys blood vessels carrying oxygen from the lungs, leaving people gasping for breath. Even if they receive appropriate treatment, a big if, only 60 percent of patients survive more than five years after diagnosis.

No pulmonary arterial hypertension success story comes without an asterisk. Lindemann has lived to tell hers. Raised in San Francisco's eastern suburbs, where she still resides, she started suffering blackouts in 2001. "For years, I was complaining to my doctor of having this general run-down feeling. I was tired all the time, and short of breath when I exercised. It was really hard for me to walk 20 or 30 yards."

At first her doctors told her it was her weight. That's ironic, as she would eventually find out that her PAH came from the use, for 72 days in 1997, of "fen-phen" (fenfluramine-phentermine), a diet-drug combination prescribed to her for weight loss. Fen-phen was subsequently withdrawn from the market.

Karen Lindemann wants other pulmonary hypertension patients to know survival is possible.

At some point, Lindemann was diagnosed with asthma. "Pretty much everybody I know with PAH is," she says.

In 2004, her symptoms started to worsen, and came to a crisis in the San Francisco train station. When she saw her doctor in Hayward, Calif., the following Monday, he immediately sent her for an electrocardiogram. She'd already had several, and they'd always come back normal. Not this time, though. She ferried her results back from the uncharacteristically unsmiling technician who'd run the test. "My doctor opens the envelope, looks at the EKG, runs out of the office, personally gets a wheelchair, puts me in it and runs me down to the emergency department with my poor mother trailing behind."

At least this time the diagnosis was correct.

A PLACE WHERE PULMONARY ARTERIAL HYPERTENSION ISN'T RARE

PAH is a subset of a spectrum of diseases collectively known simply as PH, or pulmonary hypertension. This latter, broader category includes all cases of high blood pressure in the lungs, whether caused primarily by damage to pulmonary blood vessels, as in PAH, or by other problems in the lungs, left side of the heart or elsewhere.

Stanford's Vera Moulton Wall Center for Pulmonary Vascular Disease, which opened in 2000, is one of about 50 U.S. pulmonary hypertension centers, treating patients from all over the western United States. Directed by Jeffrey Feinstein, MD, PhD, associate professor of pediatrics, the center's faculty members conduct laboratory and patient research, run a physician training program (one of only five PH traineeships in the world) and care for patients.

"We see the sickest of the sick," says Roham Zamanian, MD, who directs the center's adult pulmonary hypertension service. "Half of our new patients are on track to die within a year. By the time someone with PAH becomes symptomatic, 60 percent to 70 percent of their lung vasculature has been injured already. So we're way behind the curve when our patients come into the clinic. We ask them to think back, and on average it's about 18 months from the point that they first had symptoms they realized were abnormal until their accurate PAH diagnosis. They've often been misdiagnosed as having asthma, or told that it's all in their head, that there's nothing wrong with them," adds Zamanian, an assistant professor in the Division of Pulmonary and Critical Care Medicine.

Thus, the PAH verdict comes as a shock, says Zamanian. "They're devastated, because it is a disease that doesn't have a cure, a disease they'll live and die with."

Only one or two in a million people, most of them otherwise healthy women of childbearing age, develop the disease out of the blue. The risk is substantially higher for people with certain autoimmune diseases (such as scleroderma or lupus), HIV, congenital heart disease or liver disease; for those who have used street drugs such as amphetamines or cocaine; or for those like Lindemann, who used the diet drug fen-phen. People with scleroderma are especially at risk, with 10 percent to 20 percent developing PAH.

In the United States today, roughly 20,000 to 30,000 people are known to have pulmonary arterial hypertension, although it's likely that many more are undiagnosed because the chief symptom, shortness of breath, is so non-specific. Doctors can diagnosis the disease definitively only by right-heart catheterization, the threading of a thin tube through a vein and into the right side of the heart.

What all cases share is the narrowing of blood vessels in the lungs when, for mysterious reasons, the smooth muscle cells that ring the lungs' blood vessels start proliferating. As their walls thicken, the vessels become increasingly occluded, choking off blood flow.

It's like stepping on a garden hose. The pump — the right side of the heart — has to work harder, and it's not very good at it. It was designed by evolution to operate under low pressure. The heart muscle thickens, trying to adjust to its new job description, but it does so only imperfectly. Within a few years it gives out.

"we see the sickest

"Initially, the symptoms are minimal. But full-blown PAH is a terrible disease," Zamanian says.

If left untreated, newly diagnosed patients are looking at a 50/50 chance of surviving 2.8 more years. Barely over a third will live for five years. That gives even the more aggressive types of cancer a run for their money.

Until the mid-1990s, there were no treatments at all for pulmonary hypertension, beyond palliative care. "We've improved on that," Zamanian says. The first drug therapy, an intravenous infusion, came in 1995. It has lengthened survival times, for some lucky patients by a decade or more, he notes. "But there's still no effective cure, except for lung transplantation, which itself has a dismal outcome."

Still, the medical and pharmaceutical fields have made extraordinary strides. The past decade or so has brought significant advances, with eight new drugs to combat the disease. These therapies aren't cures either, but they have extended survival. "With active treatment, we're now seeing a two-year survival rate of nearly 75 percent to 80 percent for some pa-

drug loses its potency it's possible to switch or add another. But none of them is perfect. Some are delivered via IV tubes and pumps or painful subcutaneous injection, others through five- to 15-minute-long bouts of inhalation six to nine times a day. Even a couple of pill formulations require frequent dosage adjustments due to interactions with other drugs, or blood tests to make sure there's no liver toxicity.

One big reason for the rash of new PAH drugs is that they fetch huge prices, ranging from about $15,000 annually for the cheapest oral compounds to well over $100,000 for the mainstay, intravenous epoprostenol, and even more — up to $200,000 or $300,000 for another, similar drug with a much longer half-life. (These prices vary, depending on what deal a particular insurance company in a particular state has negotiated with the drug's maker.)

Drug companies charge more because they *can* charge more.

OF THE SICK. HALF OF OUR PATIENTS ARE ON TRACK TO DIE WITHIN A YEAR."

Roham Zamanian, MD

tient populations," says Zamanian. Half of all appropriately treated patients now live for five years post-diagnosis.

HOW MUCH WOULD YOU PAY TO SAVE YOUR LIFE?

The first treatment licensed for PAH — and still the treatment of last resort — is a continuous intravenous infusion of a drug, epoprostenol, that has to be mixed fresh every morning from a powder and saline, then delivered by an electrically powered pump. Epoprostenol has a six-minute half-life, so a delivery line that clogs or gets pulled loose by accident is a life-threatening emergency: 15 minutes to cardiac arrest, according to Zamanian.

Like epoprostenol, the newer drugs available in the United States are vasodilators: They cause smooth muscle cells to relax, permitting more blood flow through the vessels ringed by them.

The expanded pharmacopeia is beneficial, because if one

"Once you have a marketable therapy that's life-saving, how much would *you* pay to save your life?" asks Zamanian. The reality is that the audience is captive. Some of these companies make a tremendous profit. True, they have taken tremendous risks in developing some of these drugs for a very small population of patients. And they provide more backing for clinical research on PH than the National Institutes of Health does. But how do you justify a drug's costing $300,000 a year?

THE ECONOMIST

In the United States, a drug developer has the exclusive right to market a new drug for a period of time after it's approved (typically around seven to 10 years, depending on how long development took), so companies can charge monopoly prices during that period to recoup their investment. As a further incentive to drug makers, the FDA often gives candidate treatments for rare diseases "orphan drug" status, a

combination of grants to defray testing costs, expedited review, a lower threshold for approval (for instance, acceptance of what in other cases might be considered insufficient numbers of subjects participating in a pivotal trial) — and two additional years of marketing exclusivity.

"It's very easy to characterize the pharmaceutical companies as the bad guys here because they're exploiting their monopoly power," says health economist and associate professor of medicine Jay Bhattacharya, MD, PhD. "But their rationale is that if you undercut that monopoly pricing power you'd have less drug research. The argument is that you're trading off the social costs of monopoly power — more-expensive drugs now — and the social benefit of new and better drugs later, thanks to the research investments these companies presumably will be making with their profits."

Maybe one out of every 250 experimental drug research programs pays off, Bhattacharya says. "That one winner has to make up for the investments in the 249 other efforts that didn't pan out." The first pill that rolls off a drug company's assembly line can cost the company on the order of $800 million or so in total development expenditures (when you take the failed efforts into account), but the second and every subsequent pill cost only a few cents apiece. The prices charged for drugs for rare diseases such as PAH are, in part, an inevitable result of dividing the drug-development cost by the small number of patients who will buy it.

THE RUNAROUND

Zamanian and Wall Center nurse practitioner Juliana Liu, who often goes head to head with balky insurers, have been frustrated by companies that don't answer the phone, return calls or even provide working phone numbers connected to voicemail. "Most companies will eventually cover the drug if you're willing to fight the battle," Liu says. "But authorizations are typically only good for three months, and then the battle has to be fought all over again."

Insurers' reticence is hardly diminished by the fact that many patients are on combination therapies, based on growing but not completely definitive evidence that combination therapies can better stave off worsening symptoms. Yet, to the extent that these hints and glimmers find their way into medical practice, the already substantial cost of therapy for a given patient is going to go up. That spells sticker shock to insurers trying to keep their expenses, and their customers' premiums, down. There's no easy way out.

Does it have to be this way? As chief of cardiology at Jewish General Hospital in Montreal, Quebec, David Langleben, MD, runs the second-biggest PH center in Canada. The cost of PH drugs there is comparable to that in the United States, Langleben says. But in the single-payer Canadian system, the government picks up the tab, not insurance companies.

"I have to say — and I can only speak for pulmonary hypertension, and for Quebec — that the government has gone above and beyond in supporting these patients," says Langleben. "The availability has been easy, limitless and very generous. All they ask is that there be some science to support the benefit, and that these drugs be used in a controlled fashion. What's reassured the government is that, unlike Europe and the United States, not every doctor can prescribe these drugs. PH medications here have to be prescribed by approved PH centers."

"that one winner HAS TO MAKE UP FOR THE INVESTMENTS IN THE 249 OTHER

But, Langleben notes wryly, "we're going broke." In April, Quebec's government imposed (for the first time) the equivalent of co-payments for doctor visits, in order to make up for its budget shortfall.

The price problem confronting PAH patients, providers, insurers and drug manufacturers mirrors the one facing the United States at large. Who's at fault for the high cost of health care in general, and drugs in particular? Greedy pharmaceutical companies? Callous insurers? Care providers understandably trying to secure slight to moderate gains in their patients' conditions or quality of life? A payer system in which patients rarely see the bills for the services they receive, let alone have to make decisions trading off costs versus estimated benefits?

"I don't believe there are any villains," says Bhattacharya, "only trade-offs."

HOOKED UP

Karen Lindemann spent four days in the hospital in Hayward hooked up to monitors. She was fitted with oxygen tanks and a 50-foot hose so she could wander around the house when she went home.

"Constantly wearing this thing 24/7 definitely took some getting used to," Lindemann says. "People could always find

me, because they would just follow the hose. I didn't mind that, but sometimes they would stand on the hose, or close the door on it. It would get tangled on things. I had a portable tank for when I went out. But it's only good for four hours. You kind of plan your life around your oxygen usage."

Within a month or so, Lindemann hooked up to a San Jose-based support group where Zamanian — "Dr. Z," she calls him — sometimes showed up to speak and give advice and encouragement. Later that year she participated in the Race against Pulmonary Hypertension, an annual Wall Center-organized event benefiting PH research.

She went to the race again the next year. "Dr. Z was there. He saw me, came up, took one look at me and said, 'You're blue.' I said, 'What?' He said, 'Your lips are blue. I'm admitting you. *Right now*.' People around me every day hadn't noticed because it was so gradual. From then on we were glued at the hip. Dr. Z kind of kept tabs on me after that."

EFFORTS THAT DIDN'T PAN OUT."

For a couple years more, Lindemann cycled through new drugs and new doctors in the San Francisco area and even Los Angeles, almost 500 miles away. (Stanford's pulmonary hypertension service, with Zamanian, wasn't in her insurance network.) But her disease continued to progress. By late 2007 it was time to go to the last-gasp regimen: intravenous epoprostenol. "This is a serious drug," says Lindemann. "You have to mix a new batch every day. And it involves needles." Her husband, whom she'd met in 2006 and married in 2007, shouldered those burdens.

As soon as she began IV therapy, Lindemann felt better. It was not to last. In March 2008, she was admitted on an emergency basis to Stanford Hospital with blood sepsis from her IV line. She stayed for 11 days.

By now, Zamanian was adamant about getting Lindemann treated at Stanford as a regular, non-emergency patient. He and Marc Nicolls, MD, associate professor of medicine in the pulmonary and critical-care division, ganged up on her insurance provider and finally got approval for her to be treated at the Wall Center.

The spring of 2009 saw a big decline in Lindemann's condition. That May, Stanford's transplant division put her on the active list. "I saw Dr. Z the Friday before Memorial Day. He wanted to admit me into the hospital on the spot, but I didn't want to just be stuck there until a suitable set of lungs came along." She asked if she could stay home that weekend for a family barbecue. He answered, "OK. But if you feel *anything*, you call me and I will come get you with the helicopter." (He wasn't kidding. Stanford has a helicopter for such purposes.)

At the barbecue, "I was thinking, this is the last time I'm going to see all these people. I knew in my soul I was dying. And I was at peace with that."

FOUND IN TRANSLATION

The hope for lowering PAH's toll lies in attaining a better grasp of its underlying causes, and in converting such knowledge into clinical treatments — a process called translation within the drug industry. If the disease can be attacked early and on multiple fronts, it may be possible to save lives and money.

Research on pulmonary hypertension overall is racing full tilt on multiple fronts: epidemiological, biological, diagnostic and therapeutic. The number of human studies of PH in the last decade has almost doubled from the decade before. Since 2002, PH has had its own quarterly journal, *Advances in Pulmonary Hypertension*.

As scientific understanding of PAH's molecular underpinnings grows, the arsenal of available drugs appears set to broaden from its current vasodilator focus. Seeing an analogy to cancer, investigators are looking at antiproliferative agents often used to treat cancer as a possible way to block the proliferating smooth muscle cells surrounding PAH patients' pulmonary blood vessels.

The Wall Center's research director, Marlene Rabinovitch, MD, is pursuing a new course for stopping the cell proliferation. She has identified a variant of an enzyme that's produced in unusually large amounts by smooth-muscle cells in the walls of PAH patients' blood vessels. The enzyme degrades a key blood-vessel wall component, reducing the walls' elasticity and unleashing growth factors that can both attract inflammatory cells to the vessel wall and stimulate cell proliferation there. "When that happens, the vessels become stiff, blood pressure goes up and the load on the right heart is greatly increased," Rabinovitch says. In several studies using animal models, she has shown that changing the enzymatic activity can inhibit and, in many cases, reverse the course of disease. That could eventually translate into promising "root-cause" therapies, she says.

Other research explores the tie between PAH and insulin resistance — an inability to control blood sugar, which can lead to type-2 diabetes. Rabinovitch used a high-fat diet and low-oxygen environment to cause experimental animals to develop PAH and insulin resistance, then administered a

compound known to combat insulin resistance. The drug not only affected the insulin resistance but improved PAH.

Zamanian himself is hardly sitting on his hands between patient visits. Taking his cue from Rabinovitch's findings, he has shown that insulin resistance is unusually prevalent in patients with PAH. He is now conducting an early investigational study to see if pioglitazone, an approved insulin-sensitizing drug, can influence the course of PAH in patients.

Zamanian is also the principal investigator for a randomized combination drug trial — a small pilot study in which one group of so-far-untreated patients will be given one approved vasodilator drug and a second group will be given that drug plus another one from a different category. "We hope to begin to enroll patients by July of this year," he says.

Meanwhile, Stanford is the lead site of a trial of Rituxan, a drug that has been approved for treating certain cancers of the immune system caused by hyperproliferating immune cells, in 80 PAH patients who have scleroderma. Nicolls, Zamanian's colleague, designed the randomized, placebo-controlled trial's protocol and is the principal investigator. The trial will begin to enroll patients in the next few months.

On the diagnostic front, Zamanian is investigating whether new, noninvasive imaging technologies, such as cardiac MRI, might not only speed detection but allow more frequent monitoring of disease progression, which would in turn guide treatment by letting clinicians see whether a particular drug regimen is succeeding at slowing, arresting or even reversing PAH's course.

KAREN THEN AND NOW

On June 3, 2009, the Wednesday after Lindemann went home to stand by for new lungs or die waiting, she got the call from Stanford. Late that night, she was rolled into surgery and took ownership of a new pair of lungs. By November, she was able to walk the full 5 kilometers in the ninth annual Race Against PH at Stanford. Fifteen hundred people showed up. Dr. Z was there, cheering her on.

"She's reset herself," says Zamanian of Lindemann. "She's active, she's enjoying herself. I think she's healthier than I am."

"I'll always have to be careful of germs: bacteria, fungus, viruses," Lindemann says. "And rejection. Unfortunately, with a lung transplant the chances of surviving five years are 50 percent. That's why I'm trying to make the most of it now."

She goes to the gym four days a week. She rides her bike. "I can't do gardening anymore, because I'm not allowed to play in the dirt." She goes shopping, goes for long drives to wine country with her husband. And she remembers.

"I was so sick it took me 30 minutes to get dressed. We had to load four oxygen tanks into the car just so I could take a ride around town." Now, she's healthy enough to sing in a choir — literally. A one-time music major, she's looking for a new choir to join, and reforming a trio with a friend.

She can't leave her PAH community behind. "Doctors, nurses, patients, caregivers. Everybody. They're my family now. I decided I want to give something back, because of all these miracle workers who helped me out along the way."

And she's decided the biggest bang for the buck will come from adding more fuel to the research fire that Zamanian, Rabinovitch and others have sparked. So she's starting the Karen Lindemann Foundation, with Zamanian as her co-director. "My goal is to raise money for PH research at Stanford," she says. "Community education is also big on my list. Because there are still doctors out there who are misdiagnosing this disease. And there's no reason, in this day and age, that we should be missing it."

She recalls that doctor who told her, "You are going to die." But she didn't. "No doctor needs to be saying that anymore. Nobody should have to hear a doctor saying that, anywhere, ever." **SM**

Bruce Goldman is at goldmanb@stanford.edu

FEATURE

Code green

CONTINUED FROM PAGE 33

"Kaiser Permanente reports less planter fasciitis among nursing staff since substituting for VCT. With their introduction of permeable paving — which allows rainwater to pass through it, into the ground — there have been fewer slips and falls in the Kaiser Modesto Hospital lobby as less water is tracked through the entrance."

Vernon ticks off more of the technologies the hospital is planning to incorporate: solar panels on the rooftop to provide energy; fuel cells that consume stinky landfill gas to produce electricity with almost no emissions; and LED light fixtures, which produce more light per watt than other lights, last 10 times longer and, unlike most energy-efficient fluorescent bulbs, contain no mercury — a toxin that persists in the environment and accumulates in food chains.

The architects and engineers continue to consult regularly with teams of physicians, nurses, housekeeping staffers, food service workers and others. "This is our visionary opportunity, when we can say, 'Let's build and operate the greenest building we can,'" says Krisanne Hanson, a project manager for Stanford Hospital's general services division who is widely known as "the garbage gal" for her mastery of waste handling.

Hanson and a dozen other employees meet regularly as a "green team," to "see if there's anything else we can 'green

up,' as time goes by and technologies improve." She may explain new composting proposals for the hospitals' cafeterias. Or share the results of members' work — like the team of nurses who found they could save an extra 7 tons of waste per year by using slightly smaller IV bags without an exterior liner.

For those who may question the breadth of support for greener, more environmentally responsible hospitals, Hanson likes to share a brief anecdote about a friend who recently gave birth at Packard. The new mom had a great experience, with one exception: She was surprised that there weren't any recycling containers in her room.

"We health-care practitioners may sometimes feel that environmental stuff is difficult to do in a hospital setting," Hanson adds. "But the public is saying, 'Why not?'" **SM**

Diane Rogers is at medmag@stanford.edu

FEATURE

Valley of hope

CONTINUED FROM PAGE 41

"I'm going to France," he says, through static. "A bishop is paying my way. Don't forget about me. Please send money." Then the line goes dead.

Images of Haiti run through my mind. Sidewalk markets in Port-au-Prince built upon piles of rubble between block after block of tent cities. Haitians selling pineapples, cell phones, charcoal. A young boy skinning a pig in a gulley by an open-air market in Deschapelles. Schoolchildren in neat uniforms crowding around my camera. Truckloads of Haitians fleeing the capital searching for a place to live.

The boy with burns in the hospital, smiling through his pain.

Hospital Albert Schweitzer has undergone a transformation in the months since the earthquake. It's fitted nearly 300 amputees with new prostheses. On average, 35 percent of its patient base regularly comes from outside the Artibonite Valley. As one of the only functioning surgical hospitals in Haiti, it plays a key role in coordinating services, and its leaders talk to Ministry of Health officials and various hospital administrators on a daily basis. The goal of decentralization is still a good one, Rawson believes.

"The world has changed for us," says Rawson. "There are new attempts to integrate health-care services across the country. We're being called upon to do things we've never done before."

But what he wants people to know most about the earthquake was the incredible perseverance of the Haitian people, Rawson says.

"What I remember mostly of those weeks after the quake are the faces of the patients. Moving them to the operating room. Helping to clean them. To get them ready for surgery. To look into their faces and to see how little people here complain about their obvious pain and anguish. Every patient has gone through difficulties in their lives. They learn they can get through it. That the pain will pass. It's absolutely incredible."

Media reports in the United States about Haiti have dropped off dramatically in the five months since the quake. The fevers and nausea that followed me home have completely disappeared. I woke up once in the middle of the night, the week after I returned, tears on my cheeks. But now I sleep just fine. Perhaps I complain a bit less, and appreciate my life a bit more. I hope so.

"When will you be coming back?" the staff asked me when I left the hospital. It's the same question they ask everyone who visits for the first time, full of good intentions, then returns home to hot water, overstocked grocery stores and weekly garbage service — never to return. **SM**

Tracie White is at traciew@stanford.edu

Executive Editor:
PAUL COSTELLO
Editor:
ROSANNE SPECTOR
Art/Design Direction:
DAVID ARMARIO DESIGN
Director of Print and Web Communication:
SUSAN IPAKTCHIAN
Staff Writers:
KRISTA CONGER
BRUCE GOLDMAN
DAVID ORENSTEIN
JONATHAN RABINOVITZ
RUTHANN RICHTER
DIANE ROGERS
TRACIE WHITE
SARA WYKES
Copy Editor:
MANDY ERICKSON
Circulation Manager:
SUSAN LYDICK

Stanford Medicine is published three times a year by the Stanford University School of Medicine Office of Communication & Public Affairs as part of an ongoing program of public information and education.
© 2010 by Stanford University Board of Trustees.
Letters to the editor, subscriptions, address changes and correspondence for permission to copy or reprint should be addressed to *Stanford Medicine*, Stanford University School of Medicine, 555 Middlefield Road, Building 110, Menlo Park, CA 94025. We can be reached by phone at (650) 736-0297; by fax at (650) 723-7172 and by e-mail at medmag@stanford.edu.

To read the online version of **Stanford Medicine** and to get more news about **Stanford University School of Medicine** visit http://mednews.stanford.edu.
For information from the **Stanford Medical Alumni Association** visit http://med.stanford.edu/alumni/

stealth health

TAPPING INTO THE HEALING POWER OF SOCIAL MOVEMENTS

Thomas Robinson isn't a prophet, but he might be more successful if people thought of him that way. • The gospel that Robinson, MD, MPH, preaches is a familiar one: Exercise and eat healthy food. But, like most of the researchers in his field, Robinson knows that he's frequently crying in the wilderness. • For decades, physicians and health professionals have urged people to do what's good for them, but their efforts meet with limited success. After all, we know that broccoli is better for us than french fries, but few of us are likely to order veggies with our next meal. • As a professor of pediatrics and of medicine at the School of Medicine, Robinson has given a lot of thought over the last 20 years to the reasons people do — and don't — change their behaviors. If they won't eat better to improve their own health, he wondered, what other reason might inspire them? • One example stood out: religion. • "Religious conversion is something that prompts dramatic changes that are sustained over time," Robinson says. "I've always joked that, if it were ethical, I'd propose that we start a religion."

So what's another force that inspires change? Social movements. Robinson observed that many people will make large, sustained changes in their lives if they believe it serves a greater good. "A commitment to a larger belief system seems to be more compelling than personal health reasons for changing behavior," he says.

And so he began exploring social movements that also could prompt healthy behavior changes. One good example he found was environmentalism: You can reduce your carbon footprint by eating more locally grown fruits and vegetables and cutting back on meat and processed foods. While your primary motivation in making these changes may be to help the environment, you'll end up with a more nutritious diet.

That's how he came to the idea he dubbed "stealth interventions" because they address the deeper needs and desires of the participants, their intrinsic motivators, while improving health as a side effect.

He put the stealth strategy to the test by evaluating the eating behaviors of Stanford undergraduates who enrolled last year in the Food and Society course he helped develop. The course focused on food-related social and environmental issues, but not on the health aspects of food and eating. Students viewed documentaries, read sections from books such as the *The Omnivore's Dilemma* and created brief videos on relevant topics. For comparison, Robinson's team tracked undergrads enrolled in three health-related courses the same quarter.

At the beginning and end of the quarter, students in all four classes were surveyed about their eating habits. The results showed that students in the Food and Society course were eating more vegetables and fewer high-fat dairy products, high-fat meats and sweets than they were at the beginning. The comparison students reported no improvement in dietary habits. The findings were published in the May issue of the *American Journal of Preventive Medicine*.

Robinson is employing similar stealth approaches to boost exercise among children and adolescents, such as encouraging them to help the environment by walking and biking to school rather than being driven in a car.

"This approach looks very promising," he says.

Can he get an amen? — SUSAN IPAKTCHIAN

LEIF PARSONS

S T A N F O R D
M E D I C I N E

Nonprofit Org.
U.S. Postage Paid
Permit No. 2989
San Francisco, Ca.

Stanford University School of Medicine
Office of Communication & Public Affairs
555 Middlefield Road, Building 110
Menlo Park, CA 94025

Change Service Requested

Meat: the enemy

A LEADING BIOCHEMIST TURNS ECO-WARRIOR

PAT BROWN HATES ANIMALS. On your plate, that is. And he's going to do something about it. • The biochemist at Stanford's School of Medicine is taking a yearlong sabbatical — starting now — to figure out how to get you, me and, yes, even the rest of the world to stop bolting down hamburgers, chicken and ribs, and turn instead to beans, carrots and avocados. Why? The environmental cost of meat is just too high.

"People are sort of in denial about whether this is even an issue," says Brown, MD, PhD, a professor of biochemistry and a Howard Hughes Medical Institute investigator. "But eating one 4-ounce hamburger is equivalent to leaving your bathroom faucet running 24 hours a day for a week. We can't go on like this." (See a 2006 report by the Food and Agriculture Organization of the United Nations for this and other shocking statistics.)

Brown, who is also a member of the Institute of Medicine and the National Academy of Sciences, has been a vegetarian for decades and a vegan for five years. He doesn't want to outlaw eating animal products, but he does want us to begin paying for their true cost. Cows, for example, excrete methane and nitrous oxide, which contribute to global warming, and gobble down tons of water-sucking grains and plants, exacerbating water shortages facing millions around the world.

"Thirty percent of the world's land is devoted to animal farming," says Brown. "People need to begin taking responsibility for their food choices. If they can't do it voluntarily, then we can use economic incentives." Incentives that include increasing the price of meat at the supermarket counter so it costs two to three times what you're paying now.

The attempt to change the world's eating habits seems quixotic, until you consider Brown's track record. In the early '90s, he invented the DNA microarray — a method of scanning the activity levels of tens of thousands of genes simultaneously — that's since become a workhorse in laboratories around the world. And three years ago he conceived of and launched an entirely new type of scientific journal: one in which every article is publicly available, immediately. The publishing industry scoffed but now the *Public Library of Science* series of journals is one of the most highly respected in the world.

"Scientists are more inclined to do this sort of thing than most people, because we tend to be almost absurdly optimistic," says Brown. "We believe that things kind of outside the box may still work."

As for facing the wrath of the meat lovers? Brown's not fazed.

"I like angry people. If people aren't angry, I'm not doing my job."
— KRISTA CONGER

TO SUBSCRIBE
TO STANFORD MEDICINE
e-mail medicinemag-owner@lists.stanford.edu
or call (650) 736-0297.

AMANAIMAGESRF