Genetic technology moving from lab to medical practices

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In January, practicing doctors and doctors-to-be entered a new class at the Medical College of Wisconsin with a futuristic name, "Translational Genetics." The idea was simpler than it sounded: We are fast approaching the time when doctors will use our genetic profiles to treat us.

One of the students was Kevin Regner, a practicing kidney doctor at Froedtert Hospital, who had been hearing for years, "Personalized medicine is just around the corner." Doctors will tailor treatments to each patient's genes and the risks they reveal. It will all be routine.

Regner had doubts. Sequencing of the first human genome in 2003 took more than a decade and cost about $600 million -- an effort too herculean to assume doctors would repeat it with patients and insurance companies would foot the bill anytime soon.

But Regner was in for a surprise. As he and his classmates listened, Howard Jacob, head of the college's Human and Molecular Genetics Center, described what has happened since completion of the genome project. He showed two photos: a machine that helped sequence the first human genome in 2003, and then a machine the Medical College has today. The new model does the work of 200 of the old ones; it can sequence a human genome in a few months for several hundred thousand dollars.

And the Medical College has already ordered next-generation

sequencers. Within less than a decade, a complete genetic blueprint could be attainable in 15 minutes for as little as $100.

Moreover, in a case that suggests the technology is beginning the journey from research to medical practice, Jacob described how he and his colleagues used a targeted version of gene-sequencing to diagnose and treat an apparently new disease in a young boy at Children's Hospital of Wisconsin.

In the audience, Regner had a moment of recognition. "It's likely we'll see this kind of personalized medicine in my lifetime," he said, "and in the course of my medical practice."

Medical schools are coming to this recognition as well -- albeit too slowly for some. Already, companies such as 23andMe and Navigenics are selling personal genetics tests, offering consumers the chance to learn their risks for dozens of diseases. This month pharmacy giant Walgreens announced it would sell a personal genetic test in thousands of stores across the country, though the company put the plans on hold after federal regulators said the tests had not been approved.

"More and more patients are going to be walking into their doctor's office with genes sequenced," said George Church, a genetics professor at Harvard Medical School and one of the pioneers of gene sequencing. "Very few doctors even know where to refer them."

In years to come, however, some say gene-sequencing and analysis could take a place in the medical tool kit alongside such fundamentals as anatomy and family history.

Eric J. Topol, director of the Scripps Translational Science Institute in La Jolla, Calif., said there are now genetic tests that determine how patients will respond to specific medications such as Plavix, a widely

used blood clot-prevention drug. Some tests even reveal appropriate dosages. Yet when researchers surveyed more than 10,000 physicians, just 10 percent said they had the necessary information and training to use the tests, according to a report in October by the American Medical Association and Medco.

"The resistance to change in medicine, which is profound," Topol said, "is something that is part lack of education."

Some of the country's leading medical schools and institutions have launched programs to close the education gap.

• At Harvard Medical School and Beth Israel Deaconess Medical Center, doctors started a first-in-the-nation program last fall to teach pathology residents about genomics and to train them to interpret genetic data. Residents all had the option of using a Navigenics test to search their own genes for common mutations. Twelve out of 17 volunteered for the testing and discussed the results with genetics counselors, said Mark Boguski, an associate professor at Harvard Medical School who works in Beth Israel's pathology department.

Boguski said organizers of the program have discussed expanding it to several other hospitals by 2012.

• At the Mayo Clinic in Rochester, Minn., medical students and thousands of staff, including residents, doctors, nurses and technicians, have been receiving genomics education to get up to speed about the technology and how best to apply it to the practice of medicine, said Eric Wieben, director of the Advanced Genomics Technology Center. Mayo launched the program about four years ago after receiving a multimillion-dollar grant from a Chicago-based foundation.

• At Georgetown University School of Medicine, administrators have

created a new master's degree program in "systems medicine," aimed at teaching a small group of students how to pull together the information from our genes and from environmental factors to improve treatment of patients. The program, set to debut in the 2011-2012 school year, would be offered to perhaps five or 10 students as an additional year of medical school and could lead to deeper changes in the medical school curriculum.

• At the University of Rochester School of Medicine and Dentistry, all fourth-year medical students this year took a class focused partly on personalized medicine and applied genetics. Students learned not only the basic science of the genome, but also what evidence to seek before ordering genetic tests for patients, said Thomas A. Pearson, the professor in charge of the course.

By the end of the year, a sweeping international effort called the Association for Genomic Medicine will offer a comprehensive online course that practicing physicians can take for no cost to learn the ins and outs of gene-sequencing, genetic testing for medications and related topics, said Scripps' Topol, who heads the association. The project was launched in January with a $600,000 grant from the Life Technologies Foundation, a nonprofit arm of the global biotechnology firm.

One of the schools best positioned to teach student doctors about the new technology appears to be the University of Wisconsin-Madison, which began using a laboratory exercise in genetic testing some 20 years ago. Today, in the school's medical genetics class, students sample their own DNA by scraping cells from their cheeks. Instructors then test the students' DNA and provide them with anonymous results to analyze. The test, developed at UW with help from a local biotech firm, focuses on one particular gene that determines whether people taste a bitter compound when they eat vegetables such as broccoli.

"We have experienced the DNA revolution firsthand, and this allows us to convey our knowledge directly to students," said David Brow, a professor of biomolecular chemistry who teaches the course with medical geneticist Gregory Rice.

Brow said next year's class will include recent scientific reports that have explored the latest techniques for mining large amounts of hereditary material, including one that focuses on the 1 percent of the genome that contains the instructions for making proteins. This technique, called exome sequencing, was used to diagnose the boy at Children's Hospital; doctors have recommended he receive a bone marrow transplant.

First-year UW medical student Nick Coorough said the Madison class reminded him of his own family's history of heart disease. Three relatives have gone to the hospital with blocked arteries, all of the blockages eerily similar in location and level.

"I started thinking, oh my gosh, is my dad walking around with a gene that says, 'Hey if I have extra cholesterol, I've got a good spot to put it in. I'll just stick it in the arteries'?" Coorough said.

Although the American Medical Association has no specific policy dictating what colleges should be teaching students about genomic medicine, AMA Board Chairman-elect Ardis Hoven said: "We strongly encourage efforts to prepare both current and future physicians to effectively and appropriately use genetic technologies to enhance patient care."

Many medical schools teach the basic science underlying those technologies during students' first two "book-learning" years, said Greg Feero, a primary care physician in Maine who is a senior adviser at the National Human Genome Research Institute.

But during medical students' third and fourth years, when they get their clinical management training, it drops off, Feero said. And most residency programs are, as he put it: "quite light about teaching residents about genomics."

Considering that it takes four years of medical school and at least three years of residency to create a doctor, Feero said he worries the next generation of doctors won't be equipped to handle the flood of information from our genes.

Others caution that there is still much we don't know about this information, a fact that may be difficult to convey to patients who have undergone sequencing.

For only 10 percent of our genes do we have a full understanding of what they do, said Richard Gibbs, director of the Human Genome Sequencing Center at Baylor College of Medicine.

Tests are almost certain to pick up genetic variations of unknown significance. Is it responsible for doctors to worry patients by saying something in their genetic profile is different when they cannot explain whether the difference is good, bad or neither?

Still, Gibbs expressed delight that genomic medicine is making its way into medical schools and residency programs. The information in a patient's genome, he said, can be very useful even if doctors can interpret just a small fraction.

In the class at the Medical College, Jacob told the students he had learned a valuable lesson from the boy at Children's Hospital.

"My punch line," he said. "Sequence first. Ask questions later."