



Personalized Medicine and Nanotechnology: Trying to Bring Dreams to Market

Published : March 07, 2006 in [Knowledge@Wharton](#)

While personalized medicine and nanotechnology are still buzzwords rather than significant product generators, both have the potential to produce revolutionary commercial changes, according to scholars and business people who met at Wharton last month to talk about leading-edge industries. Their discussion was part of the Emerging Technologies Update Day sponsored by the Mack Center for Technological Innovation.

Personalized medicine denotes treatments tailored individually to patients. It springs from a growing understanding of genomics and augurs an ability to formulate the precise drug and dosage that every patient needs. Nanotechnology covers anything that can be done at the so-called nanoscale -- between 1 and 100 nanometers. A nanometer is a billionth of a meter; a human hair is about 80,000 nanometers wide. "It's not one technology," says Christine Peterson, vice president for policy and research at the Foresight Nanotech Institute in Palo Alto, Calif. "It's a lot of different technologies. There are nanomaterials, nanodevices and nanosystems."



This is a single/personal use copy of Knowledge@Wharton. For multiple copies, custom reprints, e-prints, posters or plaques, please contact PARS International: reprints@parsintl.com P. (212) 221-9595 x407.

Personalized medicine is closer than nanotechnology to yielding widespread benefits. Some scientists argue that it arrived, in a limited way, years ago. "Millions of Americans with potential thyroid problems get two tests, and from those tests, we know exactly what medicine they need and what dose to prescribe," says Bob McCormack, vice president for clinical and technical affairs at Veridex, a subsidiary of Johnson & Johnson.

Yet the treatment of many illnesses, and thus many patients, remains a process of trial and error, says Christine Côté, Johnson & Johnson's vice president for emerging technologies and new ventures. "Today, medicine is one size fits all. Diseases and patients are heterogeneous, and therefore treatments need to be individualized. Personalized medicine means the right medicine for the right person at the right time."

People understandably marvel at the pharmaceutical industry's advances. After all, pills and vaccines have knocked out whole classes of illnesses that just a few decades ago might have been fatal. But some modern drugs, even widely prescribed ones, don't work as well as many people believe, Côté says. Beta-blockers, a common treatment for cardiovascular disease, aren't effective for 15 million to 20 million patients, and anti-depressants don't help between 20 million and 50 million individuals for whom they are prescribed.

Some drugs and dosages do serious harm. "Improper medications account for about 100,000 deaths a year," Côté notes. Several high-profile medications, including Vioxx, a Merck painkiller, and Johnson & Johnson's Propulsid, a heartburn aide, have been withdrawn recently because of concerns about side effects linked to heart trouble. Yet these drugs also helped many patients who didn't have serious side effects. In a world of personalized medicine, doctors could distinguish between patients who would benefit from Vioxx -- or any drug -- and those who might be harmed.

Genomics offers the key to making these distinctions. A greater understanding of the human genome is giving physicians the ability to identify people with predispositions to particular diseases and to design

drugs that target particular genes, Côté points out. Consider Herceptin, a breast cancer drug made by Genentech. It's given to patients with an unusual gene called HER2. The gene can lead to the overproduction of a protein that, in turn, can contribute to a fast-growing form of cancer.

The same sort of genomic technology underpins Veridex, according to McCormack. The company, which Johnson & Johnson formed in 2004, makes cancer tests, including one that predicts the probability of early breast cancer recurrence.

Today, many breast cancer patients have their tumors removed and then receive chemotherapy. But chemotherapy can have serious side effects, and not all women need it, McCormack points out. By identifying women with a high likelihood of recurrence, Veridex's test could allow oncologists to spare low-likelihood patients from unneeded chemotherapy. "The good news here is that we have a great opportunity to decrease the amount of unnecessary treatment and cost, save anywhere from \$10,000 to \$75,000 per patient and focus our efforts on the at-risk patients," McCormack notes. "The bad news is that personalized medicine has a price. Are you willing to withhold any therapy from your wife or mother for cost savings?"

These sorts of questions will become more urgent over the next few years because Americans, on average, are getting older and sicker. "Baby Boomers are 30% of the U.S. population, and they are aging," Côté says. "Seniors consume three times more drugs than their working counterparts. At the same time, two-thirds of adults are overweight and 15% of kids are. Obesity is related to a host of diseases, including diabetes, heart disease and stroke." When you add rising healthcare costs to the mix, consumers, insurers and employers won't be able to avoid dilemmas like the one posed by Veridex's test.

Stain-, Static- and Stink-Resistant

Nanotechnology has applications in the treatment of cancer, too. Scientists are talking about using silica spheres coated with gold to attack tumors, Peterson says. Infrared light would heat the gold, and the heat would kill the cancer. Likewise, nanofilters could be used to purify blood.

Few industries will remain untouched by nanotechnology in some way, she adds. Already, companies are rolling out consumer goods that harness it. Beach lifeguards no longer look like they are smeared with white war paint because their facial sun block has been replaced by a "nanocrystalline" version. The sunscreen formerly contained "particles that reflected light. Now they use the same sort of stuff, but the particles are smaller and don't reflect light."

Perhaps the most ballyhooed nanotech products -- besides the iPod Nano, which really isn't one -- are fabrics produced by California-based Nano-Tex. They resist stains and static and breathe better than many conventional ones. To make its stain-resistant fibers, the company combines hydrophobic whiskers with normal cotton molecules. The whiskers prevent stain absorption but don't affect the feel of the fabric. Companies like Gap and Eddie Bauer are using the technology in their clothing. Another recent Nano-Tex innovation is odor-resistant socks, Peterson says. They contain particles of charcoal and silver that absorb odors.

Even though he works for a nanotech pioneer, Bill Perry, vice president of marketing, sales and business development at Nanomix, a sensor maker, counts himself among the nanotechnology skeptics -- at least when it comes to some of the sector's more self-promotional claims. "What you look for in nanotechnology are the same things that you look for in any business," he says. Seeking out "nanotechnology for its own sake is silly. Nano pants are great, but they had better help you sell more pants."

According to Perry, his company has found such a practical application. A spinout from the University of California at Berkeley, Nanomix makes sensors out of carbon nanotubes. These tiny cylinders of

graphite, with walls the width of a single carbon atom, have a diameter of only 1 or 2 nanometers, about the same size as a strand of DNA.

Nanomix's founders, a chemist and a physicist at Berkeley, originally planned to use the tubes for molecular storage. They shifted their focus to sensors and have devised one for hydrogen and another for carbon dioxide. The hydrogen detector sniffs out explosive gas, while the one for carbon dioxide helps emergency medical technicians (EMTs) monitor patients' breathing. Nanomix also has begun work on a handheld device that would enable EMTs to determine whether a person is infected with sepsis.

Unlike some conventional sensors, Nanomix's devices consume little power. "Our hydrogen detector can operate for a year on a watch battery," Perry says. As you would expect, its sensors are tiny. Twenty of them can fit on a 2x2 millimeter chip and thus 2,220 chips and multiple sensors can squeeze onto a 6-inch wafer.

So what's the future for this industry, which aims to get big while staying small? At the technological level, more companies will follow Nanomix's example and build from the molecular level upwards, Peterson predicts. "Now the typical approach is top-down -- taking big stuff and making it smaller."

Along the way, proponents will undoubtedly have to fight public relations battles because some environmental and public-health advocates have raised concerns about the dangers of these effectively invisible engineering projects. One study, at Southern Methodist University, found that fish swimming in water containing nanoparticles called "buckyballs" (soccer-ball shaped synthetic carbon molecules) ended up with brain damage.

DuPont is trying to head off these sorts of challenges by teaming up with Environmental Defense, a green group, to formulate a framework of policies and best practices for nanotech research and commercialization. "The intent of this framework is to define a ... process that can be used to identify, manage and reduce potential health, safety and environmental risks of nanoscale materials across all lifecycle stages," the partners said in an October news release. DuPont intends to test the framework with its inventions.

These guidelines may come into play sooner than many people expect, even though, for now, the United States is a bit of a nanotech laggard, Peterson says. "This isn't science fiction. It's the future of materials science and even healthcare. But the U.S. is only funding nanotechnology at about \$1 billion a year. Startups are the most important players here."

At the same time, she, like Perry, cautions that nanotechnology "is often just a marketing phrase, so don't let it affect you positively or negatively. It's like a window; just look right through it. When it comes to starting companies, it's no different than anything else." Profits, not just promise, are what will matter.

This is a single/personal use copy of Knowledge@Wharton. For multiple copies, custom reprints, e-prints, posters or plaques, please contact PARS International: reprints@parsintl.com P. (212) 221-9595 x407.