

R&D spending in healthcare is expected to exceed \$180 billion by 2020.

THE FUTURE OF HEALTHCARE

Prepare to be amazed at the ways science and technology are revolutionizing how we predict, avoid, and treat medical issues.

BY JENA PINCOTT

A CENTURY AGO, insulin, penicillin, and Pap smears were just arriving on the scene—and now it's hard to imagine a long and healthy life without them. On the cusp of 2020, we're ready for the next wave of breakthroughs. We're looking at smarter, faster ways to predict or detect disease, personalize treatment, and respond to medical emergencies, if not prevent them altogether. Let's take a look at a few of the disruptive innovations we may someday be thankful for.

1. DO-GOODER DRONES

The problem: People in hard-to-access areas often have to hope and pray that an ambulance will arrive in time to save lives.

A radical solution: Drones will fly above obstacles—rush-hour traffic, flooded roads—carrying EpiPens for allergic reactions, Narcan for opioid overdoses, antivenom kits for snakebites, and other medical supplies. You'll dial 911, and within minutes a stocked drone will be on the scene.

"Medical drones don't just have potential—they're already here," says Shubha Kumar, PhD, an associate professor at the Keck School of Medicine at the University of Southern California (USC) and education director of the USC Institute of Inequalities in Global Health. Africa has led the way, Kumar says; there, drones toting medicine and donated blood have reportedly saved more than 1,000 lives by reducing delivery time from hours to minutes. In the U.S., Kumar says, we should expect to see them taking on disaster-area surveillance, search-and-rescue missions, lab specimen transport, even delivery of organs for transplant. Kumar, whose USC program is the first to offer a certificate course on the use of drones in global health, says that within five years, we'll likely see them bringing medical services and supplies to sites nationwide.

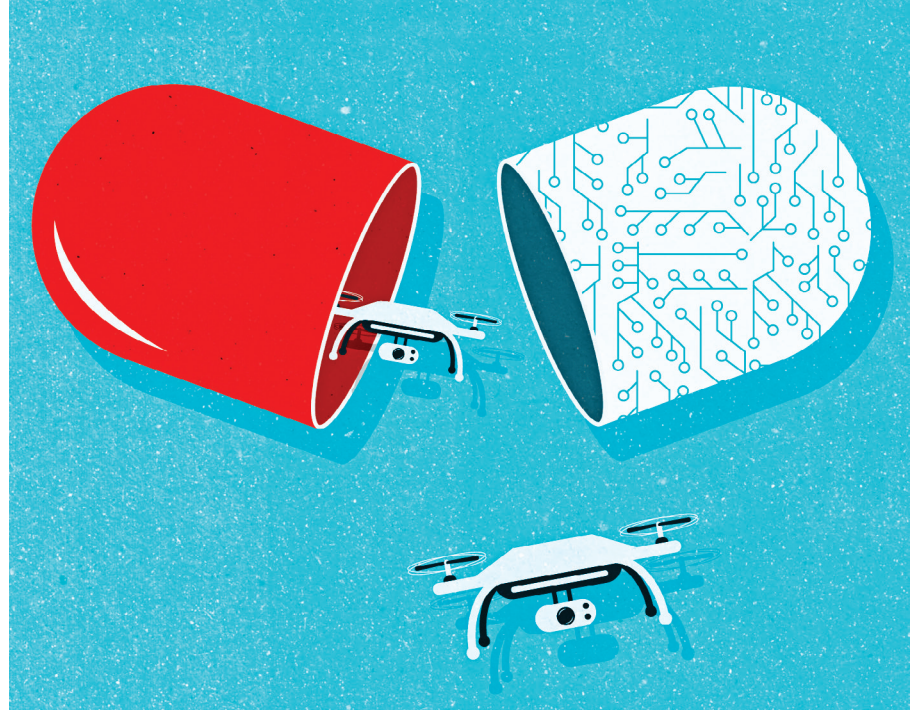
Right now, as part of a Federal Aviation Administration unmanned-aircraft pilot program, service drones are being tested in nine cities. In Reno, Nevada, drones will soon deliver automated external defibrillators for people in cardiac arrest. The idea is that a bystander can use the unit to give an electrical shock while waiting for help. "It takes an average of ten minutes for an ambulance to arrive at a scene, but only five for a drone," says Matthew Sweeny, CEO and founder of the participating drone company, Flirtey. The difference is crucial: Every minute without resuscitation decreases chance of survival by 10 percent.

2. EASY-TO-SWALLOW INJECTIONS

The problem: Some 20 percent of us delay or avoid treatment if it involves a needle.

A radical solution: Instead of a shot, you may be able to swallow a blueberry-size capsule such as the one coined by Giovanni Traverso, PhD, a gastroenterologist at Brigham and Women's Hospital at Harvard Medical School. The pill's shape helps it flip into position and then settle into your stomach lining. Once there, a dissolvable, spring-loaded needle cracks out of its shell and injects the medication directly into your tissue (where there are no pain receptors).

Soon to undergo clinical trials, the needle pill's first adopters may be diabetics



worldwide who need frequent insulin shots. But the hope is that it will replace any injected drug, says Traverso, making treatments easy and ouchless.

3. EPIDEMIC PREDICTORS

The problem: Infectious diseases such as Zika and Ebola seem to emerge out of the blue, quickly overwhelming communities.

A radical solution: Artificial intelligence forecasting systems will observe dengue, Zika, chikungunya, Ebola, the flu, or the next plague in its early stages, giving us a chance to stop it before it spirals out of control. AI may detect disease-related patterns months before an outbreak occurs, says Stephen Mooney, PhD, an epidemiologist at the University of Washington School of Public Health. Those predictions will be based on relevant data including the amount of standing water in a region, the susceptibility of the local population, and transportation networks.

AIME (Artificial Intelligence in Medical Epidemiology), a Silicon Valley-founded startup with a global presence, demonstrated in a trial run that it can pinpoint the location of a Zika or dengue outbreak with 86 percent accuracy three months in advance. Every 23 seconds, AIME's algorithm draws on more than 240 public data sources, including weather, the dew point, crop health, rooftop design, satellite images, anonymized health records, previous disease patterns, and social media rumors. AIME is currently engineering platforms to predict and spot Ebola, malaria, tuberculosis, and new scourges. And within the next two years, AIME will expand efforts in the U.S., says cofounder Rainier Mallol, building on its successes in Brazil (where it helped prevent Zika at the 2016 Olympics in Rio) and Malaysia (where it helped identify 48 percent more mosquito breeding sites than conventional methods).

4. A RESILIENCE VACCINE

The problem: People at risk for extreme or chronic stress and post-traumatic stress disorder (PTSD) don't have many options for prevention—or lasting relief.

A radical solution: A medication may make you more resilient to stressors, from long-term caregiving to military combat. Derived from a harmless soil mycobacterium called *M. vaccae*, the drug wouldn't affect your regular emotions, says Christopher Lowry, behavioral neuroendocrinologist at the University of Colorado Boulder. But you'd meet big challenges with greater resilience. In a 2004 study that inspired Lowry's work, British researchers found that patients with late-stage lung cancer who had taken *M. vaccae* were less worried and depressed than those who hadn't received this treatment, even as their condition worsened. The lipids in the mycobacterium, Lowry explains, bind to immune cells and stop the body's runaway inflammatory response—stress leading to inflammation, and inflammation leading to more stress—before it causes depression, anxiety, PTSD, and other psychiatric disorders. His research found that mice exposed to the strain show fewer signs of anxiety and helplessness when caged with a bully and recover faster after facing stressors. Lowry says he's seen protective benefits in mice that last up to a month, with no apparent addictiveness or side effects.

Within the decade, Lowry hopes to obtain FDA approval for an injectable anti-PTSD "stress immunization." People at risk could get a shot before an anticipated stressor or following an unexpected trauma. In maybe two to five years, the soil microbe could be packaged as a supplement, Lowry says. A pill to ground us when life lands us in quicksand? That's something to root for.