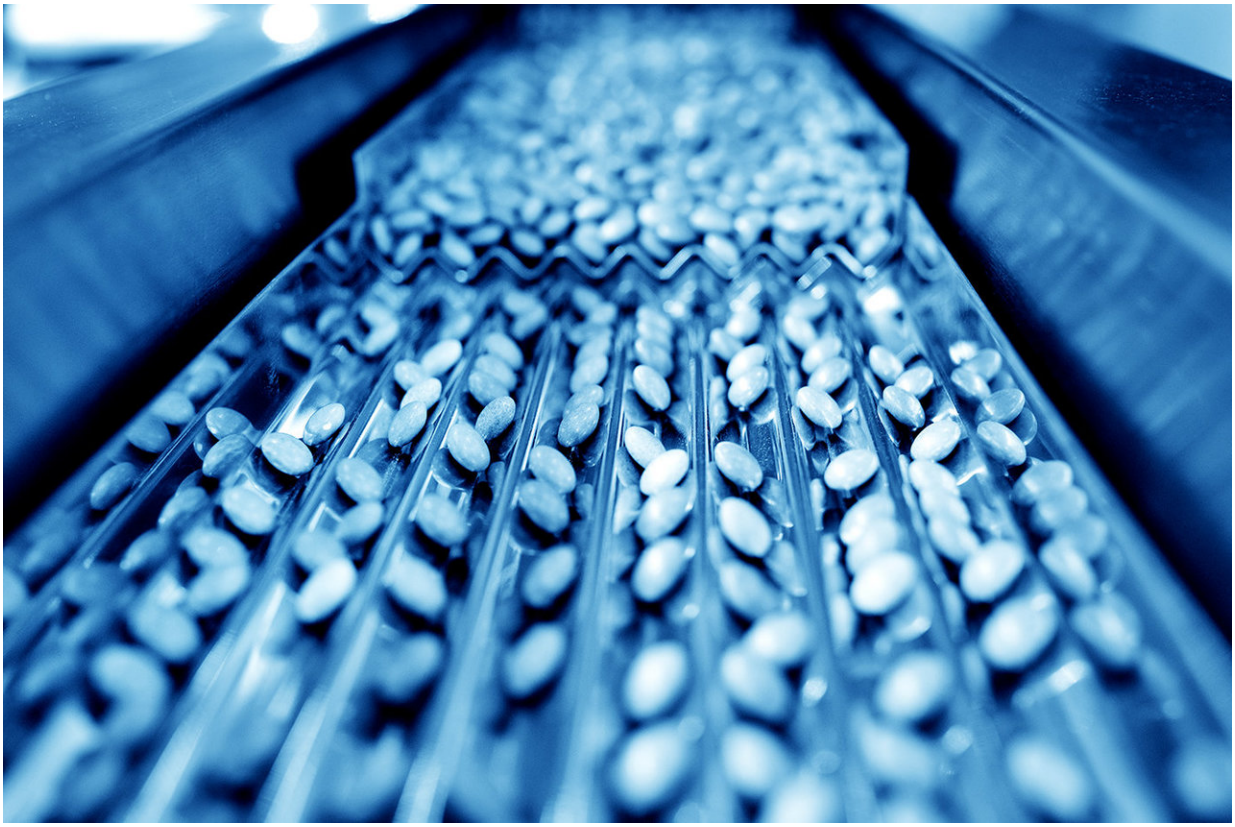
Predictive models could save lives in rampant opioid crisis

October 27 2017, by Allie Nicodemo



Credit: Northeastern University

Before Northeastern professor James Benneyan described his research, he gave a stark reminder of the opioid epidemic it aims to address.

"It's 10:30 a.m. We're roughly one-third of the way through the day, so in Massachusetts we've probably lost another person, and by the end of the day we'll have lost two more. That's every single day," Benneyan said, referencing an epidemic that each day claims up to four lives in Massachusetts alone, and 140 lives nationwide. "We need to do something."

On Thursday, President Donald Trump declared the crisis a national public health emergency, signing a memorandum that would allow states more flexibility in how they use federal funds to tackle the issue.

Benneyan has been waiting for this day. Over the past 20 years, he's developed systems engineering strategies to solve healthcare challenges. Focusing on the opioid crisis specifically, Benneyan and his team have built a series of engineering and mathematical models, including large-scale, quantitative models showing how the epidemic spreads geographically and over time. In a recent study, the models accurately predicted mortality in Massachusetts over a 16-year timespan, mapping the spread of death by individual counties and even down to zip codes.

"We're starting to replicate the work in Maine, Florida, California, Texas, and New Mexico," said Benneyan, the founding director of the Healthcare Systems Engineering Institute and professor of industrial engineering and operations research. "The important work now is to use these models to inform policy."

Squeezing the balloon

The opioid crisis is dauntingly complex. People across the socioeconomic spectrum are dying at annual rates that exceed fatalities from car wrecks and gun violence combined. But there is no simple solution to the problem, and no single intervention that's guaranteed to be effective.

One factor contributing to the epidemic's spread is over-prescription of opioid painkillers. To combat this problem, physicians must change the way they've been dolling out drugs. But fewer prescriptions won't necessarily equate to a drop in overdose deaths, Benneyan said. In fact, the opposite can be true.

"What happens is that if you constrict the supply of prescription opioids, for a dime-to-the-dollar people can go down to the subway station and buy a bag of heroin," Benneyan said. "You see spikes in heroin-associated mortality where there have been valiant efforts to reduce unnecessary, unwarranted prescribing of opiates."

Benneyan described this effect as "squeezing the balloon and it bubbles somewhere else," and said it illustrates the complexity of the opioid problem. And there are other ways the balloon phenomenon plays out. For example, after a massive legal effort to crack down on heroin trafficking in western Massachusetts, mortality actually spiked. Rather than cleaning up the streets, the drug sweep created a new market for an even deadlier substance—fentanyl.

"These are very complex dynamical systems," Benneyan said. That's where the systems engineering approach comes in. "What we've learned by running our models is that one intervention alone isn't going to make much difference and probably is just going to squeeze the balloon and cause a problem elsewhere. There really needs to be a well-orchestrated, highly attuned set of interventions that constantly adapts."

Optimize, rather than overburden

Healthcare clinics are strapped for resources. They don't have the means to screen everyone who comes in seeking painkillers, which means many potential addicts will slip through the cracks. But Benneyan has built predictive models that can identify patients at high risk for abusing

opioids. This would allow clinics to focus screening efforts where they're most needed.

Another significant problem is the availability of treatment. Many people who want to get help don't have a nearby option for care. By employing the same type of mathematical model a retail outlet like Wal-Mart uses to choose the site of a new store, Benneyan has developed access optimization models to inform where to locate short-term and long-term treatment facilities.

"There is this tragic percentage of people who want to get into care but can't. That's the heart-wrenching piece," Benneyan said. His model found that simply redistributing where the clinics are located—without spending any additional money—would save lives.

There are also opportunities for optimization within the clinics themselves. Many are grassroots, not-for-profit organizations that have staffing, layout, and flow challenges, Benneyan said. He is building a team of graduate and undergraduate industrial engineers who will go "into the trenches" and work to make the clinics run more efficiently.

"The things that bring tears to your eyes are stories like the captain of the soccer team who died unable to find a treatment facility that could take her. That tragedy, which repeats itself nationally over and over, causes us to well up," Benneyan said. "This is affecting everybody's lives."

Provided by Northeastern University