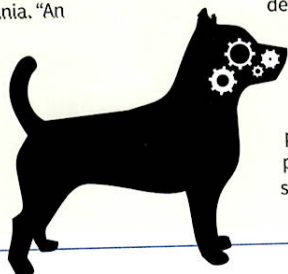


## Can a Machine Mimic a Dog?

**TRAINING THOUSANDS OF DOGS** to sniff cancer-screening samples might sound like a logistical nightmare to most scientists, let alone the prospect of detection dogs roaming a cancer ward. As a result, many researchers see a mechanical copy of a canine nose as the appropriate goal.

"Dogs cost a lot to maintain and train. They have bad days," says George Preti, Ph.D., of the Monell Chemical Senses Center, a nonprofit organization that collaborates with the University of Pennsylvania. "An instrument is the best way to go in the long run. That's the practical challenge: to make a chip with enough capacity to match the canine olfactory sample that can identify the cancer at an early stage."



Electronic noses (e-noses), which seek to mimic the mammalian nose, have been around for a while. The breath test with which law enforcement officers have screened erratic drivers for half a century is essentially an e-nose. E-noses are usually engineered to detect one particular smell, and use a variety of methods. A specially coated quartz crystal that can sense chemical concentrations was tested in Rome with results nearing those of dogs. Other devices measure reflected sound waves, or light wavelengths, or ion reflections, or metal oxide gas, or specific polymers. Still other companies are using very highly sensitive mass spectrometry

equipment to discern a "cancer signature" of several compounds.

Preti, collaborating with PennVet as well as investigators in the chemistry and physics departments, hopes to use cancer-sniffing dogs to identify which volatile organic compounds in cancers to target. The teams hope to link bits of DNA to carbon nanotubes that will act like the dog's nose and respond to volatile organic compounds with a change in the electrical signal.

However, these tests alone cannot diagnose cancer. Ultimately, the cancer must be found visually with a scan, and/or a tissue or liquid biopsy needs to be done. Studies are ongoing to validate both animal- and instrument-based cancer detection, or to incorporate these into other, more established screening tests.

until the disease is in late stages. And many types of cancer, such as ovarian or prostate, can't be detected reliably at early stages.

"There is no early screening tool for ovarian cancer," explains Cindy Otto, D.V.M., Ph.D., director of the PennVet Working Dog Center at the University of Pennsylvania. "We would love to be able to shift this, to see if there's a way to use dogs' amazing sense of smell to develop a screening tool that saves lives."

### THE HISTORY OF DISEASE-SNIFFING DOGS

People noticed long ago that illness had a particular smell. Hippocrates, the ancient Greek physician, famously sniffed his patients. In the last several decades, medical research found that dogs could smell maladies such as hypertension and malaria.

The smells of disease come mostly from volatile organic compounds (VOCs). We excrete hundreds of VOCs in our sweat, breath, urine and other bodily fluids, creating a signature smell. If we're sick, it stands to reason that our cells' metabolism changes, and so does our odor signature.

Scientists first identified cancer VOCs in 1971. But it wasn't until 1989 that someone put dogs and cancer VOCs together in an essay in *The Lancet* titled "Sniffer Dogs in the Melanoma Clinic?"

Evidence was slow to build, however. Finally, in 2004, a research team in the United Kingdom conducted a study to see if dogs could detect bladder cancer from urine. After seven months of training, the dogs got it right 40 percent of the time. That may not seem amazing today, but it was statistically significant and inspired others to conduct similar research. Positive studies began to accumulate: »

### History of Cancer Sniffing Dogs

2006

A study in *Integrative Cancer Therapies* showed that a team of five dogs trained by In Situ sniffed out breast and lung cancers from breath samples, getting it correct between 88 percent and 98 percent of the time.

2011

*Gut*, a publication of the *British Medical Journal*, published a study in which dogs correctly detected colorectal cancer from stool samples 97 percent of the time. Success rates remained high for early stages of the disease.

2013

Dogs sniffed plasma from ovarian cancer patients whose treatment had been declared successful. At three- and six-month checkups, the dogs identified samples from patients who had remaining, but otherwise undetected, cancer cells in their bodies, and who went on to have recurrences and die from their disease.

2014

An Italian study showed that two German shepherds analyzing urine samples from 362 patients with prostate cancer and 540 healthy controls could pick out the cancerous samples with nearly 100 percent accuracy.

2015

A small study showed that a German shepherd named Frankie could detect thyroid cancer with 87 percent accuracy.

2016

The *British Journal of Dermatology* reported a "proof of principle" study in which dogs could detect the difference between invasive melanoma and basal cell carcinoma 45 percent of the time.