# Electronic Nose Can Sniff Out Kidney Diseases and Lung Cancer

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by Lynn Shapiro, Writer

A carbon nanosensor "electronic nose", first developed by Technion-Israel Institute of Technology enabling researchers to detect cancer from breath samples, has been modified to identify chronic renal failure (CRF).

The findings, reported in ACS Nano, could lead to a non-invasive and fairly inexpensive way to detect kidney diseases in their earliest and most treatable stages.

This technology will enable diagnosis even before the disease begins to progress," Dr. Hossam Haick and Prof. Zaid Abassi told DOTmed News in an email interview from Israel.

"When detected at an early stage, kidney diseases can be dramatically slowed with medication and diet," the scientists say. They add that even in cases where chronic renal failure is discovered in its advanced stages, appropriate medication can slow its progress and spare the patient's deterioration toward end-stage renal disease, and the need for dialysis.

Current methods for testing for kidney diseases can be inaccurate and invasive. According to the researchers, blood and urine tests now used to diagnose CRF can come out "normal" even when patients have already lost 65-75 percent of their kidney function. The most reliable test, a kidney biopsy, may result in infections and bleeding.

So far, the researchers have tested the "electronic nose" on the exhaled breath of laboratory rats with no kidney function and normal kidney function. The device identified 27 volatile organic compounds that appear only in the breath of rats with no kidney function. Of these, the team identified the five most important compounds that signal the development of kidney disease.

Collaboration Begins

The idea to use the electronic nose to test for kidney diseases came about during a conversation between Dr. Haick, Prof. Abassi and Prof. Farid Nakhoul of the Technion Faculty of Medicine and Rambam Medical Center, who were aware that one characteristic of patients with diseased kidneys is an ammonia-like odor in the breath," Dr. Haick and Prof. Abassi tells DOTmed.

They say the team's next challenge is to distinguish between the various types of kidney disease and identify their stages.

"Developing sensors that are sensitive enough to differentiate between the various stages of different kidney diseases will enable not just the diagnosis, but also the ability to monitor with great accuracy a patient's response to medication and lifestyle changes," the scientists say.

Dr. Haick and Prof. Abassi say they are now in the midst of a clinical study in Rambam Medical Center in Israel, where they are testing the reliability of Dr. Haick's electronic nose in patients with chronic renal disease at various stages of disease, including very early stage disease, which requires highly sensitive sensors.

"We will conclude the first phase of this study and analyze the data within the next few months," Dr. Haick and Prof. Abassi say. "Hopefully, we will be able to diagnose CRF at its earliest stages, allowing early therapeutic intervention that will delay the progression of the disease toward end stage renal failure, which requires dialysis or kidney transplantation, thus saving these patients physical and mental suffering, besides reducing the economic burden on the health system."

Acute Renal Failure

In addition, they say their team is currently in the midst of a large experimental study examining whether the electronic nose can also detect acute renal failure (ARF), a clinical syndrome with serious short-term and long-term consequences, caused by several etiologies and which affects 5 percent of hospitalized patients and 30 percent of patients in intensive care units.

"It should be emphasized that like chronic renal failure, the diagnosis of ARF is frequently delayed," the researchers say. "Potentially effective preventive and therapeutic measures are available, but frequently delayed due to lack of early diagnostic tools. Therefore, the electronic nose constitutes a novel technology providing early, non-invasive, tools for the prediction and detection of ARF."

When asked where they will conduct clinical trials, they say that usually inventors seek approval for the use of medical devices in the largest markets, namely, the U.S. first and Europe second.

"If the electronic nose is approved for use in the States, we do not see any problem receiving such approval in Israel and other parts of the world," the researchers tell DOTmed.

Cancer Detection Study

The collaboration between Prof. Abassi and Dr. Haick began two years ago, after Prof. Abassi from Rambam Medical Center and Faculty of Medicine in the Technion read about Dr. Haick's novel breakthrough discovery of the electronic nose, and also about his detection of various types of cancer through analyzing breath collected from oncology patients.

As a clinical researcher who has worked for more than 23 years on renal diseases and hypertension, Prof. Abassi remembered that a fishy smell and waste retention are clinical characteristics of patients with advanced chronic renal failure.

Prof. Abassi, along with Prof. Nakhoul, a nephrologist at Rambam Medical Center, approached Dr. Haick, the inventor of the electronic nose, for possible collaboration. Since then, the three researchers have been working together, testing the feasibility of using this medical device for the discovery of kidney dysfunction.

Lung Cancer Tests in the Offing

Using an array of sensors made from gold nanoparticles, Dr. Haick and his team have also developed an "electronic nose" able to distinguish the breath of lung cancer patients from those without the disease. The research results, which will be published in the Nanotechnology section of Nature Magazine very soon, the researchers tell DOTmed, could lead to a rapid and non-invasive way of diagnosing and screening for lung cancer.

The test population for the study was composed of 40 patients with primary stage-3 and stage-4 lung cancer, clinically diagnosed by conventional methods. None had received chemotherapy or other cancer treatments prior to breath testing.

Fifty-six healthy control participants were chosen to match the lung cancer study group in age and lifestyle. Exhaled breath was collected from study participants in a controlled fashion to avoid errors that could arise from not being able to distinguish endogenous compounds (generated

by processes in the body, and which provide insight about the body's functions) and exogenous ones (which can be absorbed via inhalation, or through the blood and skin).

Using a process known as gas chromatography/mass spectrometry (GC/MS) studies, the research team identified nine uncommon organic compounds that are biomarkers for lung cancer in the breath samples. They found that these compounds appeared in at least 83 percent of the lung cancer patients, but not in the majority of healthy subjects.

Experiments with a wider population of volunteers to thoroughly probe the influence of diet, alcoholism, diabetes, and metabolic and genetic states are underway. The researchers say the technology could also be used to diagnose other diseases, leading to cost reductions and enhanced possibilities to save lives.

Source: The Technion-Israel Institute of Technology