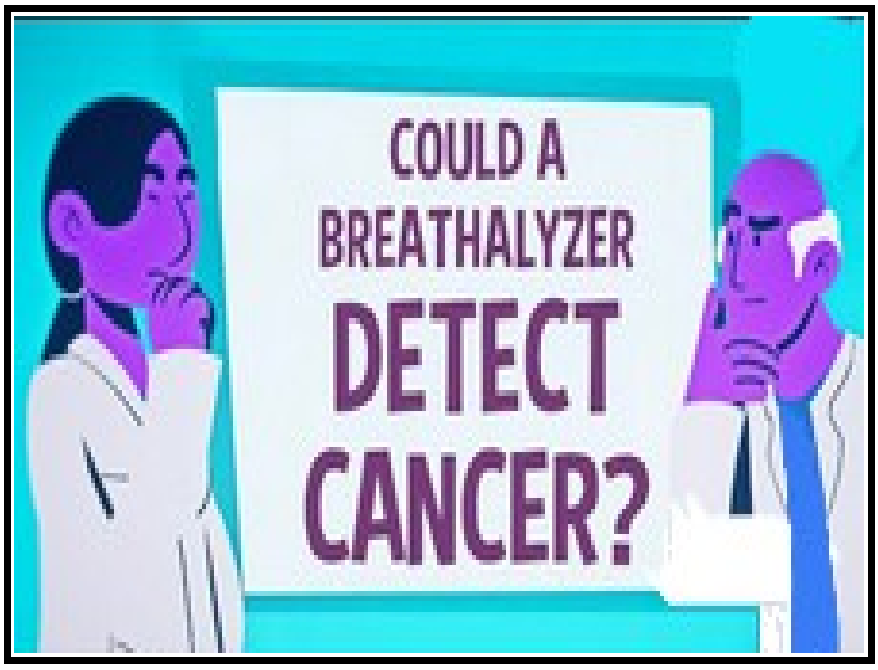
TedEd-30

Could a Breathalyzer Detect Cancer?



How is it that a breathalyzer can measure the alcohol content in someone's blood, hours after they had their last drink, based on their breath alone? Exhaled breath contains trace amounts of hundreds, even thousands, of volatile organic compounds: small molecules lightweight enough to travel easily as gases. One of these is ethanol, which we consume in alcoholic drinks. It travels through the bloodstream to tiny air sacs in the lungs, passing into exhaled air at a concentration 2,000 times lower, on average, than in the blood. When someone breathes into a breathalyzer, the ethanol in their breath passes into a reaction chamber. There, it's converted to another molecule, called acetic acid, in a special type of reactor that produces an electric current during the reaction. The strength of the current indicates the amount of ethanol in the sample of air, and by extension in the blood. In addition to the volatile organic compounds like ethanol we consume in food and drink, the biochemical processes of our cells produce many others. And when something disrupts those

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processes, like a disease, the collection of volatile organic compounds in the breath may change, too.

So could we detect disease by analyzing a person's breath, without using more invasive diagnostic tools like biopsies, blood draws, and radiation? In theory, yes, but testing for disease is a lot more complicated than testing for alcohol. To identify diseases, researchers need to look at a set of tens of compounds in the breath. A given disease may cause some of these compounds to increase or decrease in concentration, while others may not change — the profile is likely to be different for every disease, and could even vary for different stages of the same disease. For example, cancers are among the most researched candidates for diagnosis through breath analysis. One of the biochemical changes many tumors cause is a large increase in an energy-generating process called glycolysis. Known as the Warburg Effect, this increase in glycolysis results in an increase of metabolites like lactate which in turn can affect a whole cascade of metabolic processes and ultimately result in altered breath composition, possibly including an increased concentration of volatile compounds such as dimethyl sulfide. But the Warburg Effect is just one potential indicator of cancerous activity, and doesn't reveal anything about the particular type of cancer. Many more indicators are needed to make a diagnosis.

To find these subtle differences, researchers compare the breath of healthy people with the breath of people who suffer from a particular disease using profiles based on hundreds of breath samples. This complex analysis requires a fundamentally different, more versatile type of sensor from the alcohol breathalyzer. There are a few being developed. Some discriminate between individual compounds by observing how the compounds move through a set of electric fields. Others use an array of resistors made of different materials that each change their resistance when exposed to a certain mix of volatile organic compounds. There are other challenges too. These substances are present at incredibly low concentrations — typically just parts per billion, much lower than ethanol

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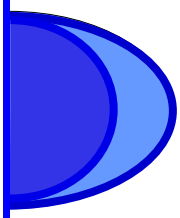
concentrations in the breath. Compounds' levels may be affected by factors other than disease,including age, gender, nutrition, and lifestyle. Finally, there's the issue of distinguishing which compounds in the sample were produced in the patient's body and which were inhaled from the environment shortly before the test. Because of these challenges, breath analysis isn't quite ready yet. But preliminary clinical trials on lung, colon, and other cancers have had encouraging results. One day, catching cancer early might be as easy as breathing in and out.

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