A smart necklace to help people stop smoking

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A necklace that could help you stop smoking is now on the horizon. Northwestern Medicine researchers have developed a smart neck-worn device resembling a lapis blue pendant that detects a user's smoking much more reliably than previous systems. It does so by capturing heat signatures from thermal sensors.

The necklace, called SmokeMon, completely maintains a smoker's privacy, only tracking heat, not visuals—which is a critical factor for people to feel comfortable wearing it.

"This goes way beyond how many cigarettes a person smokes per day," said senior investigator Nabil Alshurafa, associate professor of preventive medicine at Northwestern University Feinberg School of Medicine. "We can detect when the cigarette is being lit, when the person holds it to their mouth and takes a puff, how much they inhale, how much time between puffs and how long they have the cigarette in their mouth."

All these details are called smoking topography, which is important for two reasons. The first is that it allows scientists to measure and assess harmful carbon monoxide exposure among smokers and understand more deeply the relationship between chemical exposure and tobacco-related diseases including cancer, heart disease, stroke, lung disease, diabetes, COPD, emphysema and chronic bronchitis.

The second is to help people in their efforts to quit smoking by understanding how smoking topography relates to relapse (going back to smoking regularly), which happens frequently in people who quit.

Say a former smoker takes a few puffs of a cigarette. Do five puffs or five entire cigarettes send them into a full relapse? This information can be used to predict when a person will relapse and when to intervene with a phone call from a health coach, for example, or even a smartphone text or video message to help encourage them to prevent a relapse. The scientists also plan to study the effectiveness of the device in detecting smoking puffs and topography from electronic cigarettes.

"We want to catch them before they completely fall off the wagon," Alshurafa said. "Once they do, it's much harder for them to quit again.

"For many people who attempt to quit smoking, a slip is one or two cigarettes or even a single puff. But a slip is not the same as a relapse (going back to smoking regularly). A person can learn from slips, by gaining awareness that they did not fail, they just had a temporary setback. To avoid a relapse, we can then begin to shift their focus on how we handle their triggers and deal with cravings."

The study establishing the accuracy of the device and people's willingness to wear it is published in *Proceedings of the ACM on Interactive, Mobile, Wearable, and Ubiquitous Technologies*.

"Now we can begin to test the effectiveness of this device in improving the success rate of smoking cessation programs by preventing relapse in smokers who are planning to quit," Alshurafa said. "We will be able to test whether real-time feedback and interventions can be more effective than usual care. "

Globally, more than 8 million deaths are attributed to smoking each year. Smoking remains a leading cause of preventable disease, disability and death in the U.S., accounting for more than 480,000 deaths every year (or one in five deaths). It was estimated to cost the U.S. more than $600 billion in 2018 (combining health care spending and lost productivity). In the U.S., 12.5% of adults smoke.

Existing devices that track smoking topography must be attached to the cigarette, which changes how a person smokes and makes the data less reliable. Some researchers have investigated non-obtrusive ways to measure smoking behavior, including the use of wrist-worn inertial measurement unit sensors in smartwatches. However, such approaches are often confounded by non-smoking hand-to-mouth gestures and consequently, generate many false positives. Another option, wearable video cameras, creates privacy and stigma concerns, limiting the applicability of camera-based approaches in natural settings.

Nineteen participants were recruited for the study. They took part in 115 smoking sessions in which scientists examined their smoking behavior in controlled and free-living experiments.

As smokers wore the device, scientists trained a deep learning-based machine model to detect smoking events along with their smoking topography, including things like timing of a puff, number of puffs, puff duration, puff volume, inter-puff interval and smoking duration. They also ran three focus groups with 18 tobacco-treatment specialists to understand how they felt about the device.

One smoking cession specialist commented, "These real-time measurements can really help us understand the depth a person is at in their smoking habits and treat the patient accordingly."

More information: Rawan Alharbi et al, SmokeMon, *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* (2023). DOI: 10.1145/3569460

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