Second-hand Smoke

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Second-hand smoke has long been known to be harmful, but the mechanism by which it inflicted its damage wasn't clearly understood. Recent research here has gone a long way toward answering that question.

Smokin'??

even when you don't!

Joe Zasadzinski doesn't smoke, but the UCSB professor of chemical engineering and of materials does want to know how the smoke and fumes that waft off lit cigarettes and out of smokers' mouths might affect him.

Second hand smoke has been implicated in a host of health problems: It can cause lung cancer, and it's been linked to respiratory infections, asthma, and chronic respiratory problems, such as persistent wheezing and coughing, in children. It hasn't, however, been fully understood how the damage to the lungs is done. Now Zasadzinski is studying one aspect of how second hand smoke affects the lungs, forcing them to work harder and perhaps causing lasting damage.
Second hand smoke?the fumes and particulate matter, both drifting directly from burning cigarettes, cigars, and pipes (sidestream smoke) and exhaled by smokers (mainstream smoke)?contains more than 5,000 chemical compounds, including the same multitude of carcinogens and toxins inhaled by smokers, including carbon monoxide, cyanide, benzene, formaldehyde, and arsenic. (It?s a Group A carcinogen, along with asbestos, benzene, arsenic, and radon?)

?The chemistries of primary and second-hand smoke are basically the same,? Zasadzinski says, ?although ?people argue about concentrations a lot?about who gets more.? When they suck on cigarettes, smokers are, of course, intending to inhale a hefty hit of nicotine-laden smoke. However ?the smoker has a filter on his or her end of the cigarette,? Zasadzinski points out, ?but there?s no filter on the secondhand smoke that comes out the other end. It?s tough to say who gets the worst of it?the active smoker or the passive bystander.? Regular smokers, however, develop some degree of resilience to the persistent assaults on their lungs, notes Kamlesh Asotra of California?s Tobacco-Related Disease Research Program (TRDRP). Non-smokers don?t, so second hand smoke causes more damage to their lungs than direct smoke does to smokers, Asotra says. (TRDRP disperses funds from state cigarette taxes to researchers?including Zasadzinski.)

To look at the effects of second-hand smoke, Zasadzinski, working with Patrick Stenger and Coralie Alonso, also of UCSB?s Department of Chemical Engineering, and researchers at UCLA and UC Davis, focused on a crucial component of the respiratory system: the thin film of liquid on the inside of the lungs. This epithelial lining fluid helps the lungs function and protects them from damage. ?If you smoke or you?re around smoker, this is the first place the smoke will hit?? Zasadzinski says.

?Now I can say, ?Hey buddy, you?re destroying my proteins here.??

Epithelial lining fluid contains lung surfactant ?which is there to make breathing easier,? Zasadzinski says. Lung surfactant lowers the surface tension between the fluid lining the lungs and air, minimizing the work the lungs do as they expand and contract.

?The lower the surface tension, the easier it is to breathe,? Zasadzinski says. ?Surfactant?s there to minimize the mechanical work the lungs have to do to move
oxygen into, and carbon dioxide out of, the body. Epithelial lining fluid is continuously regenerated, so every 24 hours or so the lining of your lungs is basically replaced, Zasadzinski says. An adult’s lungs contain only about a teaspoon of surfactant, but if you don’t have it, you’re dead, he added.

Surfactant abnormalities occur in a host of diseases, including asthma, pneumonia, emphysema and sepsis, which can leave sufferers gasping for air.

Very premature babies also have trouble breathing, because lung surfactant isn’t produced until the final weeks of pregnancy. Babies born too early can be treated with replacement surfactants derived from pigs or cows. These are pumped into the baby’s lungs, which are accustomed to the fluid-filled environment of the womb, as soon as possible after birth, and help the baby breathe until its lungs start producing their own surfactants, within a couple of days.

Replacement surfactants, however, aren’t much use for adults with breathing problems. They would trigger an adult’s stronger immune response, Asotra says, and besides, respiratory distress is usually just one of a host of problems, treating adults is considerably more complicated, Zasadzinski says.

To study how second hand smoke affects lung surfactants, Zasadzinski and his colleagues used biologically-based replacement surfactants in a lab setup that replicates how smoke interacts with the fluid lining of the lungs, a very, very elegant method of mimicking what happens in a living lung, Asotra says.

The researchers produced second-hand smoke by burning cigarettes in controlled conditions using a smoking machine at UC Davis’ Institute of Toxicology and Environmental Health. They exposed purified water to this smoke for six hours, to create a tainted brew that they then used to test the effects of second-hand smoke on replacement lung surfactants. Zasadzinski and his colleagues reported their results recently in the international journal Biochimica et Biophysica Acta.

The extent of the smoke damage to surfactants was very surprising, Zasadzinski says. The researchers focused on two proteins that are important in the surfactant function, and found they were both really badly chewed up by second-hand smoke. Smoke exposure changed the chemical composition and structure of the surfactants in the study, most likely by damaging crucial proteins.

In a real, breathing animal, that kind of damage makes breathing hard work. If you’re continuously exposed to tobacco smoke, you will have breathing difficulties.

In their study, Zasadzinski and his colleagues exposed surfactants to second-hand smoke for 12 to 24 hours. It’s difficult to equate that to a specific level of exposure in humans, he says, but generally speaking, it’s typical of an environment where there’s smoking going on.

The study demonstrates how dangerous and injurious second hand smoke is, Asotra says. It’s also helpful in understanding the effects of other kinds of smoke, such as that produced by indoor wood-burning stoves, or by devastating forest fires.
Zasadzinski hopes that further research into how tobacco smoke damages the lungs will help answer the question of “how much exposure is too much exposure?”

Studies like his also bring us closer to understanding just how smoke harms the lungs, Asotra says?knowledge that may one day help scientists figure out ways to treat or prevent lung damage from smoke.

“It’s one thing to ban smoking,” Zasadzinski says. “It’s another thing to ask, as we are, ‘How do we help people who may be affected?’

In the meantime, Zasadzinski can better justify feeling aggrieved when he’s forced to share a clouded room with smokers. “Now I can say, ‘Hey buddy, you’re destroying my proteins here.’

Links:

The paper Environmental tobacco smoke effects on lung surfactant organization
dx.doi.org/10.1016/j.bbamem.2008.11.021 [2]

Joe Zasadzinski’s homepage:
www.chemengr.ucsb.edu/~ceweb/faculty/zasadzinski [3]

UCSB Department of Chemical Engineering:
www.chemengr.ucsb.edu/ [4]

California Tobacco-Related Disease Research Program:
www.trdrc.org [5]

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