

Electronic Cigarettes



RTI International stands at the forefront of e-cigarette research with expertise in health policy, exposure assessment, biomarker development, pharmacology, and toxicology. We advance the science around e-cigarettes to support our clients' needs to better understand e-cigarette users, marketing, health effects, devices, and liquids as well as e-cigarette regulations and policies.

At RTI, we recognize that the health consequences of e-cigarettes and other vapor products have not been fully studied. Our experts work with federal, state, academic, and private partners to advance the emerging science related to all aspects of these products. From monitoring populations, marketing, and policies to examining exposures and toxicology, we offer integrated solutions to help agencies and individuals make informed decisions to protect public health.

Areas of Expertise

Public Health Policy. RTI is a recognized innovator in designing and implementing studies to inform and evaluate public health policies. We have successfully conducted tobacco control research projects involving e-cigarettes for the U.S. Food and Drug Administration, the Centers for Disease Control and Prevention, the Substance Abuse and Mental Health Services Administration, and various state governments. In addition to the full range of survey activities for surveillance and monitoring, our scientists use innovative data collection techniques—such as mining social media data, eye-tracking, passive monitoring of

Public Health Policy

- Regulatory science
- Surveillance and monitoring
- Policy and program evaluation

user behavior, and experimental methods—to understand how policies for e-cigarette marketing and product characteristics might improve population health. We combine our expertise in regulatory science, surveillance, and monitoring with policy and program evaluation to inform the appropriate public health response to this pressing health issue.

Exposure Assessment

- E-cigarette vapor physical and chemical characteristics
- E-cigarette secondhand exposure assessment based on theory and wearable sensor measurements
- Inhalation modeling to quantify e-cigarette dose

Exposure Assessment. RTI researchers assess primary and secondhand exposures to e-cigarette emissions. This research uses our knowledge of aerosol physics and chemistry, along with inhalation dosimetry, to investigate the entire source-exposure-dose paradigm.

Our scientists quantify nicotine, flavorings, and other chemicals in the particulate and gas phases of e-cigarette emissions. This information determines aerosol formation and growth mechanisms that determine the dose a user receives and the potential magnitude of secondhand exposures. Our knowledge of personal exposure measurements using wearable sensors and aerosol

dispersion allows us to identify and quantify key parameters for secondhand exposure of e-cigarette emissions. For example, the RTI MicroPEM™ assesses e-cigarette secondhand exposure in real-time and provides filter samples for detailed chemical speciation.

Biomarker Development

- Targeted and untargeted biomarker identification
- Biomarker studies of exposure and effect
- Statistical toxicological relationship

Biomarker Development. RTI identifies targeted and untargeted biomarkers to characterize e-cigarette internal dose and health outcomes. Our analytical methods for the broad-spectrum analysis of metabolites to link dose with health outcomes are especially applicable to the complex exposures associated with e-cigarettes. RTI's experience developing markers for exposure, dosage, biological effect, and susceptibility based on measurement of DNA or protein adducts can be used to examine e-cigarette use. We measure phenotypic anchors, including those obtained from clinical chemistry, hematology, urinalysis, and andrology assessment.

Pharmacology and Toxicology

- Material characterization
- In vitro cell models
- Hazard identification and assessment
- In vivo: abuse liability, pharmacokinetic, and toxicology models

Pharmacology Toxicology. Researchers in RTI's Environmental Toxicology Program specialize in the preparation, functionalization, characterization, and biological/toxicological responses of particles and fibers on the nanometer- and micrometer-size scale. We use novel in vitro cell models to identify the physiological pathways that determine the physicochemical properties of particles with their biological responses at the molecular, acellular, tissue, and whole-animal levels.

Our research capabilities also include characterization of the behavioral effects of chemical constituents of e-cigarettes

in rodents, with exposure via aerosol or injection. A particular expertise is assessment of abuse liability, including evaluation of the effects of flavorants. Parallel examination of pharmacokinetic and pharmacodynamic factors allows determination of mechanisms underlying these effects.

Selected Recent Publications

Lefever, T. W., Lee, Y.O., Kovach, A. L., Silinski, M. A., Marusich, J. A., Thomas, B. F., & Wiley, J. L. (2017). Delivery of nicotine aerosol to mice via a modified electronic cigarette device. *Drug and Alcohol Dependence*, 172, 80–87. doi:10.1016/j.drugalcdep.2016.12.004

Robinson, R. J., Hensel, E. C., Roundtree, K. A., Difrancesco, A. G., Nonnemaker, J. M., & Lee, Y. O. (2016). Week long topography study of young adults using electronic cigarettes in their natural environment. *Plos One*, 11(10). doi:10.1371/journal.pone.0164038

Lee, Y. O., Shafer, P. R., Eggers, M. E., Kim, A. E., Parvanta, S. A., & Nonnemaker, J. M. (2016). Effect of a voluntary e-cigarette warning label on risk perceptions. *Tobacco Regulatory Science*, 2(1), 82–93. doi:10.18001/trs.2.1.9

Farrelly, M. C., Duke, J. C., Crankshaw, E. C., Eggers, M. E., Lee, Y. O., Nonnemaker, J. M., et al. (2015). A randomized trial of the effect of e-cigarette TV advertisements on intentions to use e-cigarettes. *American Journal of Preventive Medicine*, 49(5), 686–693. doi: 10.1016/j.amepre.2015.05.010

Thornburg, J. W., Malloy, Q. G., Cho, S., Studabaker, W. B., & Lee, Y. O. (2015). Exhaled electronic cigarette emissions: What's your secondhand exposure? (RTI Press, No. RB-0008-1503). www.rti.org/pubs/secondhand_exposure_to_electronic_cigarette_emissions.pdf.

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