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GASPING FOR ACTION | A WATCHDOG REPORT

Lab tests reveal popular e-cigarette liquids contain harmful chemicals

Testing typically used in vaping industry not sensitive enough to detect some levels

By Raquel Rutledge

Dripper's Paradise, on Milwaukee's southwest side, carries dozens of brands of smoke juice, including a locally made favorite called Foghorn.

One of Foghorn's top-selling recipes is

Randy, a flavor described as a "blend of creamy custard, mixed berries and savory cereal notes."

People who vape praise the Foghorn juice not only for its flavor but for its ability to ~~create giant cloud puffs from deep drags~~ —

Gasping for Action

Published October 20, 2015

- Lab tests reveal popular e-cigarette liquids contain harmful chemicals
- [More Marquette University students have tried e-cigs than tobacco cigarettes, survey says](#)
- [Other harmful chemicals found in smoke juice](#)

It's been known for years that diacetyl destroys lungs. Yet the federal government has failed to regulate it. A Milwaukee Journal Sentinel investigation has found the buttery flavor chemical is injuring coffee workers and has seeped into other products such as e-cigarettes.

Read our previous [Gasping for Action](#) installments on diacetyl and the flavorings industry.

a growing fascination known as "cloud chasing" among vaping enthusiasts.

But the very molecules that make Randy delicious also could make it dangerous. The juice — named after a character in the Canadian TV series "Trailer Park Boys" — contains high levels of two chemicals known to cause permanent and sometimes fatal lung disease: diacetyl and its chemical cousin, 2,3-pentanedione.

There's no way vapers would know; founders of the year-old Foghorn company said they didn't realize it. The only way to determine whether the juice, or e-liquid, includes toxic chemicals would be to test it — which the Milwaukee Journal Sentinel did.

There are no requirements that manufacturers test their e-liquids, nor are there any standards to meet. What testing is done is driven largely by the desire of e-liquid makers to market the safety of their products.

But the Journal Sentinel's testing led to yet another discovery: The method typically used to analyze e-liquids for the industry is not sensitive enough to detect

levels that could be harmful. As a result, e-liquid makers across the country claim their formulas are diacetyl free when sometimes they are not.

"We're at a point where these are not regulated by anyone," said Michael Felberbaum, a spokesman for the U.S. Food and Drug Administration. "It's a 'Buyer Beware' market."

...

Vaping is a burgeoning attraction for nicotine lovers looking to get their fix without lighting a flame to tobacco.

Vapers can choose from a variety of electronic nicotine delivery systems, as they are technically called. These systems are battery powered and use liquid nicotine extracted from tobacco. The nicotine is mixed in a base of propylene glycol or vegetable glycerin — often with added flavors — and heated into vapor for users to inhale.

A LOOK AT E-CIGARETTES

E-cigarettes began as a smoke cessation aid but now have become a popular consumer product. Revenue from electronic cigarettes for the top U.S. cigarette manufacturers is projected to near or surpass revenue from traditional cigarettes by 2023.

While much of the concern about e-cigarettes has been about nicotine, the flavor cartridges often contain diacetyl, a chemical known to cause severe lung damage when inhaled. Some contain a diacetyl substitute that has been found to be equally toxic.

How e-cigarettes work

Light

Simulates cigarette glow, indicates when device is ready for use and works as battery indicator.

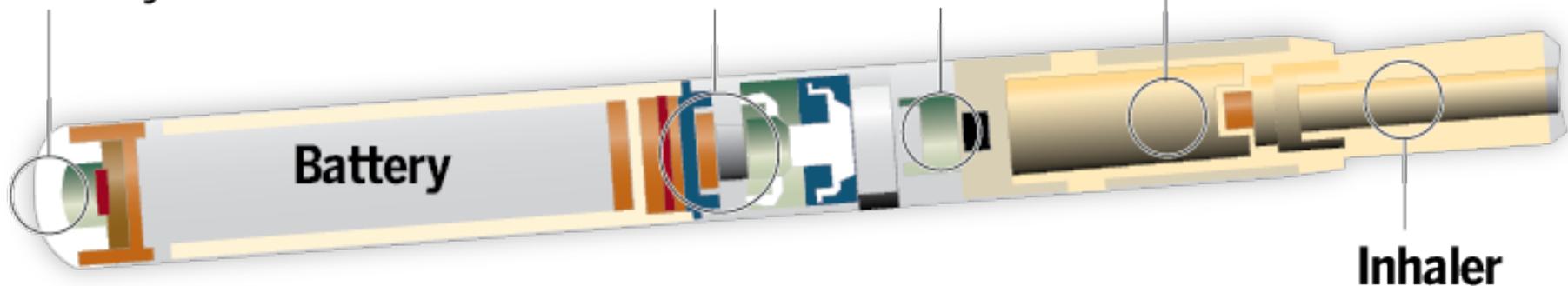
Electronic components

Include control circuits, pneumatic airflow sensor.

Vaporizer

Atomizes the nicotine smoking liquid in the liquid container.

Flavor cartridge



Diacetyl found in many e-cigarettes: A September 2014 study by the Society for Research on Nicotine and Tobacco examined 159 sweet-flavored samples of "e-liquid" – sometimes called "smoke juice" – from three dozen manufacturers in seven countries.

Konstantinos Farsalinos, a researcher and doctor with the Onassis Cardiac Surgery Center, in Athens, Greece, found nearly 70% contained diacetyl. About a third contained a related chemical that has been found to cause similar lung damage.

SOURCES: TNS; E-CIG; JOURNAL SENTINEL RESEARCH

The first iteration to hit the U.S. market en masse was the e-cigarette in 2007, patented and made in China. E-cigarettes, or "cigalikes," are thin, stick-like devices that look like cigarettes. Some brands feature a light at the tip to mimic the glow of a tobacco cigarette. Some offer refills; others are disposable.

E-cigs are typically bought at gas stations, convenience stores and online. Many of the most popular ones are manufactured by big tobacco companies.

Other devices — sometimes called mods — are larger and feature refillable tanks that let users mix and match flavors. Dozens of devices and thousands of flavors, with multiple nicotine levels, are available

online and at scores of vape shops popping up across the country.

Despite its highly addictive properties, nicotine liquid is unregulated. While the FDA regulates smoking cessation drugs and devices, such as nicotine patches and gum, nicotine itself — a stimulant tied to cardiovascular disease — is not a controlled substance. It's for sale online.

With easy access to ingredients and soaring demand, the global vaping market is awash with small start-ups trying to make a name for themselves in the e-juice business. Much like microbrewers, they experiment with recipes, come up with clever names and see how they sell.

Some mix their liquids in the back of their stores. Others contract the work out to what they claim are accredited laboratories.

At Foghorn, the liquid is mixed in a "clean room," which owners describe as a sanitary room dedicated to mixing e-liquids, that adjoins an office in a former storefront. Owners did not respond to repeated requests by the Journal Sentinel to visit the production space.

With U.S. sales predicted by Wells Fargo Securities to reach \$3.5 billion by the end of 2015, the vaping industry has gone from fledgling to flourishing in a few short years.

And flavor is key.

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Diacetyl and 2,3-pentanedione are hailed for their buttery taste and are added to everything from chips and candy to cream cheese and ice cream. The chemicals are byproducts of fermentation and form naturally in butter, beer and other foods. They have been deemed safe to eat in trace amounts, but studies

show they can be toxic when inhaled.

Diacetyl is more commonly recognized for its links to injuries and deaths of microwave popcorn workers. More recently, a Journal Sentinel investigation found potentially dangerous levels of the chemical [in coffee roasting facilities](#) and exposed cases of lung disease in [commercial coffee roasters and grinders](#). Diacetyl destroys the lungs' tiniest airways, leading to scar tissue buildup which blocks airflow. Its damage is irreversible. The U.S. Centers for Disease Control and Prevention [posted a warning](#) to coffee industry workers in September.

Nothing on the Foghorn e-liquid label mentions the lung-destroying chemicals. A warning reminds buyers only that the product may contain nicotine and should be kept away from children.

VAPE SHOPS AT THE FOREFRONT OF E-CIGARETTE BOOM



KATIE KLANN

E-liquids come in thousands of flavors and are available online and at vape shops nationwide. Testing by the Milwaukee Journal Sentinel found high levels of lung-destroying chemicals.

Same with the stickers on the Vape Apes house-brand liquids. Vape Apes is a line of e-liquids and a wholesale and supply company owned by the same people who run Dripper's Paradise. The Vape Apes website assures customers that all its e-liquids are free of both diacetyl and 2,3-pentanedione (also known as acetyl propionyl). But that promise applies only to Vape Apes brand juices, according to a note at the top of the page. Not the 30-plus other brands the store sells.

Vape Apes co-owner Damien Thompson said he screens the outside brands as best he can but can't control what other e-liquid makers use. As for his in-house brand, he buys flavors from a few different manufacturers — Michigan-based LorAnn Oils and California-based Capellas Flavors and Flavor West — and says he trusts them not to sell hazardous chemicals.

"When I'm asking them the ingredients in their liquid,

and when they tell me it's not in there, I know it's not," Thompson said. "I don't need to pay someone and take money out of my wallet to have it tested. I wouldn't trust (a testing lab) any more than I would trust the company making it."

The Journal Sentinel bought five e-liquids dubbed top-sellers by sales clerks at vape shops around Milwaukee — including Foghorn's Randy and a Vape Apes house brand called Goji Melonberry — and had them tested for diacetyl and 2,3-pentanedione.

The results: All five contained both chemicals. And Foghorn's Randy had levels well above those that scientists say can destroy lungs, according to analyses by two labs.

Kyle Ehlert, co-founder of West Allis-based Foghorn, said he expected his flavor suppliers would have alerted him if there were dangerous ingredients in their products. He uses some of the same suppliers as

Thompson at Vape Apes.

"I just figured they would give you the kind without it," Ehlert said. "I just assumed they would know it had diacetyl in it and give you something else or tell you about it."

Websites for LorAnn Oils and Capella Flavors state that the companies do not use diacetyl in any of their products. [LorAnn also has a disclaimer](#) stating that none of the flavors had been approved for inhalation.

"LorAnn Oils cannot make any claims as to the safety of the use of flavoring substances in e-cigarettes," it states.

Flavor West posted [a list disclosing](#) its flavors known to have diacetyl and/or 2,3-pentanedione. It's unclear who does the company's testing and to what level of detection.

No one can say for certain how often e-liquids are mislabeled as diacetyl free — or exactly how much risk

they pose.

While dozens of studies are underway, few — if any — have been completed that reveal all the respiratory impacts from inhaling e-liquids laced with diacetyl and 2,3 pentanedione.

"Certainly those two chemicals are known to be problematic," said James Pankow, a chemistry professor with Portland State University in Oregon who has studied e-liquids. "Trying to come up with a single, bright-line number to compare risk is impossible.

"All of this toxicology is a very, very crude science."

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LAB TESTS FIND HARMFUL CHEMICALS IN E-JUICE



MIKE DE SISTI

Scott Reid, a professor and chair of Marquette University's chemistry department, found diacetyl and another lung-destroying chemical in five e-liquid samples bought from vape shops around Milwaukee. To view photo

galleries, go to

Photo Gallery: Lab tests find harmful chemicals in e-juice

In conducting its spot check of e-liquids, the Journal Sentinel bought Wisconsin brands that boast their own recipes and labels. The samples were analyzed by a team from Marquette University, spearheaded by Scott Reid, a professor and chair of the university's chemistry department.

"We clearly see that all of the samples contained the (chemicals) at some level," Reid said. "The key issue is what the long-term health effects are."

Three of the liquids with the highest levels, including Foghorn's Randy, were then sent to Enthalpy Analytical, a North Carolina lab that specializes in e-liquid testing for the industry. Enthalpy's analysis — like Marquette's — found high levels of diacetyl and 2,3-pentanedione in Randy.

It's what the lab didn't find that raises questions.

Enthalpy's tests did not detect either of the chemicals in the two other samples. The standard testing the company does is designed to detect levels above 1 part per million, according to company representatives and printed information that accompanies the results.

Yet Marquette's analysis found concentrations of both chemicals in each sample at concentrations ranging from 4 to 50 parts per million.

Marquette and Enthalpy said their analyses passed their quality control measures and that they stand by their results.

The discrepancy highlights differences in testing methodology and desired levels of detection.

Marquette's approach used a more sensitive technique that scientists say can detect lower levels, down to parts per billion. The Journal Sentinel consulted with three independent experts who said the university's method was superior.

The problem is, it is also more time-consuming and costly.

"We're a commercial lab here to make money," said Bryan Tyler, a representative of Enthalpy who handled the Journal Sentinel's testing request. "We're different than academia where they get grants and have plenty of time."

Tyler said Enthalpy is capable of detecting lower concentrations when customers request it and are willing to pay for it. That's not common for e-liquid manufacturers, he said.

"The issue is why do I need to look at parts per trillion when many are detected at 100 parts per million?" he said. "The industry isn't to that point yet. They've got a lot of cleaning up to do."

Tyler said Enthalpy runs tests on about 500 e-liquid samples per month, from industry giants to folks who

mix their own juices to sell to local shops.

Patrick Rainey, a toxicology consultant with Creative Process Solutions in Raleigh, N.C., said the onus is on the industry — not a lab — to seek more sensitive testing.

"If the industry out there selling the product is driving the investigation, where are the checks and balances?" he said.

...

Trade associations in the United States and Canada are taking their cue on how to test e-liquids from a cardiologist in Greece — a doctor who touts the virtues of vaping.

HOW DIACETYL DAMAGES LUNGS

Exposure to diacetyl, a chemical widely used in the flavoring industry, can cause *bronchiolitis obliterans*, a potentially fatal disease that can attack and quickly destroy the respiratory system. The condition has been found in popcorn workers and more recently, coffee workers, among others. Diacetyl is also a common ingredient in e-cigarettes. Here's a look at how diacetyl enters the body, symptoms of exposure and the

effect of *bronchiolitis obliterans* on the lungs:

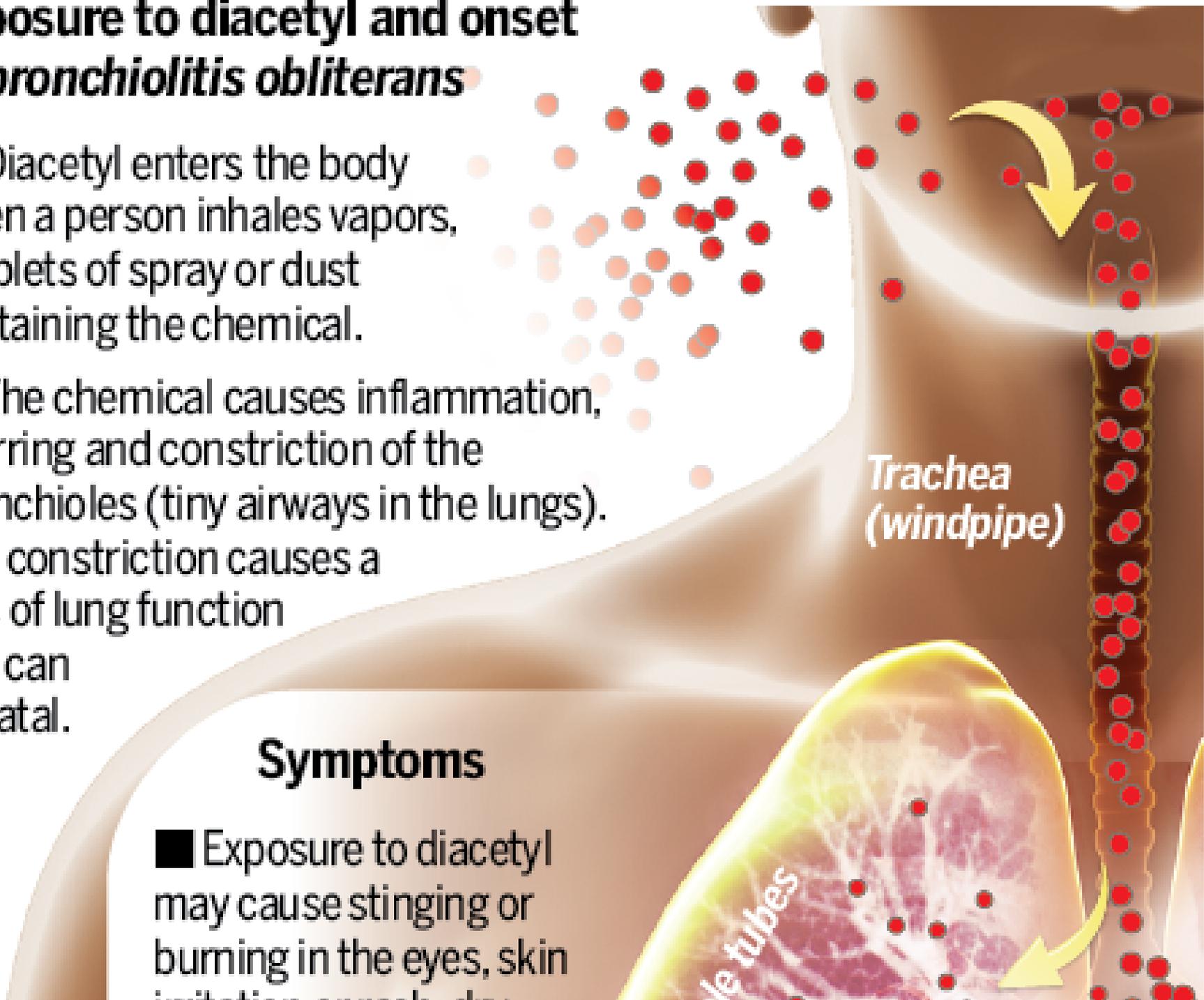
Exposure to diacetyl and onset of *bronchiolitis obliterans*

■ Diacetyl enters the body when a person inhales vapors, droplets of spray or dust containing the chemical.

■ The chemical causes inflammation, scarring and constriction of the bronchioles (tiny airways in the lungs). The constriction causes a loss of lung function and can be fatal.

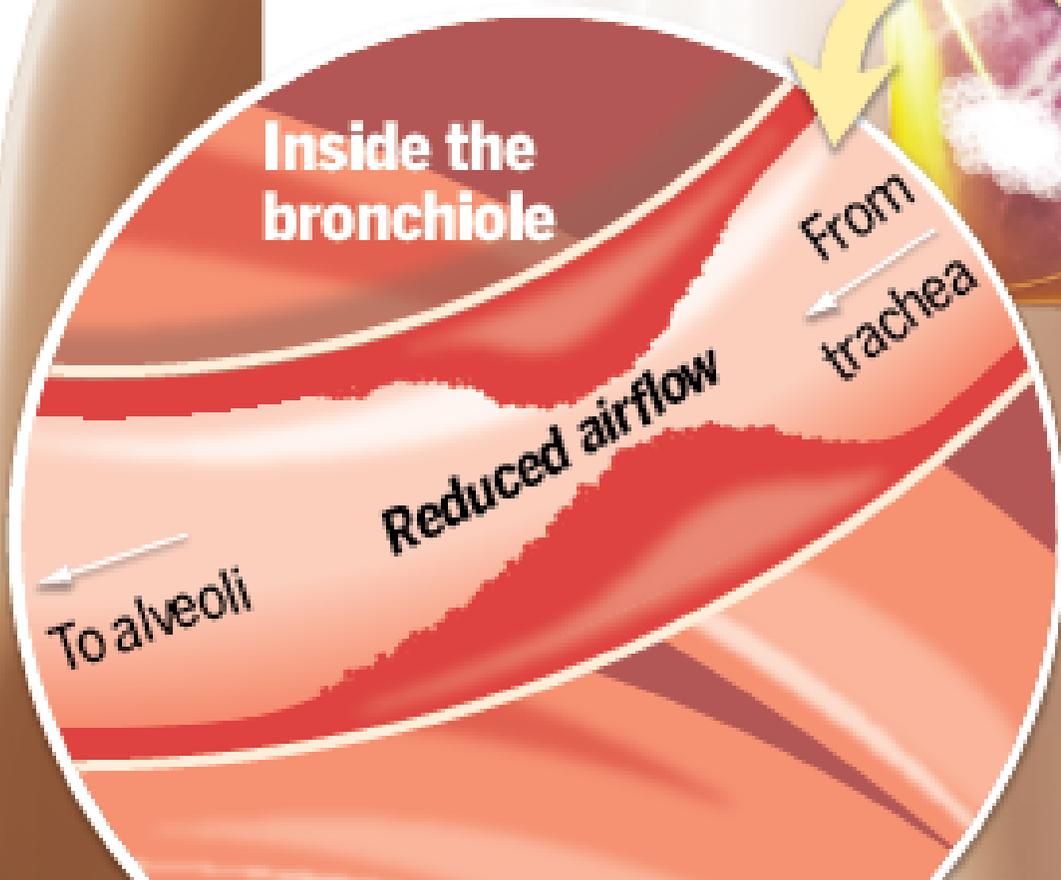
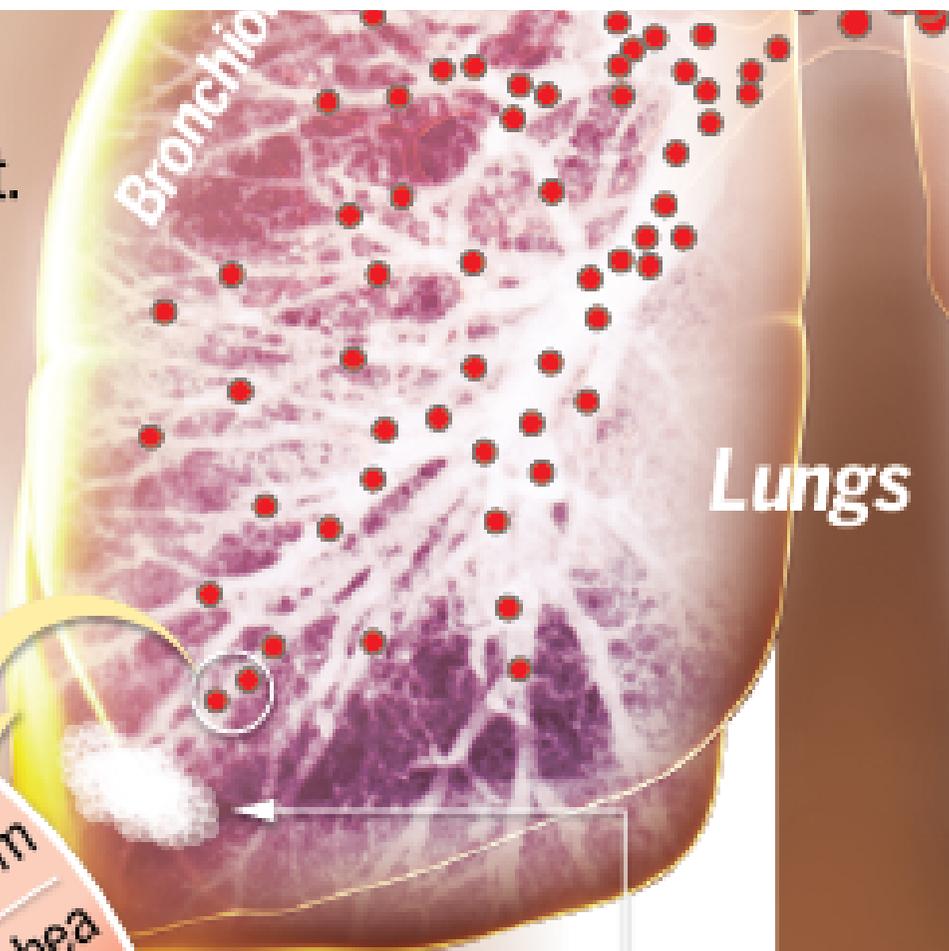
Symptoms

■ Exposure to diacetyl may cause stinging or burning in the eyes, skin



Irritation or rash, dry cough, shortness of breath and sore throat.

■ The disease is irreversible. In severe cases, patients may be placed on a lung transplant waiting list.



Brochiole tubes end in **alveoli**, small chambers in the lungs where oxygen and carbon dioxide are exchanged.



* Diagrams
are schematic

SOURCES: U.S. CENTERS FOR DISEASE CONTROL AND PREVENTION

Konstantinos Farsalinos, with the Onassis Cardiac Surgery Center in Athens, is an outspoken proponent of e-cigarettes to help smokers replace conventional cigarettes — which are to blame for more than 438,000 deaths in the United States every year, according to the American Lung Association.

He was the primary author on a study published last year by the Society for Research on Nicotine and Tobacco on sweet-flavored e-liquids and maintains that measuring parts per million is "more than enough" to detect dangerous levels of diacetyl.

Farsalinos analyzed 159 e-liquid flavors from 36 manufacturers in seven countries and found as many as

70% of sweet-flavored e-cigs contain diacetyl. [In his study](#), he compared exposures from vaping with [proposed limits suggested](#) by the National Institute of Occupational Safety and Health, which were designed to protect Americans exposed to chemicals in the workplace.

The NIOSH limits are "extremely strict," he said, noting they are figured to allow no more than one person in 1,000 to suffer lung damage over a 45-year work life. NIOSH is the research arm of the CDC.

Farsalinos has advocated for the removal of diacetyl and 2,3-pentanedione from e-liquids, saying they are an avoidable risk. Still, he's not alarmed about lower concentrations.

By Farsalino's calculations, vapers should be able to withstand roughly 86 micrograms of diacetyl a day from vaping and not exceed NIOSH's recommended safeguards. For 2,3-pentanedione it would be about

182 micrograms.

The Foghorn brand contained 92 micrograms of diacetyl in just 1 gram of e-liquid aerosol and more than 269 micrograms of 2,3-pentanedione. One gram is approximately equal to 1 milliliter of e-liquid.

Farsalinos' studies suggest an average vaper uses roughly 3 milliliters a day, though other studies show the average is around 5 milliliters and in interviews conducted by the Journal Sentinel some vapers said they used more than 15 milliliters a day. Puffing behaviors vary and comparisons are rough, but inhaling vapor from 3 milliliters of e-liquid is similar to smoking 30 to 40 conventional cigarettes, or a pack and a half to two packs, in terms of number of puffs.

That exposes Randy fans who vape an average of 3 milliliters to more than three times the level of diacetyl deemed acceptable for workers. And more than four times the amount of 2,3-pentanedione. Those who vape

heavily face a greater threat.

That's if you believe Farsalinos' framework for calculating the risk.

Not everybody does.

Some scientists familiar with the chemicals argue the exposures from vaping could be far more hazardous. Inhaling 86 micrograms in 500 to 600 breaths from vaping could be more detrimental to the lungs than stretching the same amount over 5,000 to 6,000 breaths in an eight-hour period, they say.

In addition, occupational exposure limits are calculated factoring in 16 hours at home, away from any exposure, and two days off during the week.

Because the two chemicals have similar toxicological effects, scientists also consider an "additive mixture formula," meaning exposure should be measured based on the combined levels.

The Flavor and Extracts Manufacturers Association, a flavor industry lobbying group, called it "improper" to use occupational exposure limits as indications of safe levels of exposure from flavors in e-cigarettes. The group warns e-liquid makers that the flavors are not intended to be inhaled.

And puffing from an e-cigarette pulls vapor deeper into the lungs than simply breathing while you work, said Rainey, the toxicology consultant. Rainey [wrote a white paper last year](#) analyzing the existing literature on the toxicology of diacetyl and 2,3-pentanedione in e-cigarettes.

Moreover, comparing levels of the chemicals in e-cigarettes to conventional tobacco cigarettes is dicey science for the same reason. Scientists don't even agree how much of the chemicals is in conventional

cigarettes. Studies show aerosol from vaping is deposited deeper into the lungs, to areas more susceptible to injury from toxic chemicals.

"Arguing concentrations is fruitless," Rainey said. "You can have those discussions, but at the end of the day nobody is going to know. These things haven't been around long enough and been studied.

"What's unfortunate is that young people are going to be the guinea pigs."

...

The number of young people using e-cigarettes tripled last year, according to data published in April by the CDC.

Roughly 2 million high schoolers — about 13% — reported that they had used an e-cigarette in the last 30 days, findings from the 2014 National Youth Tobacco Survey show.

It's the first time since 2011, when the survey started collecting data on e-cigarettes, that current use among youths has surpassed use of every other tobacco product, including conventional cigarettes, according to the CDC's news release.

A CLOSER LOOK AT VAPING

Your System Status

WE'RE SORRY!

You need to update your Flash Player.



IMPORTANT: After installing the required upgrade please reload this browser window to view the video player.

Marquette University student Mathew Baez started vaping about a year ago. He views it as as a safer than smoking regular cigarettes. But some of the chemicals involved, including diacetyl, have been shown to damage lungs. Video by Sarah Hauer.



Featuring flavors such as Blazberry Creme, Cola Gummy and Cherry Croissant, the e-cigarettes are drawing in college students as well.

A survey of more than 700 randomly selected Marquette University students conducted in March found that about 30% had tried an e-cigarette, compared with about 20% who had smoked a conventional one.

When asked if they knew what diacetyl is, 91% said, "No."

Advertisements and other messages in the media purport e-cigarettes are a healthier alternative to

conventional cigarettes.

Public Health England, the country's health protection agency, published a "landmark" report in August suggesting e-cigarettes are 95% safer than traditional cigarettes. The report was quickly criticized by heavyweights in health circles across the globe. An editorial in *Lancet* blasted the agency and said the finding was based on an "extraordinarily flimsy foundation," was "methodologically weak" and was rife with authors who had conflicts of interest.

The report makes no mention of diacetyl or 2,3-pentanedione.

A writer in the *British Medical Journal* called the report "appalling" and lacking "a shred of actual evidence."

But the criticism didn't get the media attention that the agency's study did. That headline trumpeting e-cigarette safety traveled the world through the BBC, Bloomberg Markets and other news outlets.

HOW WE REPORTED THIS STORY

To conduct this spot check of chemicals in e-liquids, the Milwaukee Journal Sentinel bought five locally made e-liquids from vape shops around Milwaukee and had them tested for diacetyl and 2,3-pentanedione by a team from Marquette University's chemistry department. Scott Reid, chair of the department, oversaw the project.

The samples were derivatized and then analyzed with gas chromatography-mass spectrometry. This method is considered to be highly sensitive and is designed to determine levels at 1 part per billion or greater.

All five samples were found to have both chemicals, which are known to destroy lungs. Diacetyl has been tied to a rare and sometimes deadly disease called bronchiolitis obliterans. One sample had especially high levels. The

Show More

Samples tested for concentrations of diacetyl and 2,3 pentanedione, by testing institution

Marquette	Liquid test: in parts per million (ppm)/ micrograms per milliliter (ug/mL)		Enthalply Analytical	Liquid test: in micrograms per milliliter (ug/mL)		Aerosol test for compound mass In micrograms per gram (ug/g)	
	DIACETYL	2,3- PENTA- NEDIONE		DIACETYL	2,3- PENTA- NEDIONE	DIACETYL	2,3- PENTA- NEDIONE
Foghorn: <i>Randy</i>	10	300	→ Foghorn: <i>Randy</i>	61.8	207	92.1	269
Matik: <i>Pomegranate</i>	11	50	→ Matik: <i>Pomegranate</i>	<1.13 ND	<1.07 ND	<4.31 ND	<5.10 ND
Radioactive Vapes: <i>Grape</i>	4	13	→ Radioactive Vapes: <i>Grape</i>	<1.13 ND	<1.07 ND	<9.33 ND	<11.0 ND
Vape Apes: <i>Goji Melonberry</i>	5	4					
Brew City: <i>Blue Jazz</i>	0.5	0.5					

ND=Reported value is less than the minimum detection limit.

*Estimated uncertainty: 10%.

SOURCES: MARQUETTE UNIVERSITY CHEMISTRY DEPARTMENT; ENTHALPLY ANALYTICS; JOURNAL SENTINEL ANALYSIS

Julian Rozwadowski, a senior at Marquette, said he is trying to persuade his parents, both 30-year cigarette smokers, to switch to electronic cigarettes.

Rozwadowski admits he hasn't done enough research but learned through advertisements that e-cigs are healthier than cigarettes.

"I've just heard enough to figure it can't be as bad as tobacco cigarettes," Rozwadowski said.

...

Following a failed attempt in 2009, the FDA last year proposed new rules to regulate e-cigarettes. The rule-making process allows for stakeholders, including the public, to weigh in. The comment period ended in August 2014. Regulators received 135,000 remarks and are still sifting through them more than a year later.

"All of our decisions are grounded in science," said Felberbaum, the FDA spokesman. "Rule-making is a

complex process."

The agency is involved in more than 50 studies relating to e-cigarettes and vaping, many of which will take years to complete.

Felberbaum couldn't say when a final rule might be issued.

"To date, the FDA has not been able to fully assess the public health impacts of unregulated tobacco products," he wrote in an email. "For example, some testing of e-cigarette cartridges has revealed significant variability in nicotine content and the presence of chemical constituents that raise concerns of toxicity."

Meanwhile, the industry is left to regulate itself — or not.

In Canada, vape shop owners and e-liquid makers established the Electronic Cigarette Trade Association, composed of more than 50 members who agree to

adhere to a set of standards including having their products tested for diacetyl, 2,3-pentanedione and other ingredients every six months.

But the association counts on tests that only pick up higher concentrations. It has a contract with Enthalpy and says it trusts Farsalinos' risk modeling.

"We understand this is a problem," spokeswoman Kate Ackerman said of the higher levels of detection. "We're working to bring levels down as low as possible and eventually eradicate them. If we said, 'Let's do it at way, way lower detection levels,' we wouldn't have many flavors at all."

She said the testing, as insensitive as it is, has had a positive impact and cut the amount of the chemicals in Canadian e-liquids.

Last year, when a trade association member's e-liquid failed the safety test, it was required to stop production and sale of the flavor, inform vendors and retail

locations of the concern, and pull the product from the shelves.

No one can say for certain how effective the "recall" was. The public wasn't required to be notified of it.

Neither Vape Apes nor Foghorn owners said they planned recalls of the flavors flagged as having diacetyl by the Journal Sentinel's testing. Instead, both said they were talking to their flavor suppliers. Ehlert said Foghorn emailed its distributors after being informed of the findings, to let them know the Randy flavor contains lung-destroying chemicals.

ABOUT THIS PROJECT



O'Brien FELLOWSHIP
IN PUBLIC SERVICE JOURNALISM

Milwaukee Journal Sentinel reporter Raquel Rutledge investigated the hazards of diacetyl and other chemicals used in the flavoring industry during a nine-month O'Brien Fellowship in Public Service Journalism through the Diederich College of Communication at Marquette University.

Rutledge was assisted by Marquette student researchers Sarah Hauer, Alyssa Voboril, Robyn St. John, Shiyao Li and Kelly Meyerhofer.

"It's up to them what they want to do about it," Ehlert said of the retailers who bought Randy from his company.

Thompson, of Vape Apes, said the industry is doing a fine job regulating itself.

"It's not like we're just picking up juice out of some guy's backpack, or the back of his truck, and saying, 'That looks good,'" Thompson said. "I talk to the guys who make the stuff, find out what they're doing, how they're doing it."

The conversations might last 30 minutes to an hour or two, he said.

"You don't walk up to a used car lot with a blindfold on and say 'I'll take that one,'" he said. "It's common-sense stuff."

Research assistant Sarah Hauer contributed to this report.

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GASPING FOR ACTION

The yellow liquid used to flavor candy, chips, coffee and e-cigarettes smells and tastes like butter. It's hard to tell from looking at it that it can obliterate your lungs if you breathe it in.



Emanuel Diaz de Leon didn't know it as he poured jugs of the concentration into giant vats at a coffee roasting plant in Tyler, Texas.

Neither did his co-workers, who spent 12-hour days roasting and grinding the coated beans that would later be sold in grocery stores and restaurants nationwide as hazelnut flavored coffee. **READ MORE**

COFFEE ROASTERS' HEALTH AT RISK

Tucked inside a burlap sack at room temperature, green coffee beans pose no known danger.



Funnel a 90-pound batch into a 430-degree roaster and things change. A chemical reaction between the beans' sugars and amino acids creates a toxic compound capable of crippling the lungs of anyone nearby.

But few, if any, commercial coffee roasters know it. **READ MORE**

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