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University's Department of Environmental Toxicology, sees broad implications for chemical standards.

- Jim Tarr, chemical engineer who worked for TCEQ's predecessor

His research wasn't focused on chemicals common in natural gas work. But given the wide variety associated with such sites, it doesn't strike him as unreasonable to be concerned about those mixtures.

"You should worry," he said. "In my view."

**An unexpected diagnosis**

Taylor Ishee started college and his first real job in late August 2011, and by the end of that first week, he knew something was wrong. He felt so terrible he had to call in sick that Friday, as much as it embarrassed him to do it.

He dragged himself to a clinic for tests. The results went to his family doctor, who sent him straight to the emergency room.

His white blood counts were elevated. His platelet levels were in the basement. His entire family was in shock when they learned why.

"The worst thing I've ever had to do in my whole life was to tell Taylor that he had cancer," said his father, Joe Ishee.

Until that August, Taylor's family had no concerns about his health. He played basketball in high school, landing a spot on the Argyle High School varsity team his junior and senior year.

But now he had Burkitt leukemia, a rare and aggressive form of a blood cancer his doctors told him is typically found in patients with compromised immune systems. As with many cancers, they couldn't tell Taylor what

immune systems. As with many cancers, they couldn't tell Taylor what caused it, only that he didn't have the risk factors such as HIV.

He went through four rounds of chemo and had several weeks blessedly cancer-free. Then it roared back, this time as Burkitt lymphoma.

As the family battled through it all, they thought of Taylor's cancer as simple bad luck. Then in May, Taylor's best friend, Justin Eaklor, was diagnosed with acute lymphoblastic leukemia.

"It was just shocking," said Taylor's sister, Nicole, 25. "I thought, 'This has got to mean something.'"

Eaklor, Taylor's high-school basketball teammate, lives in another Barnett community. So Nicole went digging into natural gas development, a common link between Eaklor's suburban Highland Village and the semi-rural Argyle, where her brother lived with their father and stepmother from 2009 to 2013.

She had thought of natural gas extraction as safe, when she'd thought of it at all. Now she found reports of carcinogens being used in the extraction process and coming up out of the ground, naturally occurring, with the gas. She read with alarm about benzene, which can damage the immune system and trigger leukemia.

The family knew drilling was common in their region but didn't realize how many sites Taylor had lived near until the Center did its analysis.

Taylor's mother, Anita Ishee, gave a deep sigh when she heard the number, 37 in all. "No wonder we are where we are," she said.

As she sat with her son at the Baylor T. Boone Pickens Cancer Hospital in Dallas in October, she put into words what had weighed on her for months.

"Some people can bring cancer on of their own actions," she said. "But to think that he's been like this because of something completely out of his control that could have been prevented, if it was regulated in the right way—"

She had to pause to compose herself. "It's hard to accept," she said.

The family also has had to accept that they might never have the information they need to conclusively prove their suspicions or rule them out. It's not just that research on cancer risks from living near gas development is sparse. It's also the lack of specifics about what Taylor was exposed to — if anything — before he got sick.

Argyle has no stationary air monitors. The clues to air quality from when he lived there are scant, primarily brief samples taken by TCEQ investigators after other residents complained about bad odors and health problems.

Between the time Taylor moved in and his diagnosis, the agency tested the air on 21 occasions within about a mile and a half of his home, according to online TCEQ records. The 30-minute samples offer insight into conditions in certain parts of the area for a total of less than a dozen hours during those two years.

Frequently when investigators arrived, whatever the residents had smelled was gone — at least, the investigators couldn't smell it.

Only three of the samples near wells were taken at times when the closest one could have been in the midst of drilling, fracking or the "flowback" that follows, when air-emission spikes are likely.

And none of the tests were on the Ishees' property. What wafted their way, and in what range of concentrations, is unknown.

The tests detected low levels of individual chemicals, generally measured in

The tests detected low levels of individual chemicals, generally measured in less than one part per billion. But each sample contained anywhere from a dozen to more than three dozen substances. Benzene and xylenes without fail. Toluene almost as frequently. 1,3-butadiene once. And other chemicals the Endocrine Disruption Exchange identified as affecting the immune system, including 1,2,4-trimethylbenzene, n-decane, n-nonane and n-octane.

The air samples were tested for a range of volatile organic compounds, but not every possible harmful substance. Formaldehyde and acetaldehyde, the former a carcinogen and the latter a probable one, are among the chemicals not on the list. They've been detected near wells and compressor stations in other locations.

Eaklor thinks it's "just so crazy" that both he and his best friend developed cancer — and that he keeps finding more people from the area who are their age and in the same situation.

"That's why I'm thinking it has to be something chemical," he said.

Joe Ishee, a self-described conservative, believes the U.S. should tap its resources to be less dependent on foreign sources. He can see the impact that work has on the Texas economy. But he doesn't think enough effort had been put into determining whether people and wells should coexist.

He sees potential parallels in history, people exposed to dangerous substances that were thought at the time to be safe. Both his parents died from cancer after working with asbestos.

"I would just like to see a nonbiased review of the process," Joe Ishee said.

Last year Taylor, his father and stepmother moved to Denton, a city whose residents voted November 4 to ban fracking locally. He's been in remission for two-and-a-half years.

But the battle is far from over. The stem-cell transplant that saved his life prompted graft-versus-host disease, the new cells turning on him and attacking his body. He's been in and out of the hospital with complications ranging from infection to coma. His skin has thickened painfully, his face is periodically swollen from steroids and his teeth were undermined by radiation — he's lost five and required a dozen root canals.

Taylor, 22, wants to restart the life he had to pause three years ago. He dreams of going back to college to become a physician assistant and help people fight off cancer.

While he lay in his hospital bed in October, though, his own struggle was top of mind.

"I wouldn't wish it on my worst enemy," he said.

**The industry's view**

Gas-extraction companies in Texas aren't generally eager to talk about health concerns. None of the five largest operators in the Barnett region agreed to be interviewed. One referred questions to the Barnett Shale Energy Education Council, but that industry trade group did not respond to repeated calls.

Still, the council's statements on its website make its position clear.

"While some activists would lead the

public to believe that shale gas development, particularly through hydraulic fracturing, is a threat to public health, numerous scientific studies prove otherwise," the council said.



Gas wells were drilled and fracked in two locations beside this neighborhood in Denton in North Texas, including the one being flared behind these homes. City voters went on to ban fracking in Denton last month. Courtesy of Maile Bush

One industry executive willing to talk directly is Chris Faulkner, CEO of Dallas-based Breitling Energy and a passionate defender of fracking.

"With proper setbacks, proper monitoring … I see absolutely no problem with fracking," he said. "Managed properly, the process is safe."

Some companies don't do a good job coexisting with residents in populated areas, in his view, but he contends that health concerns have been fueled by environmentalists with an ax to grind. He summed up the arguments he's heard as "everyone's going to get cancer," whether through contaminated air or water.

"I just don't believe it," said Faulkner, who lives atop the Barnett near two wells. "If that was the case, I wouldn't drink tap water every day and I wouldn't live where I live."

He's similarly skeptical of complaints about asthma and other non-cancer health woes that nearby residents have blamed on natural gas. In the case of Denton, the city that just banned fracking, Faulkner argues that air pollution from cars "far outweighs" what comes from the approximately 270 gas wells there.

Where's the evidence, he asked, that gas development is to blame for anybody's bad health?

Regarding the studies that suggest links — to respiratory problems, for instance, or birth defects — he said, "Look, I'm not a scientist, nor do I pretend to be." He said the state and federal government would step in if there were a problem. Surely if there were any proof of health effects, he said, the Obama administration "would be all over us."

"Obama does not like oil and gas," Faulkner said.

But states are the industry's primary regulators. After several decades of congressional action, the EPA has less control over oil and gas development than other industrial activities.

The agency says those limits include exemptions to parts or all of several major federal environmental laws, including the Clean Water Act, the Superfund law and the hazardous-waste Resource Conservation and Recovery Act.

The EPA's efforts to control air pollution in Texas have been met with pushback — not only from the industry but also from the state. Texas is suing the EPA over ozone regulations in the Barnett region. And the TCEQ saw little to like in the EPA's first effort to reduce nationwide emissions from oil and gas wells after appeals for help from residents, including ones from Texas.

"EPA has seriously underestimated the impact of these rules on industry," the TCEQ said in comments for standards that were instituted in 2012 and are being phased in. "From a regulatory perspective these rules will significantly increase the permitting and enforcement workload for TCEQ."

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**Chasing air**

The reason it's so tricky to quantify oil and gas emissions, let alone potential health impacts, is that they vary. A great deal, in fact.

Rob Jackson, an environmental scientist at Stanford University, said he's seen many well pads with low emissions but some "leak a lot." Even near a single site, two families could have very different experiences if one is typically upwind and the other downwind, he said.

"I'm not trying to generate a crisis," Jackson said. "But I think air quality for people living near any industrial operation is a potential issue, and … air quality and human health issues are likely to be very important for a minority of people living near oil and gas operations. We just don't have a good idea of who they are."

When Texans suspect they fall in that group, they can contact the TCEQ and have an investigator come out to do brief testing. Bob Parr, whose family called the agency frequently in 2010 and 2011, has a term for that: "trying to chase air" — hours or days after the problem started, at which point the wind, the emissions or both might have changed.

It took two days on average for investigators to respond to air complaints related to oil and gas the last two fiscal years in the Barnett, Clawson said, though the agency prioritizes health complaints when those come in.

In some of the cases in which investigators found violations, they did so by arriving on the weekend or in the middle of the night — times when problems often seem to crop up, residents say.

Parr's wife, Lisa, said she prevailed on the TCEQ to send an employee one particularly bad Sunday evening in 2010. The Parrs raise cattle in Wise County, a more rural part of the Barnett, and they're ringed by wells. Investigators showed up in time to get a whiff of the fumes sickening the Parrs — 30 seconds in the plume of toxic compounds was enough for one of the men to feel dizzy and develop a sore throat.

The report described "very strong, offensive odors." The air test came back with chemicals over the TCEQ's guidelines. Contractors were just finishing up work called a nitrogen lift on one of the wells, and Lisa Parr doubts an investigation the next day would have done much good.

After another bad evening a few months earlier, she said, the TCEQ found nothing of concern in the air. That time, the investigator arrived the following morning.

David R. Brown, a public health toxicologist working for the nonprofit Southwest Pennsylvania Environmental Health Project, said his group's measurements show emissions from wells and compressor stations typically have big fluctuations. Any monitoring that isn't continuous can miss the irregular spikes reaching nearby residents, he said.

"The exposures are very high exposures for short periods of time," said Brown, an official at the federal Agency for Toxic Substances and Disease Registry in the 1990s. "And so a person can get a tremendous dose in an afternoon."

**One problem after another**

Annette Wilkes was sitting in her backyard in Flower Mound in 2004 when she got her first clue that a natural gas well had been drilled in the North Texas community, less than half a mile from her property.

"We saw them flaring," said Wilkes, now 43. "We wondered what it was."

She had to stop taking her children to the elementary school playground beside the field with the gas-well pad because her eyes would swell up in what seemed like severe hay fever. But she didn't spend much time thinking about the new neighbor. She had other matters on her mind.

Her sinus issues rapidly worsened, eventually prompting two surgeries to try to get the infections under control. Around the same time, she lost much of her hair. Alopecia areata, her specialist said — an autoimmune disease.

"He put me in the allergy category," she said, meaning she was reacting to something — what, no one knew. "He could not believe I'd never had alopecia before because it was such an extreme case."

In 2006 her then 3-year-old son was diagnosed with a type of periodic fever syndrome that doesn't have a known cause. His temperature would spike as high as 104 degrees for several days straight every few weeks, requiring frequent doses of medicine to keep the fever from turning dangerous.

Then Wilkes was diagnosed with Hashimoto's disease, a thyroid-attacking autoimmune disorder. It was so advanced that she needed surgery to remove her thyroid.

Early on in this parade of bad news, Wilkes — who had previously been healthy — went searching for external explanations. Mold in the house, maybe? Her husband was having "bizarre skin reactions," after all. But a mold test found nothing.

Others in her immediate neighborhood fell ill, too.

A next-door neighbor died of leukemia. Within a block, one woman developed

A next-door neighbor died of leukemia. Within a block, one woman developed a brain tumor and another was suffering from what turned out to be multiple myeloma.

Lorrie Squibb, diagnosed in 2010 with that blood cancer, said the first words out of her doctor's mouth were, "What have you been exposed to?"

"I was 40 years old," said Squibb, a stay-at-home mother who had just moved from Flower Mound to Michigan. "I was the second-youngest my oncologist has ever seen with multiple myeloma."

Like Wilkes, Squibb is convinced gas development made her sick. As children in the neighborhood developed cancer, others had the same thought.

In 2010 and 2011, the Texas Department of State Health Services responded to the concerns by tallying several types of cancer in the two ZIP codes that cover most of Flower Mound to see whether the cases were higher than expected.

The state calculated its figures using a 99-percent confidence interval. That meant the number of cancer cases had to be so elevated that there was only one chance in 100 that happenstance alone was responsible.

Using this standard, staffers concluded that only breast cancer was higher than expected, and they thought population growth could explain that.

This spring an article in an environmental law journal said that if the state had used a 95-percent calculation, more typical in such cases, it would have found clusters of blood cancers among boys — lymphoid leukemia in one ZIP code and non-Hodgkin lymphoma in the other.

The attorney who wrote the article, University of Texas at Austin researcher Rachael Rawlins, also suggested that studying a smaller area than broad ZIP codes might have better addressed people's fears about specific

codes might have better addressed people's fears about specific neighborhood exposures.

The state health agency responded with another analysis — this time using a 95-percent calculation with more recent cancer data, but still focused on the two ZIP codes that bisected the town. Christine Mann, a spokeswoman for the state health department, said it wasn't possible to analyze the cases in neighborhoods because the numbers would be too small to produce statistically valid results.

Again, only breast cancer was higher than expected. Again, the agency suggested that problems other than environmental exposure could explain it.

"Relative to other risk factors, the chance of a person developing cancer as a result of exposure to an environmental contaminant is small," the July report said. It cited an estimate, drawn from 1981 research, that exposure to environmental contaminants is to blame for only 2 percent of cancer deaths.

But that figure is far from universally accepted. A presidential advisory panel declared in 2010 that "the true burden of environmentally induced cancer has been grossly underestimated."

When asked about that, Mann said the point of the Flower Mound study wasn't to evaluate "environmental or other risk factors," simply to look at the number of cancer cases there.

Flower Mound now has among the most restrictive gas-development rules in the Barnett, including a setback preventing drilling within 1,500 feet of homes. Wilkes, who moved her family out of Flower Mound in 2006 after deciding gas-extraction was the root of her problems, returned three years later to a neighborhood where she felt comfortable no drilling would occur.

Her health has improved. Her son's fevers stopped.