Something in the Air

Photographs by Lori Nix

THE HEALTH RISKS OF LEADED GASOLINE ARE A THING OF THE PAST, RIGHT? WRONG.

BY MICHAEL BEHAR

IT'S IMPOSSIBLE TO have an uninterrupted conversation with Kelly Kittleson in her home. Kittleson, who lives in Hillsboro, Oregon, is a single mom with four kids. But her children are not the distraction. The two youngest—a boy, age 2, and a girl, age 4—sat quietly with us at the kitchen table. They hardly made a peep while we chatted. Instead, about every five minutes, a low-flying plane screamed above the rooftop. "They are constantly going over all the time," Kittleson complained. "It's crazy. When I first moved here, it felt like they were going to crash into our house."

Kittleson's house is directly beneath the final approach for the primary runway at Hillsboro Airport. The perimeter fence is visible from her backyard, where her kids spend countless hours. But the noise, it turns out, is just a nuisance. What really scares Kittleson is the lead. Like most Americans, she had no idea it was still in use in airplanes—the last remaining mode of transportation in the United States to use leaded fuel. (It was banned from automobile gasoline in 1996 after a phase-out that commenced with the passage of the Clean Air Act in 1970.) When the Oregon Department of Environmental Quality surveyed the airport in 2005, it found a lead cloud hovering above Hillsboro, a circular plume spanning 25 square miles. At its center—right about where the Kittlesons live—lead levels were twice as

high as the National Ambient Air Quality Standard threshold set by the Environmental Protection Agency (EPA).

In children, lead can damage the central nervous system, resulting in learning disabilities, stunted growth, and hearing loss, as well as cause anemia. Recent findings indicate that children who are repeatedly exposed exhibit violent behavior in later life. Adults may be at risk of kidney failure, cardiovascular disease, cancer, stroke, miscarriages, and premature births.

Even at infinitesimal levels in the blood, lead has been linked to ADHD. Kittleson's 8-year-old son has been diagnosed with the disorder; she now suspects her 4-year-old daughter might be showing symptoms too. Valorie Snider, who lives nearby, also has a son with ADHD. "Airplanes circle over the top of our house," she told me over coffee at a Starbucks across the road from the airport. "The windows rattle. Sometimes it feels like an earthquake."

Both families have the same pediatrician, James Lubischer. "I never knew how much [lead] would impact us until Dr. Lubischer told me," Snider said. She herself has been diagnosed with fibromyalgia, Hashimoto's disease (a thyroid disorder), and adrenal fatigue. She wonders if the lead has anything to do with these ailments.

Lubischer told me later that he lives right under the flight-training path, and that his daughter, too, has ADHD. He acknowledges that it's challenging to prove a direct connection to lead in a specific instance—much like a case of lung cancer in an individual smoker. While an inordinate number of residents I met in Hillsboro have health problems, the evidence is anecdotal, and there have been no longitudinal studies tracking illness in populations close to these "general aviation" airports (a term that covers nearly all types of flight activity except scheduled commercial passenger service).

Even so, Lubischer believes the scientific evidence is clear. He cited the work of Joel Nigg, a professor of psychiatry, pediatrics, and behavioral neuroscience at Oregon Health & Science University, who has published two influential papers showing a propensity to ADHD in children with only slightly elevated lead levels. Todd Jusko, now a professor in the University of Rochester's department of public health sciences, conducted an earlier study, published in 2008 in the journal *Environmental Health Perspectives*. Jusko found that children's cognitive abilities declined with blood lead levels of 2.1 micrograms per deciliter—less than half the level currently deemed toxic by the Centers for Disease Control and Prevention.

IT WAS A SUNNY weekday morning in mid-April when I stopped on the way to the Kittlesons to take a look at the Hillsboro Airport. Single-engine prop planes soared overhead in near-constant succession, dispersing lead into surrounding neighborhoods.

Since 1990 the population of Hillsboro, a bedroom community 15 miles west of Portland, has nearly tripled, to more than 91,000, largely because semiconductor and biotech firms have moved into the area. The boom has transformed the town's airport. Once home to weekend aviators, it has become a hub for corporate jets, a pilot training school, and a spillover facility for Portland International Airport. Training flights, in particular, are problematic. Student pilots perform touch-and-go's—repeated landings that require gunning the engine at each go-around. They also do laps above the airfield. Takeoffs and landings at Hillsboro now total more than 200,000 annually, making it one of the busiest general aviation airports in the United States.

While jets and turboprops run on kerosene-based fuels, the majority of general aviation aircraft are piston-powered and consume aviation gasoline, or avgas, which is produced in several grades. The most common is 100-octane low lead, or 100LL, used by 167,000 aircraft, about 75 percent of the nation's general aviation fleet. (People in the industry use the terms *100LL* and *avgas* interchangeably.) No other country in the world has a fleet that still relies predominantly on leaded gasoline.

By the 1940s lead had become the go-to additive to avgas because it produced a fuel with low anti-knock properties, increasing horsepower while adding only a smidgen of extra weight. Lead's toxicity had been well documented in innumerable studies. But most scientists (and pilots) assumed small doses were benign. By the 1960s advances in detecting trace amounts in the blood told a different story.

The lead added to avgas is a clear liquid known technically as tetraethyllead. Only one company in the world makes it: Innospec, a Colorado-based chemical corporation, which produces it at a

plant near Liverpool, England. In addition to its anti-knock qualities, tetraethyllead performs several functions in piston-powered airplane engines. It boosts performance and reduces wear and tear. It also prevents something called "early detonation," which can melt pistons and trigger an explosion. At the moment, there is no widely available substitute. Unleaded blends are in development but still experimental. The upshot: piston-engine planes consume about 248 million gallons of avgas a year, spewing out 551 tons of lead.

These planes operate primarily from general aviation airports, of which there are about 3,000 in the United States (though most are podunk airstrips that see little activity). In 2010 the EPA compiled data on avgas emissions at the busiest of these airports—those with emissions of more than 1,000 pounds of lead a year. Hillsboro, with 1,360 pounds annually, ranked 21st on the EPA's list of 58. Many of these airports are situated in heavily populated neighborhoods. In Los Angeles, for instance, some 14,000 people live within a mile of Van Nuys Airport, which sees annual lead emission totals above 1,500 pounds.

At least 3,200 students who attend schools near the Hillsboro Airport are at risk. A Montessori preschool is located across the street from the airport's entrance, and a day care center is situated just 800 yards from the end of the main runway. According to statistics gathered by the Natural Resources Defense Council, nationwide more than three

million children attend schools in close proximity to airports where avgas is burned.

In 2011 Marie Lynn Miranda, a professor of pediatrics and dean of the School of Natural Resources and Environment at the University of Michigan, published a groundbreaking study in *Environmental Health Perspectives* on the effects of aviation gasoline on children. Miranda sampled 66 airports in North Carolina where air-quality sensors had recorded at least 448 pounds of lead emissions per year and found that blood lead levels in children living nearby were alarmingly high. She explained to me that lead accumulates in human tissue—every exposure adds more of the toxin to your body. "Children are more vulnerable because of their higher metabolic rate," Miranda said. "So if you and your child were exposed to the same amount of lead, your child would uptake five times as much."

Miranda's study has galvanized efforts to ban avgas by local grassroots organizations such as Oregon Aviation Watch, an environmental advocacy group in Hillsboro founded by Miki Barnes, a social worker.

In battles with city, state, and federal policy makers, citizens like Barnes are trying—so far largely without success—to stop airport expansions, reroute flight paths, and curb air traffic.

During my visit to Hillsboro, representatives from the Port of Portland and the Federal Aviation Administration (FAA) held a meeting at the town's civic center to hear public comments on the port's proposal to add a third runway to the airport. Port officials brought copies of their 246-page environmental assessment, which projects a nearly 40 percent increase in lead emissions by 2021, to 1,840 pounds annually, as a result of increased flight traffic (though not necessarily of the proposed runway.)

The hearing was standing room only. More than 60 residents turned out, and nearly two dozen of them took to the lectern to make impassioned pleas not to approve the project. "Do you know what lead does?" Barnes asked when she testified. "It reduces IQ. It's linked with ADHD. It's linked with miscarriages. It's linked with birth defects. It's absolutely toxic. [The runway project] is shameful." Residents could each speak for five minutes, but it took Barnes only two before she got teary-eyed.

During a break in the proceedings, I spoke to Renee Dowlin, the Port of Portland's manager for the project. Lead, she told me, "is not the Port of Portland's issue. It is a federal issue, which the EPA and FAA will deal with. Nor do we have control over the number of planes

ILLUSTRATION BY BRUCE MORSER

from NRDC A 40-YEAR BATTLE

MIRIAM ROTKIN-ELLMAN
Senior scientist with NRDC's health and environment program, based in San Francisco

The fight to eliminate the health risks from lead began 40 years ago. What has NRDC's role been during that time?

NRDC began to fight for the elimination of lead almost as soon as the organization was founded in 1970. The Clean Air Act, which was passed in the same year, said that regulating lead was a federal issue. But when New York City passed a stringent law banning lead in gasoline, we went to court to argue that it would be absurd for Washington to preempt the right of states and cities to pass tougher pollution controls than the federal government. We won. Then, when successive administrations dragged their feet on a ban on leaded gasoline in automobiles, NRDC continued the fight for more than two decades until the ban took full effect in 1996. It was a huge victory.

What has the impact of the ban been on public health?

For our kids especially, the progress has been tremendous. The concentration of lead in a child's blood is measured in micrograms per deciliter, or µg/dL. In the late 1970s the median level was 15 µg/dL. By 2009–2010 it was down to 1.2, although there are significant disparities that reflect ethnicity and household income. The economic impact of lead contamination remains staggering. Researchers estimate that the annual cost of childhood lead poisoning, in terms of health care and lost productivity resulting from cognitive impairment, could be as much as $60.2 billion. The consensus today among child health experts and the Centers for Disease Control and Prevention is that there is no safe level of exposure for children, so we need to continue to get the lead out so that they can learn and flourish.

Is lead in aviation fuel the only challenge that remains?

Unfortunately not. There are still many hot spots of lead pollution in this country. In 2008, as a result of continuous efforts by NRDC and our allies, the Environmental Protection Agency tightened the standard for airborne lead for the first time in more than 30 years. In 2010 our work resulted in an expanded monitoring network to help identify locations with elevated lead levels. Industrial facilities, such as primary and secondary lead smelters (mainly battery recyclers), continue each year to belch out tons of lead, which contaminates the air and builds up in the soil. We're working hard to curb these emissions and support the communities that are most affected. The fight has also gone international. As U.S. industrial activity has moved across the Pacific, so has lead pollution, and we're engaged in a major effort to improve China's standards for prevention and cleanup.

that can come to the airport. We are preempted by the FAA because we accept federal money."

Barnes is unconvinced. "There are legal precedents for airport operators to limit these flights," she insists. "The Port of Portland simply chooses not to do so because it values the revenue generated from the sale of leaded avgas over the well-being of the community."

SO WHY HAS the federal government done nothing to halt the use of avgas? By law, the EPA is required to make an "endangerment finding" when it deems that a pollutant or toxin presents an imminent threat to public health—and the health risks of lead are well established. Under the Clean Air Act, the agency must promptly set rules to regulate or ban harmful emissions from any source once it makes such a finding. But it hasn't done so with avgas, despite having published dozens of studies on lead's toxicity, including a 2000 report warning that "there currently is no demonstrated safe concentration of lead in blood, and adverse health effects can occur at lower concentrations."

In March 2012, Friends of the Earth filed a lawsuit against the EPA, accusing the agency of having "unreasonably delayed" its duty to make an endangerment finding. Between the passage of the Clean Air Act in 1970 and 2007, piston-powered planes burned 14.6 billion gallons of avgas, expelling 34,000 tons of lead into the environment. Each year avgas accounts for nearly 60 percent of total lead emissions in the United States. (The remainder derives mostly from the metals industry.)

"We got rid of lead in cars," says John Froines, a professor of environmental health sciences at UCLA, "and there is no argument that says we should allow it in aircraft." Froines directed the Occupational Safety and Health Administration's Office of Toxic Substances in the 1970s, where he wrote the first lead standards.

Meanwhile, the EPA has commenced yet another study, which it expects to complete in May 2014. Justin Cohen, communications director for the agency's Office of Transportation and Air Quality, would not speak about the new study or allow me to interview anyone at the EPA about it (or anything else avgas-related) on the record. Instead, he pointed me to the agency's website, where I learned how scientists will use computer models to calculate lead emissions at various airports. But if computers can already determine lead pollution at any airport, why does the EPA need another investigation to conclude that avgas is endangering public health? Cohen wouldn't comment, and Kim Hoang, air toxics risk coordinator for the EPA's air division, whose staff created the computer models in 2011, declined requests for an interview.

Marianne Engelman Lado, an attorney with Earthjustice who is leading the legal team for Friends of the Earth, told me, "[The EPA] has argued that they need to do more monitoring. And after they study the results, they can think about doing an endangerment finding. So we could be looking many, many years down the road before there's even any set of deadlines for getting lead out of avgas. But when you think about the harm that lead causes, there's grounds to be calling for major change at a very fast pace."

"We know what the answer to the question about the problem of lead is," Froines says. "It's not something that needs further study. That's ridiculous."

Instead of dealing directly with lead in aviation fuel, the Clean Air Act left it to the EPA administrator to decide whether to tackle avgas emissions; if that happened, any new regulations could not "adversely affect safety." Remember that part about lead preventing engines from exploding? That's why industry groups, including the Aircraft Owners and Pilots Association, the National Air Transportation Association, and the General Aviation Manufacturers Association, have been reluctant to support a ban on avgas until a "drop-in" replacement fuel is available. They insist that such a fuel must match the performance of avgas across all parameters, cost the same or less (now about $6 per gallon), and require no changes to aircraft or the fuel distribution infrastructure, such as pumping stations, tanker trucks, and pipelines.

Peter White, who manages the FAA's new Fuel Programs Office—created specifically to focus on avgas—doubts that many petroleum companies would invest the cash and assets needed to develop a spec-for-spec substitute until the EPA is compelled to make a move. In February 2012 the FAA announced a set of formal recommendations, known as the Fuel Development Roadmap, to "support [the] transition to an unleaded aviation gasoline." EPA officials have indicated they won't ban avgas (unless forced to by a judge) until a suitable substitute is available. Doing so, they say, would wreak economic havoc, grounding most of the general aviation fleet. The Fuel Programs Office is bringing the EPA and FAA together in an unprecedented partnership to resolve the stalemate. "We're trying to incentivize fuel producers to help develop new [unleaded] candidates," White told me.

Nonetheless, he reckons a free-market solution is going to need some legislative prodding. So does Representative Henry Waxman of California. Last October Waxman, a Democrat, wrote to FAA administrator Michael Huerta, pleading with him to fast-track the availability of unleaded avgas. "There is a cloud of uncertainty hanging over the future of 100LL and it's stymying growth," White said. "Without some sort of regulatory change, some sort of requirement, there's really no other force that's going to drive 100LL off the market and bring in a replacement."

AT THE MOMENT only two small firms are exploring replacements for 100LL. Swift Fuels, based in West Lafayette, Indiana, has developed an unleaded avgas by blending isopentane, a chemical found in mouthwash, with mesitylene, an industrial solvent. According to project co-founder Jon Ziulkowski, the fuel, called 100SF, can be manufactured from renewable biomass sources, such as switchgrass and sorghum, and burns cleaner than 100LL, with 30 percent fewer greenhouse gas emissions.

In Ada, Oklahoma, engineers at General Aviation Modifications Inc. (GAMI) have developed a rival fuel to the Swift blend called G100UL. GAMI co-founder George Braly hopes to license the formula, for which a patent is pending, to a major refiner, such as Phillips 66, the nation's largest producer of avgas. "But avgas is a specialty fuel," Braly said. "It's a pain for [Phillips and other companies] to make because the volume is so small. So they want status quo until there's no other alternative." Phillips declined to comment.

Could either fuel emerge as a drop-in replacement? Brian Watt,

Innospec's vice president of strategic planning and regulatory affairs, is doubtful. "People have been looking at 100LL replacements for 40 years, and there is still not a credible alternative," he told me. "Legislation would help."

Peter White sees things differently. "I don't want to say yes or no until we really have the chance to evaluate all the data," he said. It's up to the FAA to certify specific engine models permitted to burn any new fuel, but that will take years. "It's a huge effort," White observed. "You need to collect data, there are material compatibility issues, there are operability issues, there's performance, there's weight—a whole bunch of things you need to address and a very large number of models."

FAA officials have said they're committed to certifying a drop-in avgas replacement by 2018. But as Waxman pointed out in his letter to Huerta, certification is only the initial step. After 2018, he wrote, "it may be 11 years or more before the new fuel will be phased in. This extended time frame is simply too long, given the certain and serious harms to human health from lead exposure."

Ordinary unleaded gasoline—mogas—might, in fact, offer the simplest and quickest interim solution. While its octane is lower than that of 100LL, "it has been conclusively shown that over 80 percent of all current piston-engine aircraft can operate on mogas," notes Kent Misegades, director of the Aviation Fuel Club, a nonprofit group formed to champion unleaded alternatives to 100LL. The hurdle with mogas is finding it without ethanol. Because of the EPA's 2005 Renewable Fuel Standard (RFS) requirement, automotive fuel in the United States must be blended with ethanol. This works fine for cars but can be catastrophic in airplanes.

The reason is that ethanol is hygroscopic, meaning it absorbs water—for example, water that forms from condensation in a fuel tank. In cars, ethanol can damage engines but (usually) isn't life-threatening. In airplanes, however, ethanol not only is corrosive but can retain moisture that may freeze in the frigid air at higher altitudes. "It's like throwing ice cubes through your fuel system," Ziulkowski explains. "It will cause the engine to stop in midair."

For his part, Misegades is making headway. He says, "Despite all the odds against us—and with no help from the FAA, EPA, avgas suppliers, or our own aviation lobbies—we have been able to slowly increase the number of airports now offering mogas." In the United States, all gasoline is produced initially without ethanol. Petroleum refiners add just enough to fulfill their RFS quota. Once that has been met, the untainted surplus is sold to consumers who prefer it for engines more susceptible to ethanol damage, including those in boats, snowmobiles, farm equipment, power tools, lawnmowers, and vintage automobiles. Misegades's group taps into this supply. Of the 3,600 airports that carry avgas, at least 118 have an adjacent pump supplying ethanol-free mogas. As for 100LL, Misegades, who is an aerospace engineer and recreational pilot, admits, "Our continued use of a substance that was banned decades ago in cars makes us look like cavemen."

IN MARCH U.S. District Court judge Amy Berman Jackson dismissed the Friends of the Earth lawsuit against the EPA. She didn't address the obvious hazards of avgas or dispute that mitigating lead emissions was one of the principal objectives of the Clean Air Act. Instead, her written opinion hinged on the language of the act, which she found ambiguous. She ruled that the EPA's responsibility to make an endangerment finding was discretionary, not mandatory.

So what comes next? "We're weighing our options," says Lado of Earthjustice. "I think legal action is still needed to put the pressure on." One possibility is to petition the U.S. Court of Appeals for the District of Columbia Circuit. But there is also a wild card: the entity with the greatest power to eliminate lead in avgas may be Innospec, its sole producer. In 2012 tetraethyllead generated one-tenth of Innospec's $776 million in revenue, down from 90 percent in 2000. Today, sales of tetraethyllead to avgas producers account for just 3 percent of Innospec's business. The remainder comes from their customers in Algeria, Iraq, and Yemen, which still blend the additive into gasoline for older cars. But with phase-outs under way in those countries, demand is waning fast. "As soon as they get their refineries and motor fleet sorted out, [tetraethyllead] there will be gone," Innospec's Watt predicts.

For the time being, Watt says that the company is committed to keeping its Liverpool plant running until there is a suitable 100LL replacement. And yet, he admits, "If we weren't making money on it, we'd obviously do something different." Annually, Innospec sells about 450,000 gallons of tetraethyllead to avgas producers. "But we've already been stepping down [production] every year," Watt says. Outside the United States, there are about 60,000 aircraft that require avgas, but most can operate on the mogas that's readily available in the rest of the world, which doesn't blend ethanol with fuel. "Our position with the aviation market is that we don't want to be in this business long term," he says. "There is no future for tetraethyllead."

All the more reason, urges Lado, "to get the phase-out process under way now. [The EPA] is wasting time. The handwriting is on the wall that lead is bad, that lead is being spewed from these airplanes, and that lead has to go."

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