

## Wind Turbine Syndrome: A Twenty-Minute Crash Course

The following was a videoconference presentation in Shelburne Falls, Mass., January 28, 2012



**Nina Pierpont, MD (Johns Hopkins), PhD (Princeton: Population Biology/Ecology), Fellow of the American Academy of Pediatrics, former Clinical Professor of Pediatrics, College of Physicians & Surgeons, Columbia University (NY)**

I'm going to start with a difficult word, one I struggled with in college: the word is *epistemology*. I could never remember what it meant then, but it's an important word to me now. It means *how we know things*—what we accept as real, as true—what we trust as evidence, and what we do with that evidence. Epistemology is a framework or set of assumptions for reality, a framework into which we fit data. Every day, all of us throw out data that doesn't fit our assumptions. I have patients who tell me they see ghosts and UFOs, but give me no other evidence that they're psychotic. I have to put this information on hold—in a sort of suspended state—because they believe it and I don't. There's no part of my reality box or set of assumptions that can accommodate it. On the other hand, I have patients who tell me that painful sensations from their GI tracts affect their mental state—causing anxiety, depression, and agitation—rather than the mental state causing the GI problems, as other doctors have told them. Unlike these other doctors, this does fit my reality box, because I know there are autonomic stretch and vibration receptors around the internal organs that are anatomically linked in the brain to anxiety centers. I've been able to successfully treat these patients, unlike these other doctors. In response to

unusual symptom states that my patients tell me about, it's my job to read the medical literature to expand my knowledge of how the body works. When patients talk to me, I take seriously and believe the symptoms and observations they present, especially when I see evidence that the observer—the patient—is thoughtful and alert. My job is to provide the explanation, which becomes a working hypothesis for how to treat the problem within a physiologic or neurophysiologic framework. I studied and described Wind Turbine Syndrome with the same set of assumptions about clinical truth and reality that I apply to my patients. In fact, I never set out to prove that wind turbines cause Wind Turbine Syndrome. This was already obvious. Instead, I chose to study and document the observations made by people who had already figured it out and proved it on their own. They *proved* that their Wind Turbine Syndrome symptoms—a distinctive and consistent set of symptoms the world over—were *caused by wind turbines* through the rather common-sense means of watching what happened to their symptoms when they left their homes near turbines and came back, or when the turbines were still and quiet, vs. active and noisy. My goal was to answer a different question: Why do some people get sick around wind turbines and others don't? The answer to this question would take care of one objection to the idea of Wind Turbine Syndrome—though it is a silly objection, since there isn't a disease in the world where some people aren't more susceptible than others. But finding out why some individuals are more affected than others—by comparing their past, pre-turbine states of health and medical histories—could also reveal something about the mechanism: how, physiologically, are these effects coming about? So I looked for people to study who definitely had Wind Turbine Syndrome—they had gone away and come back and had definite, clear information on how their symptoms went away and came back—and I looked for people who gave clear evidence of the degree of their distress and their certainty that the turbines were the cause by doing something really expensive and inconvenient—and possibly even impoverishing and ruinous—to restore their health. *They moved out of their homes.* I looked for people who were articulate and clear and alert and intelligent—who were able to tell me in detail about their daily functioning *before* the turbines went into operation near their homes, their sensations and functioning *while* turbines were operating near their homes, and what they experienced *after* they went away—and ultimately moved away—from their homes. Including a medical doctor and several nurses. There are epidemiologic labels for how I did this study. Studying people as they move into and out of an exposure is called a *case-crossover study*. It's appropriate for a condition, such as Wind Turbine Syndrome, which is *immediate* and mediated by the sensory system. The symptoms of Wind Turbine Syndrome come on during exposure and leave or improve when exposure ends. You couldn't study cancer this way, since it might take 10 or 20 years for the disease to show up after the exposure happens, while the person is meanwhile moving place to place under all sorts of different conditions. But you can study an immediate sensory effect in this way. The other epidemiologic principle that applies here is called a *revealed preference measure*. This applies to that really expensive or even impoverishing thing the person did to get away from the exposure and restore his health. For example, if someone leaves a home he owns and rents another place to live, you know he values his symptom relief more than the cost of renting and heating the second home, plus the less quantifiable loss of convenience and amenity of being in his own home. He has to move, or move repeatedly. The rental is smaller and not as nice, and he has to travel frequently to the first home to maintain it. When the first home is a farm, the loss of convenience and efficiency is marked and interferes with his ability to earn a living. *Revealed preference.* "My monthly budget can't afford an extra \$1500 for rent and utilities for a second place and I don't have the time to travel back and forth

and also work or farm or take my boat out and catch fish, but I'm so debilitated when I'm living at home that I don't have a choice, because then I can't get anything done." In Wind Turbine Syndrome, because the effects are both *immediate* and *noticeable* to the person experiencing them, people can compare their own experiences before, during, and after exposure. Or a researcher can compare them. Or even do an exposure experiment. It's not ethical to put other people in harm's way to see if they get sick during an exposure, but last year two acousticians managed to do exactly this to themselves in Falmouth, Massachusetts, documenting their own experience along with their noise measurements. They were surprised. With between 30 and 40 years each of professional experience measuring and documenting noise disturbances for homeowners, neither had ever had the experience of nausea, vertigo, and physical and mental debilitation they experienced in the home where they came to measure noise, starting within 15 minutes of their arrival during a high wind with a lot of activity from the single neighboring turbine. These two acousticians were accustomed to measuring noise that was annoying or noise that kept people awake, but this problem was different. They in fact don't describe it as noise but as *rapid air pressure fluctuations*. The effects on the two acousticians had nothing to do with sleep disturbance or deprivation—they arrived awake and well rested, and had never attempted to sleep in this house. Noise engineers Rick James, George Kamperman, Wade Bray, Rob Rand, and Steve Ambrose, all of whom have been refining the equipment and protocols necessary to measure the relevant acoustical energy from wind turbines, now think that the problem is low-frequency noise or in this case *infrasound that pulsates, creating rapid air pressure fluctuations that are felt rather than heard* and which are extremely difficult to measure. Similar noise and similar symptoms are found in Sick Building Syndrome, where the cause is pulsating low-frequency noise from maligned fans in large ventilation ducts. When this occurs in office buildings, these symptoms, too, have nothing to do with sleep. The symptoms of Wind Turbine Syndrome include classic symptoms of vestibular disturbance, which are:

» nausea » vertigo or illusory movement » blurred vision » unsteadiness » difficulty reading, remembering, and thinking spatially

These are the questions I get from people: "Why did I lose my keys again?" "How could I forget that pot on the stove?" "Why can't I figure out how to put this thing together?" "What's wrong with me that I can't follow this recipe?" "I was only going to get three things; how come I can't remember what they are?" "Why can't I follow what's going on in this movie?" These are all examples of everyday, visual-spatial thinking that my study subjects found they were inexplicably struggling with. Remember, a physician, two nurses, five fishermen, a farmer, an accountant—all practical people. Outside the study, nurses, pharmacists, teachers, programmers, contractors, realtors, an air traffic controller, a diplomat. If the signals from the vestibular system are distorted, eye movements and spatial thinking—including mathematical thinking—become difficult and full of errors. This has been proven with a lot of research. Your body and brain *literally* have to know with great consistency, moment to moment, *which way is up* in order to orient in space, and to orient successfully in the *mental representation of space*, where a lot of memory and understanding take place. Spatial thinking is almost invisible or unconscious until something goes wrong with it. It's that great space in the mind where you *know* things before you can say them, where you suddenly realize how things fit together, and where you can retrieve all sorts of visually interlinked memories. Its functioning depends on a smoothly operating and signaling vestibular system. This kind of thinking is most mysteriously

and frustratingly distorted in Wind Turbine Syndrome, just as it is in other clinical forms of vestibular disturbance. Other symptoms of Wind Turbine Syndrome suggest impacts on the inner ear in a general way: ringing in the ear or tinnitus, muffled hearing, and feelings of fullness, pressure, or pain in the ear. The inner ear includes the vestibular organs, which detect motion and position, and the cochlea, which mediates hearing. Together, the cochlea and the five vestibular organs (the three semicircular canals and the two otolith organs, the utricle and saccule) are delicate membranous structures linked together with the same fluid space inside all of them. The sensations that come from them are mediated by hair cells, which are so sensitive to motion that they respond to being bent the width of a hydrogen atom. Still other symptoms of Wind Turbine Syndrome point to activation of the autonomic nervous system, meaning the adrenaline surge of the fight-or-flight reaction. These symptoms are episodes of panic, rapid heartbeat, constricted breathing, and the urge to flee. These symptoms may start while a person is awake, but also startle them out of sleep. If the symptoms starts when you're asleep, it's not because you are lying there thinking of how mad or worried you are. Getting back to sleep after this type of awakening takes hours because the body is all revved up with the same physiologic response as fear. Autonomic activation is a typical brain response to unusual signals from the vestibular organs—just think of how you feel and respond when you step on a patch of ice and start to slip. The brain cell connections between the vestibular centers and the parts of the brain that control the autonomic nervous system and adrenaline are well known. In doing the study, once I had found a family that had recently moved or was planning to move, I collected information on the symptoms, behavior, and past medical history of *all* the family members, not just the one or two most affected. Adults and children alike. Thus each family was a little cloud of study subjects, all exposed to the same turbines in the same house but affected to different degrees. These clusters gave me a comparison group, not as formal as a control group, but similar to the comparison groups set up in ecological studies of free-ranging animals (in which I was trained at Princeton as a PhD population biologist). The family members were included without regard to whether they were affected or not. It is important that they were *not selected in any way*, once the family had been selected—all the family members were included. This is a regular pattern of sampling. *This is why it was valid to use statistics in the comparisons.* It also got my study free of the noise variable. I knew there was enough of the relevant noise or pressure fluctuations in each house because at least some people were affected, leaving me free to focus on the differences among people that were intrinsic to each individual. Essentially the study design eliminated the degree of noise exposure as a variable, so that I could study individual differences in susceptibility without having to take a multivariate approach. The risk factors that emerged from this analysis were:

(1) migraine disorder (2) motion sensitivity or repetitive episodes of vertigo independent of migraine disorder, and (3) pre-existing inner ear damage from industrial noise exposure or chemotherapy

By comparing my study population to the population at large, a fourth risk factor emerged: age over 50. These risk factors, as well as the nature of the symptoms of Wind Turbine Syndrome, all point to *unusual sensitivity and activation* of the vestibular or balance system of the inner ear *in the presence* of active wind turbines. Though no formal dose-response curves exist in terms of measured noise, many of the affected subjects in my study and elsewhere, including Falmouth, MA, did their own qualitative dose-response studies by associating the intensity of

their symptoms with the speed the turbines were turning, the loudness of the audible noise, or measured wind speed. As those in clinical medicine know, migraine disorder is a highly heritable brain condition of *unusual sensory sensitivity* in a variety of modalities, including hypersensitivity to sound, motion, barometric pressure changes, light, and chemical substances eaten or smelled. Any of these can trigger episodes, which start neurologically as a wave of spreading depression over the surface of the cerebral cortex, and may be followed by headache. Foggy thinking during episodes, anxiety, and depression are frequently associated. About 12% of the North American and European populations have migraine disorder, about 6% of men and 18% of women. It's hereditary and common in children, too, often declaring itself by 8-10 years of age. Motion sensitivity—the tendency to get carsick or seasick—is common in migraine but can also exist on its own, as a condition of increased sensitivity to vestibular stimulation. It's common in young children, but may also be acquired later in life, with repetitive episodes of vertigo. A Ménière's-type physiology may be responsible, which I will get to in a moment. Inner ear function, both hearing and balance, tends to deteriorate in older age and in response to certain environmental insults, including chronic exposure to industrial noise. Ménière's disease is an imbalance of fluid pressures in the inner ear that disrupts the function of the whole inner ear, both hearing and balance. It occurs more commonly in older adults. A Ménière's-type mechanism is one possibility for the vestibular hypersensitivity and vestibular function disruptions in Wind Turbine Syndrome. Dr. Alec Salt, an inner ear physiologist at the Washington University School of Medicine in St. Louis, showed several years ago that infrasound exposure in experimental animals causes endolymphatic hydrops, which is the inner ear fluid abnormality found in Ménière's. Infrasound applied directly to the ear is also used to treat the inner ear fluid shifts in Ménière's—but at high risk of causing nausea and vomiting in the process. Mine is not the only study of wind turbine effects. In terms of physiology, Dr. Salt has also shown experimentally how the inner ear, specifically the cochlea, both detects (in a non-hearing way) and suppresses our hearing of sounds below certain frequencies, such as the low-frequency sound or infrasound produced by turbines. He has expanded our knowledge of the ear's reaction to infrasound, but when he has presented his work at professional conferences, he tends to get comments from other neurophysiologists that the symptoms are probably vestibular, not from the cochlea. Professor Nelson Kiang, emeritus professor from MIT and Harvard Medical School, founder of the Eaton-Peabody Laboratory of Auditory Physiology at the Massachusetts Eye and Ear Infirmary, made this comment after a presentation by Dr. Salt in 2010. Dr. Steven Rauch, the vestibular specialist at the Massachusetts Eye and Ear Infirmary, commented in the *Boston Herald* last year that one should not disregard the symptoms described in Falmouth. (I wonder why neither of these eminent Massachusetts inner ear specialists was invited to be on the Massachusetts expert panel?) To continue with other work done on wind turbine-associated health effects, Drs. Michael Nissenbaum and Christopher Hanning have done a small, systematic study around two wind farms in Maine, showing that scores on established questionnaires about sleep disturbance and general mental health are correlated with distance from turbines, with worse sleep and mental health status closer to turbines.

» Dr. Amanda Harry from the UK published in 2007 a series of 42 affected patients from her practice with typical symptoms of Wind Turbine Syndrome.

» Dr. David Iser from Victoria, Australia, in 2004 formally notified the Victoria government of his

patients' becoming unwell after the startup of a wind farm.

» Dr. Sarah Laurie in Australia has interviewed over 100 affected people in Australia in the last 15 months. She has extended the study of the adrenaline surge effects into the cardiovascular realm.

» Members of the Society for Wind Vigilance in Ontario, Canada, members of which include physicians and other health professionals, have collected 131 cases by questionnaire since 2008.

Returning to the beginning of my talk, how do we know what is real? The Commonwealth of Massachusetts has just issued an expert, supposedly independent, panel report which asserts that, and I quote:

There is no evidence for a set of health effects, from exposure to wind turbines that could be characterized as a "Wind Turbine Syndrome."

A similar report was issued by AWEA and CanWEA, the American and Canadian Wind Energy Associations, in 2009, coinciding exactly with the publication of my book. Both panels included medical doctors, but nobody, on either panel, bothered to interview any affected people. Since it's really easy to interview an affected person—you just pick up the phone and, in the case of Massachusetts, you can even get a preview from half-hour interviews that are posted on the Internet—and since every doctor is trained to take a medical history—I can only conclude that leaving affected people out of this process of discovery was quite deliberate. What affected people have to say just doesn't fit in the reality box of the Massachusetts Department of Environmental Protection or the Massachusetts Department of Public Health, or the American or Canadian Wind Energy Associations. Instead, the Massachusetts report takes great pains to prove to itself why it is justified in rejecting multiple forms of evidence, some of which I have presented here. Its final conclusion is that there's no problem. These people aren't sick, or if they *think* they're sick then the victims themselves are to blame—they're hysterical, possibly consumed by envy that someone else is making so much money from having a turbine on their property. Or they are sick for some entirely different reason that has nothing to do with turbines. Or they became sick after reading my book—imagination and hysteria, again. When I went to Falmouth, I met a group of about 20 victims of the two active turbines there. This was an impressive group, many occupying important and responsible professional positions, and all intelligent, observant, and distressed. (The one I happened to be sitting next to at dinner was a retired high-level State Department official and his wife.) About a third of these people consented to be interviewed on videotape, but many could not because of the sensitivity of their professional positions. In conclusion, the choice before you is, *Which reality box, which epistemology, will you put your faith and belief in when making an important and irrevocable decision about your homes, your neighbors, your community?* The reality box of the Massachusetts Departments of Environmental Protection and Public Health has no room for the well-enunciated, well-documented, obviously turbine-associated health problems of its own citizens in Falmouth. Do you believe your Falmouth neighbors, or do you believe the "official" report?