Industrial Wind Turbines, Human Variability, and Adverse Health Effects

By Michael A. Nissenbaum, MD

Current generations of Industrial Wind Turbines (IWTs) have changed in many ways from those initially installed in Europe in the late 20th century. The generating power of modern IWTs is many times that of earlier generations. Current 1.5, 2.5, and 3MW turbines dwarf the 400 and 600KW turbines most Europeans and Americans encountered in the past. In addition to larger generators, current turbines have much longer blade lengths and are positioned much higher off the ground, often on ridgelines, to better capture the greater wind forces required to turn them. Many jurisdictions have already been identified as hosts for new IWT installations, with plans for tens of thousands of ever larger IWTs worldwide in the decade ahead.

Improvements in turbine design and more efficient blade profiles and materials have resulted in less sound output per unit of energy produced compared to older turbines, but current turbines, being much larger, still produce considerable amounts of sound energy. Unfortunately, the factors that have resulted in less noise per unit energy have been used to justify closer placement of turbines to human residences. It is not unheard of in the UK and North America to find turbines sited within 250m of homes. With the increasing (Continued on page 2)

NECOEM NRCME: training course update

By Jay Poliner, MD, MPH, FACOEM

In the Winter 2013 edition of the NECOEM Reporter, NECOEM Board of Directors member Ron Blum, MD, FACOEM, explained the training requirement for healthcare providers to become a certified Medical Examiner (ME) in the US DOT Federal Motor Carrier Safety Administration (FMCSA) National Registry (NRCME) program. Prior to sitting for the NRCME certification exam, a ME must complete a training course. Through the leadership of Dr. Blum and Dianne Plantamura, NECOEM Executive Director, NECOEM has offered this training.

NECOEM has offered courses to its members and interested non-member healthcare providers. For some courses it partners with other professional groups in providing geographically-convenient, in-person training. Since the first course in Boston on December 1, 2012, NECOEM has offered courses in Springfield, MA, Sunday River and Portland, ME (jointly with the Maine Academy of Family (Continued on page 6)
number of installations close to housing, many anecdotal reports from around the world began accumulating early in the last decade of adverse health effects of remarkable similarity from many differing locales worldwide.

In Maine, the towns of Mars Hill and Vinalhaven underwent the installation of IWTs in 2009. These towns were the source of multiple complaints of adverse health effects of IWTs that were reported in the local media. Over the last 6 years, I developed an interest in and researched issues relating to the human response to noise arising from Industrial Wind Turbines, beginning with the complaints heard from Mars Hill (about 90 miles from where I live), and the announced objectives of the then-Baldacci Administration to install 3000MW of IWT generation within Maine by 2020. If the problems at Mars Hill were real and not understood or acknowledged by the Maine DEP, with steps taken to prevent adverse effects that may be occurring, this project by implication risked creating over a hundred more Mars Hill type situations state-wide.

Jeffery Aramini, Christopher Hanning and I published a study in the journal Noise and Health in late 2012 (Effects Of Industrial Wind Turbine Noise On Sleep And Health, Noise & Health, September-October 2012, Volume 14:60, 237-43). This was the first published study of adverse health effects associated with IWT’s that used a control group and well accepted, previously validated, medical investigative tools targeted at the most common, and arguably most serious, of the commonly reported adverse health effects: sleep disorders and deteriorated mental health.

Questionnaires incorporating standardized, validated tools were administered to 79 subjects living between 375 and 6600 meters from industrial wind turbines (IWTs) at both Mars Hill, and Vinalhaven, Maine. Sleep quality (Pittsburgh Sleep Quality Index - PSQI), daytime sleepiness (Epworth Sleepiness Score - ESS) and general health (SF36v2) were assessed. Functional inquiry and before and after type questions were asked as well, utilizing Likert scales.

Subjects living within 375-1400m (n=38, the ‘near’ group) were compared with those living 3.3-6.6km from IWTs (n=41, the ‘far’ group). Those living within 1.4km had significantly worse sleep (assessed by Pittsburgh Sleep Quality Index (PSQI)), were significantly sleepier during the day (assessed by Epworth Sleep Scale (ESS)) and had significantly worse SF-36v2 Mental Component Scores. Significant dose response relationships between PSQI, ESS, SF36 Mental Component Score and distance to nearest IWT were identified after controlling for gender, age and household clustering. There were no significant differences between the two sites.

There was a significant increase in use of prescribed psychotropic medications for those living within 375-1400 meters compared to those living farther away. Nine of 38 individuals in the near group were newly diagnosed with depression or anxiety disorders and received new prescriptions for psychotropic medications compared to 3 out of 41 in the ‘far’ group.

Figures 1, 2 and 3 summarize the findings from the validated questionnaires. Additional symptoms of note are provided in the table.

Please refer to the full study in Noise &Health for further details and discussion.

Based on our Mars Hill/Vinalhaven Study, it is clear that there is a high probability of significant adverse health effects for residents whose homes are located within 1400 meters (.87 miles) of industrial turbines. The health risks include:

1. Sleep disturbances/sleep deprivation and the multiple illnesses that cascade from chronic sleep disturbance. These include cardiovascular diseases mediated by chronically increased levels of stress hormones, weight changes, and metabolic disturbances, including the continuum of impaired glucose tolerance up to diabetes.
IWT installation. Let us review a few of these.

The intended use of an 'equal loudness contour graph' is to demonstrate the sound pressure levels (SPL) at which a tone of a particular frequency becomes audible. It is the graph that is the basis for the widely held belief that at the sound pressure levels under discussion, humans are simply incapable of hearing noise that is below 20Hz at SPLs below 79. This belief informs essentially all the preconstruction sound modeling the industry has used to place turbines. It is wrong - for several reasons. To begin with, the equal loudness contour graph was created using pure sinusoidal tones. It is known physiology, however, that complex tones are audible at lower sound pressure levels than those represented on such a graph, by up to 6 to 7 dBA.

Additionally, it is often overlooked that every point on every line of an equal loudness contour graph represents an average of multiple listeners, with a standard deviation of 6 dB. A significant proportion of people may in fact hear sub-20Hz noise at SPLs significantly lower than the commonly used 79 dB.

Wind turbine noise is complex. It is broadband, and has a pulsatile nature to it, with a periodicity depending on rotor speed. The preponderance of noise is at the lower frequencies.

Instruments that are used in traditional studies are unable to accurately measure short duration pulsations, leading to measurement data that understate both the peak SPL levels and average levels. This error can be as much as 20-30dB. Additionally, environmental regulations allow the averaging of noise peaks; this renders them unsuitable for measuring noise with the complex characteristics of IWTs. Unfortunately, preconstruction sound modeling utilizes targets meant to be confirmed with these same, not optimally sensitive instruments. Even more recently, microbarometers have been employed and have demonstrated detectability of IWT activity at downwind distances of 10km (personal communication Richard R. James, INCE).

GE 1.5MW turbines are in use at both Mars Hill and Vinalhaven. Most modern turbines of any given size have similar sound profiles, regardless of manufacturer. Larger turbines will have greater lower frequency output, but because dBA weighted measurements are stipulated in siting/DEP regulations, the increased lower frequency noise output (which is clinically important) is hidden from consideration in preconstruction sound modeling, at this point in time, in most jurisdictions. Reliance upon dBA instead of unweighted sound recording or less weighted dBC is another problem with current IWT siting protocols. The difference between heavily weighted dBA and less weighted dBC is visible in figure 4.

Wind Turbine Noise has the following characteristics:

1. Preponderance of lower frequencies (associated with increased audibility at distance, increased resonance within homes, increased physiologic threat/fear response, possible long term potentiation)

(Continued on page 7)
Rhode Island Occupational/Environmental
Happenings

By Steven G McCloy MD

LANDFILL EXPLOSION. The town of Johnston, RI, licenses an enormous landfill operation. Isn’t it a good thing when that landfill uses methane off-gases to generate power? Yes. What if it releases noxious odors for months? Maybe not so yes. An unexplained explosion occurred in July at the operation of BroadRock Gas Services. It is so far unexplained. It damaged the pipes, valves and parts of the methane collecting system. Inspection by Gov. Chafee and Mayor Polisena also found duct tape around valves and holding pipes together. After the town shut down operation, BroadRock workers, without town approval, fired up old auxiliary generators. The town had received complaints of noxious odors and gases. Authorities then padlocked the facility and asked for investigation by the US EPA, the State Dept. of Environmental Management and OSHA. This month a quieter report indicated that BroadRock has paid a fine, not admitting any wrongdoing but wanting to “keep the town happy.” [Extracted from Providence Journal and RI-PRI].

WATER QUALITY in RI. We enjoy (for the most part) good water. A portion of the state water comes from the single source of the Scituate Reservoir. It is clean and, to my palate, quite good. It has had a persistently elevated lead level (25 ppb in the 2012 official report). Providence is engaged in a multimillion dollar program to replace old lead piping with modern, rubber lined water delivery piping. At least at my house, the new piping still delivers water with elevated lead. But it tastes great. Not the case in my office. We are on Pawtucket water there. That water is drawn from shallow reservoirs and tastes of lake bottom and chlorine. Not so much to my taste. To be continued...

SCHOOL SITING. Rhode Island was the home of the Industrial Revolution and continued to be a major manufacturing state through the 20th Century. It has more than its fair share of grey- and brownfields. Last year the Legislature passed a law forbidding siting of new school construction on contaminated lands. This year, the bill was largely gutted by the House and Senate under intense pressure from the Rhode Island Mayoral Academies. They wanted to build a school on a contaminated site in Pawtucket. I guess no one remembers

NECOEM Sponsors an OHIP Intern

By Katherine H. Kirkland, DrPH, MPH

Many of today’s occupational health and safety leaders entered the field in the 1970s as interns in a program created by the Oil, Chemical and Atomic Workers Union (OCAW). Using that model the Occupational Health Internship Program (OHIP) was formed. The OHIP is a paid summer internship. Interns are paired up in teams and placed with a union or worker organization to work on a project to investigate job-related health and safety problems. This is a national program; one of the sites is located in Boston. This year marks the 10th anniversary of the OHIP and the successful completion of the internship by 179 students.

The mission of OHIP is to recruit, train, and mentor the next generation of occupational health and safety (OHS) professionals who are committed to working in partnership with workers and their organizations for social justice and the right to a safe workplace. Over a third of the interns have gone on to jobs in OHS or related fields. While the majority have pursued careers outside OHS, all have been influenced by their experiences as OHIP interns.

OHIP is a very structured internship with both site supervisors and academic mentors. OHIP interns usually work in teams of two for nine weeks during the summer. Projects encompass workers in key industries/occupations facing a range of hazards. Some of the projects involve working with organized labor but many others involve worker centers and community based organizations that are part of a growing movement including many contingent workers. These workforce demographics necessitate the interns have skills to address diverse languages and cultures. Over the past ten years OHIP interns have been involved in projects with nail salon workers, restaurant workers, taxi drivers, health care workers, forestry and agricultural workers, teen workers, airline baggage handlers and many more.

As indicated by the diverse workforce, the projects have involved workplace hazards from chemicals, ergonomics, heat stress, and workplace violence among others. It is a paid internship since that is not only the right thing to do but also the best way to get minority and economically pressed students. A majority of the students speak two or more languages and many are first generation citizens.

Anyone interested in learning more of the history of both the OCAW internship and OHIP are invited to read the current issues of New Solutions: A Journal of...
New Member Spotlight: Erin Teeple, MD

New NECOEM member, Dr. Erin Teeple, is currently in her first year of training in the occupational and environmental medicine residency program at the Harvard School of Public Health. Prior to this residency, she completed an orthopedic surgery residency at Rhode Island Hospital and then a sports medicine research fellowship in the Department of Emergency Medicine at Rhode Island Hospital where her time was divided between clinical work and research. She is particularly interested in the pathophysiology, treatment, and rehabilitation of degenerative musculoskeletal disease. Most of Dr. Teeple’s prior scientific work has focused on the biology and biomechanics of osteoarthritis, but her ultimate goal as a clinician researcher is to help people return to productive lives after injury. In the near term, her goal is to investigate functional and imaging outcomes in patients with meniscal injuries. This will be her research focus during the subsequent two years of her residency at Harvard.

Dr. Teeple has published 11 scientific papers and presented her papers at international meetings. How did this talented orthopedic surgeon/sports medicine research clinician end up in occupational medicine? Has this been her professional goal all along? Well, not exactly.

Pittsburgh was home for Erin Teeple until she headed to Rhode Island and Brown University to attend college, medical school and her orthopedics residency. Throughout all this training she had never encountered our specialty area of occupational medicine. It wasn’t until she was in her sports medicine research fellowship, searching for interesting master’s degree programs and was reviewing the Harvard School of Public Health website that she encountered the formal field of occupational medicine for the first time. She does not recall hearing about occupational medicine in medical school [are any of us surprised?]. As an orthopedic surgeon she saw a lot of work-related injuries but never heard of occupational medicine or encountered a physician specializing in occupational medicine. Dr. Stefanos Kales, the director of the Harvard occupational medicine residency – and the ACOEM 2013 Kehoe Award Winner – was the first specialist in occupational medicine that she had ever met. Now Dr. Teeple is passionate about occupational medicine. She has always loved to see patients and get them back to work. In a sense, she has always loved occupational medicine – she just didn’t know that was what she was doing. Her research focus on degenerative musculoskeletal disease, begun in orthopedics and continued through sports medicine is now seamlessly flowing right on into this new phase of her life in occupational medicine.

The 2013 NECOEM Conference, December 5-6 in Newton, Massachusetts, will be Dr. Erin Teeple’s first occupational medicine conference and her first opportunity to meet her fellow NECOEM members. Please look for her, welcome her to our NECOEM family and share a tale or two from your occupational and environmental medicine exploits.

- Editor

Environmental and Occupational Health Policy, Volume 23, Number 2 / 2013. In it you will find two articles that provide an in-depth review. The articles are: “Student Internships with Unions and Workers: Building the Occupational Health and Safety Movement” by Gail Bateson or “Shaping the Future: Ten Years of the Occupational Health Internship Program” by Linda Delp, et al. The journal is currently posted by Baywood Publishing.

The OHIP is administered by the Association of Occupational and Environmental Clinics (AOEC) and funded through federal grants, private foundations, union and worker center donations and other sources. In spite of a solid history of success, OHIP faces the same issues as many programs in an era of decreased funding and increased need. In 2013, OHIP received 338 applications, but given our funding constraints, we could only support 6% (21/338) of the eligible candidates. This meant that many qualified applicants are unable to participate. This is particularly troubling since OHIP is one of the few programs that provide pathways for young people entering the field.

In addition to the summer program, each year OHIP has a session at the American Public Health Association meeting (APHA). The goal of this session is to provide the students with an opportunity to make presentations and really immerse them in both APHA and the OHS section. Scholarships are provided to help the students attend.

We are very grateful this year for a generous donation to those scholarships by NECOEM. The NECOEM funding was awarded to Ivan Rosales, a graduate student at NYU in Bioethics. Ivan is planning to apply for medical school upon completion of his Bioethics program. The NECOEM funding generously contributed towards his expenses for the APHA meeting registration, membership for a year, travel, and hotel in Boston.

Dr. Kirkland is the Executive Director of the Association of Occupational and Environmental Clinics
For example, at the Springfield course, our faculty and course participants encourage sharing the experience of FMCSA curriculum requirements, that fulfills training for 215 healthcare professionals who attended the courses in ME and MA (see Table 2). Twenty-six (26) of the 216 NCOEM course attendees have certified (see Table 3).

At present there is only one testing organization administering the NRCME test. There are a limited number of test centers in New England, especially in Maine. NCOEM has contacted the Office of Medical Programs at FMCSA to raise concerns about the impact of a limited number of test centers on certification. FMCSA plans to add additional testing organizations and test centers before year’s end to correct this problem.

In addition to offering NCOEM course participants training that fulfills FMCSA curriculum requirements, we encourage sharing the experience of our faculty and course participants. For example, at the Springfield course, Dianne Plantamura enjoys her time in the drivers seat of an 18-wheeler!

As of October 1, 2013, there were 94 certified MEs in the New England states (see Table 1). NCOEM has provided training to 215 healthcare professionals who attended the courses in ME and MA (see Table 2). Twenty-six (26) of the 216 NCOEM course attendees have certified (see Table 3).

Thanks to my co-faculty members - NCOEM Fellows Ron Blum, MD and Robert Swotinsky, MD - as well as Dianne Plantamura for their continuing efforts to make the NRCME course a success.

Jay Poliner, MD, MPH, FACOEM, a NCOEM member based in West Hartford, CT who provides prevention-oriented occupational and corporate health services, has experience with commercial driver health issues in aerospace, explosives manufacturing, healthcare imaging, papermaking and forestry, and petroleum companies.

TABLE 2: NECOEM ME course attendees

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TABLE 3: NECOEM ME attendees who have certified

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% professionals % % %

TABLE 1: Certified MEs in New England, by office address and profession, Oct 1, 2013

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<tr>
<td>TOTAL</td>
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2. Highly modulated, pulsatile, or periodic (associated with increased engagement of the human brain, possible long term potentiation)
3. To-date, poorly understood (consequently poorly regulated, with poor preconstruction modeling)

It is conjectural in the case of IWTs, but the pulsatile nature of IWT noise may recruit the speech or rhythm parts of our brain. Additionally, it has a preponderance of low frequencies, which we are hard wired to pay attention to, as most threats to life and limb during human evolution carried with them ominous low frequency components.

What distance is safe? It depends on the terrain, the climate, the size of the project and the turbines themselves. Accurate preconstruction modeling with safe targets in mind is critical, and must be informed by an understanding of human physiology.

In 2009, the World Health Organization released a 184 page peer reviewed summary of research regarding the risks to human health from noise induced sleep disturbance. Adverse health effects included poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality (World Health Organization, Night Noise Guidelines for Europe, 2009: http://www.euro.who.int/).

The WHO says that 30dBA at night is ideal, and noise levels above 40 dBA have definite health consequences. At Mars Hill, sound levels have been measured at over 52.5 dBA.

‘Nocebo’ Effect?
Advocates of siting IWTs close to populations are fond of referring to variations on a concept some of them refer to as 'nocebo' (a psychologically mediated effect analogous to a psychosomatic illness/response), the opposite of placebo. In a 'nocebo' situation, people suffer ill health from IWTs because they have been led to believe that IWTs are harmful, not because of anything related to the IWTs themselves. These advocates acknowledge that people may be 'annoned' by the noise, but that 'annoyance' is not a disease. They seize upon the use of the term 'annoy' from early European papers on adverse effects of IWTs, but attribute to it the colloquial American definition of a disturbance without real consequence; this is a perversion of the original intent of the word in the original papers (personal communication, Eja Pedersen, PhD).

A physician using the diagnosis of 'nocebo' must ensure that it be done subsequent to a process of thoroughly excluding the possibility of any pathophysiological pathways that are plausible, more likely, or more important because of serious downstream implications. To jump to a diagnosis of nocebo without considering the above is, frankly, malpractice. Most of the people advocating the 'nocebo' concept as being at play here are not medical doctors, and carry no responsibility to individual patients.

In summary, in many IWT projects, the preconstruction sound modeling has underestimated the eventual real world sound levels those turbine projects eventually produce. When coupled with the underappreciated human physiological responses to the type of noise large turbines produce (adverse sleep and mental health effects), this has had real world consequences for those living near them. The relationship of noise to sleep disturbances is established. The biological plausibility of sleep disturbances resulting in ill health is settled science. Chronic noise exposure leads to chronic sleep disturbance in many of those exposed, often resulting in ill health. Observed adverse human effects must trump preconstruction sound modeling; changes in practice must occur when there are errors. It’s all about distance when siting decisions are made.

Graph courtesy of Richard R. James, INCE, and Wade Bray, Head Acoustics

For references and comments, please contact Dr. Nissenbaum at mnis senbaum@att.net.

Dr. Nissenbaum is a Radiologist. After an academic career, he has lived and worked in Ft Kent, Maine, for the last 15 years.
The New England College of Occupational and Environmental Medicine is a not-for-profit regional component society of the American College of Occupational and Environmental Medicine.

The mission of the New England College of Occupational and Environmental Medicine is to support the optimal health and safety of workers and workplace environments through educating our members and other health care professionals, encouraging research, workplace safety, and high quality practice, guiding public policy, and promoting the specialty of Occupational and Environmental Medicine.

The editorial board welcomes letters to the editor. Write or email to NECOEM at the above address. The editor reserves the right to edit letters for publication purposes.

Gearing Up!

The Annual Conference Committee is very excited about this year’s conference. Highlights include: Jay Himmelstein, MD, MPH, the 2013 Harriet Hardy Award Winner, whose talk is entitled "Work Without Limits: Observations on 30 years of Occupational Health, Health Care, and Employment Policy."

The William B. Patterson Memorial Lecture on Excellence will be given this year by Michael Erdil, MD on "Shared Decision Making - A Key to Excellence in OM Practice." The conference will also feature lectures on two current controversial topics, hydrofracking and medical marijuana.

There are 11.5 hours of Category I CME credits, contact hours, CCM credits, and ABIH credit as well as 11.5 hours of MOC credit available. We will again be holding a President’s Dinner Reception and Poster Competition, with a buffet dinner. There will be a live jazz duo performing at the dinner reception. Drink tickets are included in the registration fee. Additional guests may attend for an additional fee.

As always, there will be ample opportunities for networking and exploring vendor exhibits. MaAOHN and NECOEM Annual Meetings will take place on Friday during the noon luncheon. We look forward to you joining us. Please make sure to make your reservations ASAP as the hotel has filled up for past conferences!

By Matthew Lundquist, MD, MPH. Dr. Lundquist is Assistant Medical Director at Middlesex Hospital Occupational & Environmental Medicine in Middletown, Connecticut. He is Chair of the 2013 NECOEM Annual Conference and a member of the Board of Directors.