

What Clinical and Acoustic Clues Can Tell Us About The Causes Of Deteriorating Physical and Mental Health

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A Diagnostic Conundrum

- Some residents living near sources of industrial infrasound and low frequency noise (ILFN) in quiet rural areas report **worsening** existing physical and mental health, and a wide variety of **new** symptoms with **variable** time of onset after ILFN exposure starts
- Many experience **new** repeated sleep disturbance – including “**waking up suddenly at night in an anxious, frightened, panicked state**”
- Some report **new** sudden “**pressure bolt**” symptoms

Clinical question - *What is causing these symptoms?*

What Causes Annoyance Symptoms?

Question - Are the symptoms caused by “suggestion”, (the “nocebo effect”) or are the symptoms caused by the sound energy itself?

A nocebo effect is an ill effect caused by the suggestion or belief something is harmful..

Answer – Psychoacoustic research, community reaction and attitudinal studies over the last forty years have shown that excessive noise can harm health.

Animal research evidence, careful clinical histories, and human physiological studies from the last thirty years, all provide evidence of ***direct physiological effects and tissue pathology***, from sound and vibration energy, ***including infrasound***.

What We Already Know

- Low frequency noise from ***any*** source can cause a range of symptoms described by engineers as “noise annoyance”
- UK Acoustician Professor Geoff Leventhall in June 2011 at NHMRC Workshop: “***noise annoyance symptoms are the same as wind turbine syndrome symptoms***” and are “***the stress effects from audible noise***”

What We Already Know

1982 - 7 – Kelley, et al and Hubbard (NASA)

- *Impulsive infrasound & low frequency noise* from a variety of sources *directly caused annoyance symptoms* in field and laboratory studies
- The dose of sound energy may be *amplified* inside homes by the resonance effects on the building structure
- *Small rooms* facing the sound source the “*worst*”
- Impacts worse with ongoing exposure – “*sensitisation*”
- Sources of ILFN include gas turbines, wind turbines, and military aircraft

What We Already Know

- “Annoyance” symptoms can be caused by excess sound energy, and include ***sleep disturbance*** and ***physiological stress*** responses, as well as psychological stress effects
- ***Chronic sleep deprivation*** and ***chronic stress*** are both well known to cause serious adverse consequences for physical and mental health
- ***Sudden acute physiological stress*** can also cause serious problems eg adrenaline surge pathology can cause cardiomyopathy / “heart attacks” and dangerously high blood pressure

New Evidence – Direct Physiological Impact in Brain

- **2014 - 5 – Inagaki et al, Japan**

Small study of 15 Japanese wind turbine workers

Exposed to reproduced wind turbine noise from 600 kW wind turbine in a laboratory study

EEG studies showed changes consistent with brains being “unable to achieve a relaxed state”

In other words, the sound energy induced a physiologically stressed state directly in the brain, visualised on objective EEG studies

What Are The Consequences Of Inagaki et al's Study?

- The “annoyance” symptoms of physiological stress are ***directly caused by*** the impacts of (wind turbine) sound energy on the brain
- The “nocebo effect” hypothesis **does not explain the annoyance symptoms** reported by workers, residents, and wind turbine hosts
- In other words, the ***nocebo hypothesis is “dead and buried” as an explanation for the annoyance symptoms reported by residents***

Who Predicted The Inagaki EEG Results Showing Physiological Stress?

- **2003/4 – Tharpaland Buddhist Monks, UK – *could not attain a meditative state near operating wind turbines***, report of a field investigation with experienced monks in Scotland
- **February 2011 – Waubra Foundation** called for EEG / sleep studies in homes of impacted residents, based on clinical histories of severe sleep disturbance and “*waking up suddenly in an anxious frightened panicked state*”

Who Predicted The Inagaki EEG Results Showing Physiological Stress?

- **November 2011 – Steven Cooper**, after visit to Capital Wind Development. In an email to a psychologist who conducts EEG's, he stated the following:
“I have hypothesised that what the residents are receiving is low frequency noise that is affecting their brain functions and in turn their sleep patterns and their health”
- **December 2011 – Rob Rand and Steve Ambrose** were the first to specifically hypothesise this effect publicly in their report of the Bruce McPherson Acoustic survey, Falmouth USA (pp 32-33)

What Clues About Physiological Stress Do We Have From Animal Studies?

- **Salt's** recent work on guinea pig cochlea – *infrasound stimulation of afferent nerves from the outer hair cells to the brain resulted in an “alerting response”* (the fight flight response) which Salt suggested could explain the repeated sleep disturbances experienced by rural residents, especially in a quiet background noise environments

What Clues About Physiological Stress Do We Have From Animal Studies?

- **Nishimura 1988** – infrasound (16 Hz, 120 dB) stimulation “*appears to induce sympathetic – dominant responses early in the exposure period, due to stimulation of the sympathetic nervous system by the hypophysis* directly, or indirectly via the adrenal glands*”

* *Hypophysis = Pituitary gland*

Therefore rare clinical reports of conditions resulting from acute adrenaline surges with no usual cause are highly relevant - *transient ILFN pulse pressure peaks could explain these acute episodes*

Which Adrenaline Surge Pathologies are being Reported?

- **Acute Hypertensive Crisis** –can be caused by adrenal tumour called “phaeochromocytoma” and commonly presents with either incidental markedly elevated blood pressure or classic symptoms of an acute crisis
- **Tako Tsubo Cardiomyopathy** – usually caused by a sudden severe emotional shock. Sometimes named Tako Tsubo “Heart Attacks” – the clinical presentation with chest pain can be very similar to that of blocked coronary arteries

Clues From Clinical Cases

Case 1 – Farmer from Waubra with **Acute Hypertensive Crisis** whilst working outdoors

- Overcast day, turbines operating, working approx 1km from nearest turbine cluster (128 in total)
- Sudden onset symptoms – severe headache, felt “heart was going to leap out of his chest”, severe nausea, felt very unwell - so went home.
- Checked blood pressure – over 200 systolic (normally 120), BP stayed elevated for days, and farmer felt jittery, nauseous, and anxious

Clues From Clinical Cases cont.

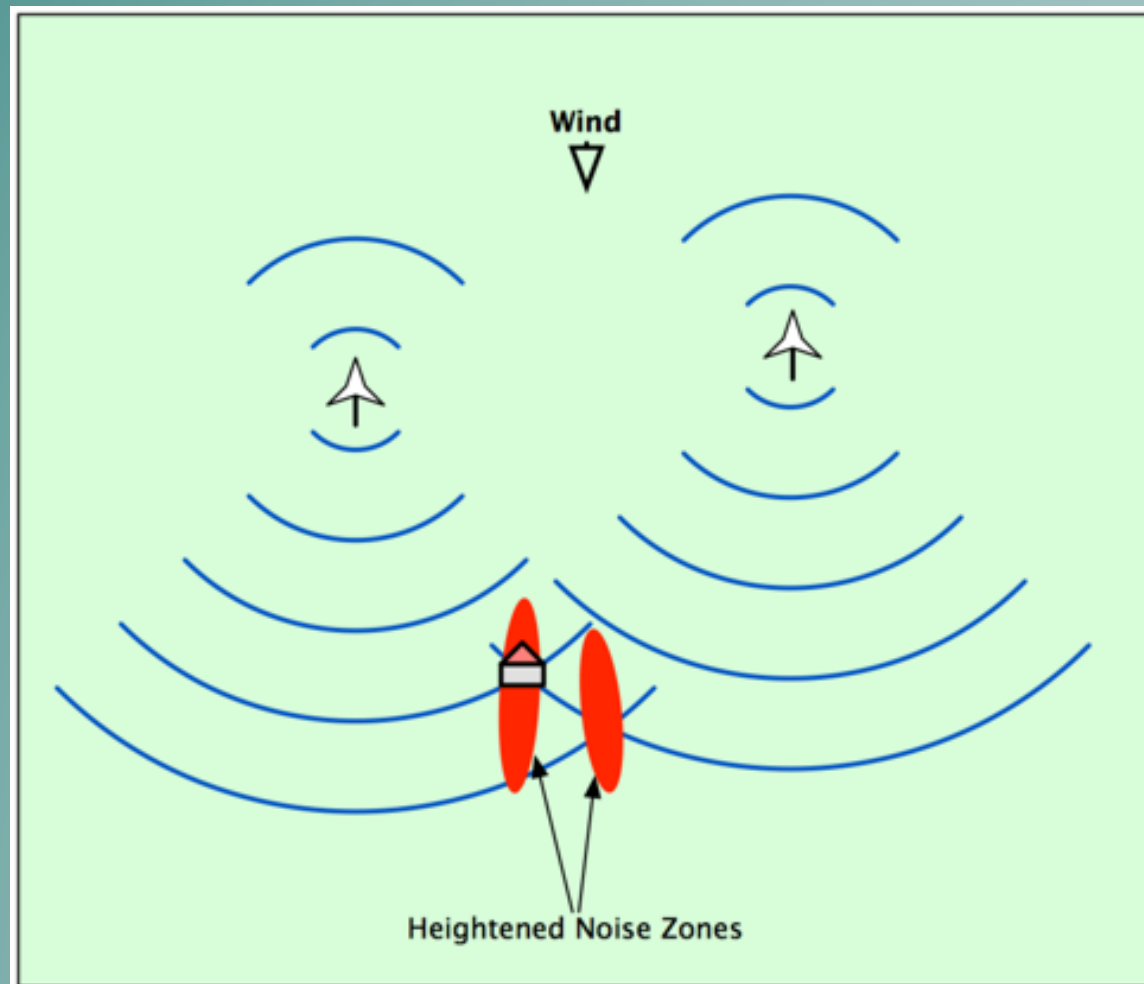
Case 1 continued

Diagnosis – Symptoms consistent with Acute Hypertensive Crisis BUT *no underlying adrenal tumour found with subsequent investigations*

Cause of symptoms – *unknown*

Hypothesis – he was hit by the *convergence of infrasound pulse pressure peaks* from multiple turbines (*convergence from multiple wind turbines was described by Pierpont 2009, Thorne 2010, Rapley, Bakker & Thorne 2011, Bell 2014*)

Convergence of Sound Waves – Heightened Noise Zone (Bakker & Rapley, 2011)



Clues From Clinical Cases cont.

Case 2 – Farmer (light work outside), Waubra

- Overcast day, turbines operating nearby
- Felt unwell, chest pain and nausea (but **not** severe, central crushing chest pain)
- Went home, and when symptoms failed to resolve went to hospital. **Tako Tsubo Cardiomyopathy “heart attack”** diagnosed by cardiologist. No usual precipitant for symptoms (eg intense emotion) was present

Waubra



Clues From Clinical Cases cont.

Case 3 – Widow resting in her home at night

- Sudden onset chest pain – wind turbines operating, location of house - downwind of a line of turbines, operating at the time
- **Tako Tsubo Cardiomyopathy** subsequently diagnosed in hospital by cardiologist
- No usual precipitant cause
- 2 other family members had heart attacks at same location, one fatal

Clues From Clinical Cases cont.

Case Cluster of Tako Tsubo “heart attacks”

- Location – Cumbo Valley, Hunter Valley, New South Wales, (Australia) near multiple open cut coal mines over 5 km away
- Cluster of multiple residents with Tako Tsubo heart attacks over a period of months – usually between 1 – 3 am on cold frosty nights, in residents reporting “noise annoyance” symptoms and perceptions of vibration inside homes
- Cardiologists could not explain the cluster of Tako Tsubo cases occurring overnight from this region

Hunter Valley, NSW



Comment from Cardiologist, Expert in Takotsubo Cardiomyopathy, July 2014

“I have not encountered, nor am I aware, of any literature on low frequency sound as a possible trigger for takotsubo cardiomyopathy. In my opinion, any physiologic stress (including sound) which causes a substantial increase in plasma catecholamines might serve as a trigger for this condition. There are a substantial proportion of patients (perhaps 20%) in whom we cannot identify a specific trigger”

Dr Scott Sharkey, MD, Cardiologist, Minneapolis

Case with Concurrent Infrasound Measurement

Final Case – “*Pressure Bolt Sensations*”

- Resident at Macarthur – gave evidence in Cherry Tree Court Case about sudden onset of pressure bolt sensations perceived in the back of his head, whilst sitting relaxing in his home
- Mr Les Huson – acoustician – coincidentally collected concurrent infrasound measurements at the same time – to which the resident was “blinded” (ie unaware of pressure pulse peaks subsequently identified in the data)

Case with Concurrent Infrasound Measurement cont.

Mr Les Huson's expert opinion

“Industrial infrasound levels of 0.5 Pa peak-peak at 12.5 Hz have caused recognised and accepted nuisance complaints. Pressure transients exceeding 5 Pa peak-peak have been observed that correlate with observation of Mr G..... that causes him concern. Other lower amplitude peak-peak pressure transients have also correlated with Mr G.....’s diary logs with an overall correlation of 86% “

The Next Steps – Infrasound Dosimeters and Physiological Data

Future Research Priorities:

1. **Physiological data** (EEG, heart rate, non invasive blood pressure studies and biomarkers) with ***concurrent full spectrum acoustic measurements inside homes*** to
 - ***confirm direct causation*** of physiological stress,
 - ***establish triggers*** (frequencies & threshold) for ***acute sleep disturbance episodes***, and
 - ***validate infrasound sensation perception thresholds*** established by Kelley (1985) and Cooper (2014) of 50 dB 4-5 Hz narrow band for chronically sensitised residents - 6 years exposure at Cape Bridgewater

The Next Steps – Infrasound Dosimeters & Physiological Data

Future Research Priorities

2. Infrasound Dosimeters – wind turbines

- occupational exposures (farmers, wind turbine workers, acousticians)
- measure exposures during acute adrenaline surge events
- measure individual exposures for severely impacted people

The Next Steps – Infrasound Dosimeters & Physiological Data

Future Research Priorities cont.

3. Infrasound Dosimeters – other applications

a wide range of other ILFN sources – mines, gas and coal fired power stations, aircraft, trains, passenger ferries and other shipping with large diesel engines where ILFN related pathology is also being reported (ie symptoms of noise annoyance/WTS or “ILFN Syndrome”, and vibroacoustic disease)

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See also the **Waubra Foundation** summary of the
Cooper study and its implications
[http://waubrafoundation.org.au/resources/
acoustic-engineering-investigation-at-cape-
bridgewater-wind-facility/](http://waubrafoundation.org.au/resources/acoustic-engineering-investigation-at-cape-bridgewater-wind-facility/)