

## **Dirty electricity, chronic stress, neurotransmitters and disease**

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### **ABSTRACT**

Dirty electricity, also called electrical pollution, is high-frequency voltage transients riding along the 50 or 60 Hz electricity provided by the electric utilities. It is generated by arcing, by sparking and by any device that interrupts current flow, especially switching power supplies. It has been associated with cancer, diabetes and attention deficit hyperactivity disorder in humans. Epidemiological evidence also links dirty electricity to most of the diseases of civilization including cancer, cardiovascular disease, diabetes and suicide, beginning at the turn of the twentieth century. The dirty electricity level in a public library was reduced from over 10 000 Graham/Stetzer (G/S) units to below 50 G/S units by installing plug-in capacitive filters. Before cleanup, the urinary dopamine level of only one of seven volunteers was within normal levels, while four of seven phenylethylamine levels were normal. After an initial decline, over the next 18 weeks the dopamine levels gradually increased to an average of over 215 µg/g creatinine, which is well above 170 µg/g creatinine, the high normal level for the lab. Average phenylethylamine levels also rose gradually to slightly above 70 µg/g creatinine, the high normal level for the lab. Neurotransmitters may be biomarkers for dirty electricity and other electromagnetic field exposures. We believe that dirty electricity is a chronic stressor of electrified populations and is responsible for many of their disease patterns.

**Keywords:** [biomarkers](#), [capacitive filters](#), [catecholamines](#), [chronic stress](#), [dirty electricity](#), [diseases of civilization](#), [dopamine](#), [phenylethylamine](#)

### **Introduction**

Chronic urinary neurotransmitter changes in residents near a new cell tower erected in Rimbach, Austria, were recently reported ([Buchner & Eger, 2011](#)). Microwave radiation from the tower was presumed to be the active agent. The catecholamine neurotransmitters were studied in volunteers over a period of a year and a half. Epinephrine, norepinephrine, dopamine and phenylethylamine (PEA) all had significant changes in level, indicating chronic dysregulation of the stress system. Dopamine levels dropped significantly during the first year of study. PEA levels were unchanged for 6 months and then dropped significantly over the next year. The authors postulated that cell tower radiation generated a chronic stress response in the residents, accounting for the great variety of morbidity and mortality that has been reported in residents near cell towers.

All cell towers have switching power supplies to convert the grid alternating current (AC) into direct current (DC) to operate the cell tower transmitter and to charge the batteries used for backup power during grid outages. These switching power supplies interrupt the AC current flow and create dirty electricity (high-frequency voltage transients), which flows back into the grid. All transmitters, computers, compact fluorescent lights, DC chargers and variable speed motors contain switching power supplies. Dirty electricity is a term coined by the electrical utilities to describe electrical pollution contaminating the 60 and 50 Hz electricity on the electrical grid. It is generated by arcing, sparking and any device that interrupts the current flow. Each interruption of current flow results in a voltage spike described by the equation  $V = L \times di/dt$ , where  $V$  is the voltage,  $L$  is the inductance of the electrical wiring circuit and  $di/dt$  is the rate of change of the interrupted current. The voltage spike decays in an oscillatory manner. The oscillation frequency is the resonant frequency of the electrical circuit. The Graham/Stetzer (G/S) Microsurge meter measures the average magnitude of the rate of change of voltage as a function of time ( $dV/dT$ ). This preferentially measures the higher frequency transients. The measurements of  $dV/dT$  read by the Microsurge meter are defined as G/S units. They are a function of voltage and frequency. Dirty electricity can be measured using an oscilloscope or multimeter set for peak-to-peak voltage or a Microsurge meter that provides a digital readout (G/S units) and is easily used by non-professionals. G/S capacitive filters short out high frequencies and reduce transients on electrical wiring with an optimal filtering capacity between 4 and 100 kHz. (Microsurge meters and filters are available from <http://www.stetzerelectric.com/>.) We have observed that structures near cell towers have high levels of measurable dirty electricity in their electric outlets and in air.

Dirty electricity was shown to be a potent universal carcinogen in a study of cancer in teachers at a La Quinta, California, middle school ([Milham & Morgan, 2008](#)). A single year of employment at the La Quinta school increased cancer incidence by 21%. In 2010, one of us (SM) studied a cluster of cancers in personnel at Vista del Monte elementary school in North Palm Springs, CA, with a cell tower on campus within a few feet of a classroom wing. The cancer cases were overrepresented in the classroom wing closest to the cell tower. The dirty electricity readings were highest in classrooms closest to the cell tower base and decreased linearly with distance from the cell tower base ([Milham, 2010a](#), [2010b](#)). Cell tower microwave radiation decreases with the square of the distance from the transmitter. A fourth grade teacher at this school complained that her students were hyperactive and unteachable. Filtering this classroom made an immediate and dramatic improvement in student behavior. The teacher removed and plugged the filters a number of times and reported that she could change student behavior in about 45 min ([Milham, 2011](#)). At this time, the cell tower was functioning normally, and classroom microwave levels were high. This suggests that the behavioral response of the students was driven by dirty electricity and not the cell tower microwaves.

Unfortunately, historical US mortality and electrification data suggest that all the so-called diseases of civilization including cancer, cardiovascular disease, diabetes and suicide are caused by electromagnetic field (EMF) exposure, most likely dirty electricity ([Milham, 2010b](#)). This was observable in US mortality records very early in the twentieth century before the invention of microwaves.

In the summer of 2011, at a book signing at the Olympia Timberland Public Library in Olympia, WA, SM measured very high levels (>20 000 G/S units) of dirty electricity in the outlets of the

room where the book signing took place. The recommended level for no effects is 50 G/S units or less. In the hundreds of dirty electricity measurements made by us over the years, only a very few were this high. Excess mortality in 2608 female librarians dying in Washington State between 1970 and 2010 was seen for the following causes: cancers of the tongue, breast, ovary and brain; Alzheimer's disease; diseases of the veins and pulmonary embolus (<https://fortress.wa.gov/doh/occmort/>). Since the La Quinta school teachers study showed a dose/response between increasing dirty electricity classroom levels and increasing cancer incidence, we felt it important to offer to reduce the dirty electricity exposure of the library employees.

With the permission of the City of Olympia, and the cooperation of the library manager and library staff, on 10 October 2011, we reduced the dirty electricity levels in the library and measured urinary dopamine and PEA in seven volunteers a few days before and after the cleanup, and every 2 weeks for the next 18 weeks beginning 1 December 2011. A final sampling is planned 1 year after the cleanup.

## Methods

After a meeting with library staff to explain the project, mail-in kits were distributed to each of the seven volunteers for collection of urine before and after the cleanup. A consent form was signed by the volunteers. The second morning urine was collected. There were six female and one male volunteer, between ages 40 and 59. We collected information from volunteers about the use at home of digital enhanced cordless telephone (DECT) cordless telephones, wireless routers and compact fluorescent lights.

A count of computers, copy machines and television sets in the library was made to estimate the number of capacitors needed to short-out the dirty electricity in the library wiring. Urine collecting kits were obtained from Pharmasan Labs, a division of NeuroScience in Osceola, WI. The Rimbach study used the same lab.

On 10 October 2011, a Fluke 199 B ScopeMeter was plugged into an outlet in the library manager's office for continuous monitoring of the dirty electricity in the library wiring during the cleanup. A modified G/S Microsurge meter was used to make simultaneous dirty electricity readings in the same outlet. Forty-four G/S plug strips each containing 2 G/S filters were plugged in, one at each computer, and 20 single G/S filters were plugged into library wall outlets to reduce the outlet reading to below 50 G/S units. Filters were also provided to clean up dirty electricity in the volunteers' homes after the library cleanup.

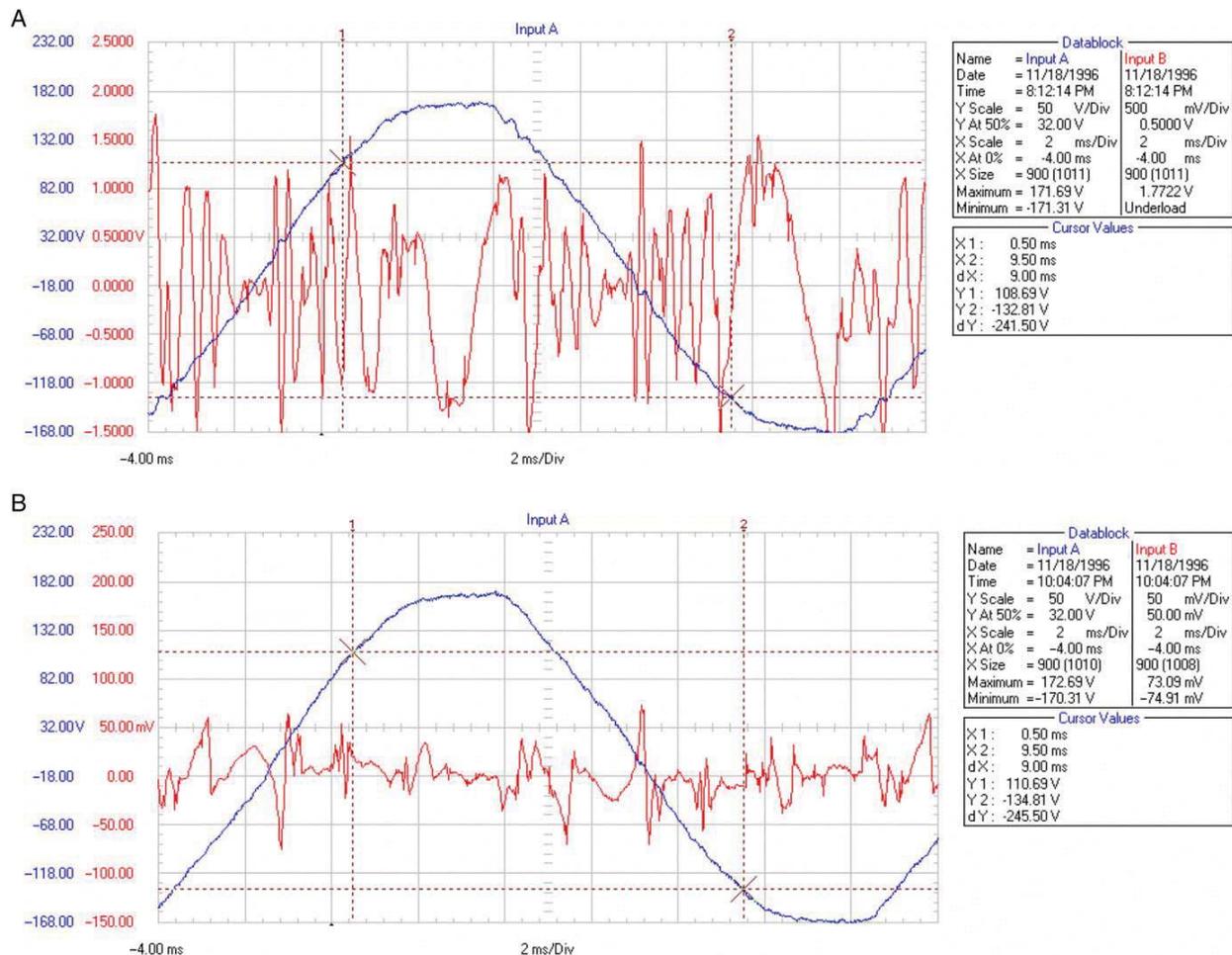
## Results

[Figure 1](#) shows the oscilloscope tracings taken in the manager's office before and after the cleanup. The Microsurge meter readings in the same outlet were 11 190 G/S units before the cleanup, 540 G/S units during the cleanup and 39 G/S units at the end of the library cleanup, which took about 2 h. The upper tracing in [Figure 1](#) is the corrupted utility 60 Hz sine wave. The lower tracing shows the dirty electricity riding on the sine wave by filtering out the low frequencies. The change in the lower tracing before and after oscilloscope tracings shows the attenuation of the dirty electricity in the library wiring by the filters. The time stamp in the data blocks in the figures is wrong. The time between when the two figures were recorded is 2 h and

12 min, and is accurate. The cleanup began at about 9 am and ended shortly after 11 am on 11 October 2011.

[View larger version\(84K\)](#)

Figure 1. Oscilloscope tracing of the dirty electricity in a wall outlet in the director's office of the Olympia Timberland Library before and after installing G/S filters. (The date and time in the data blocks are incorrect. These tracings were taken on 10 October 2011 between 9 and 11 am.) Channel A was connected to the 120 V AC wall receptacle. Channel B was connected to the same potential, except through the ubiquitous filter (removes the 60 cycle). (A) No G/S filters were used at the time. The Microsurge meter readings were 11 190 after filtering. (B) Several G/S filters were used at the time. The Microsurge meter readings were 39 at the time.



Each one of the seven volunteers had an abnormal urinary level of either dopamine or PEA in the sampling in the days before the cleanup. In four of them, the dopamine levels were elevated, two were low and one was normal. Three of the PEA levels were elevated, and four were normal. After an initial decrease, over the next 6 months, the average urinary dopamine concentration in the volunteers who provided urine after the cleanup gradually increased to an average of over 215  $\mu\text{g/g}$  creatinine, which is well above 170  $\mu\text{g/g}$  creatinine, the high normal level for the lab. Average PEA levels also rose gradually to slightly above 70  $\mu\text{g/g}$  creatinine, the high normal level for the lab. After the initial post-cleanup urinary sampling, the volunteers' homes also had their dirty electricity levels reduced with filters. [Table I](#) shows the average urinary dopamine and PEA levels in the volunteers before and after the dirty electricity cleanup.

Table 1. Olympia Library study: average urinary dopamine and phenylethylamine levels before and by weeks after dirty electricity cleanup ( $\mu\text{g/g}$  creatinine).

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<b>Weeks</b>	<b>Number of samples</b>	<b>Dopamine</b>	<b>Phenylethylamine</b>
Before	7	180	65
1	7	134	53
6	7	196	56
8	7	157	61
10	7	200	54
12	7	172	67
14	6	227	58
16	6	215	70
18	6	217	73

## **Discussion**

Beginning with Thomas Edison's Pearl Street generating station in New York City in 1882, the generation and distribution of electricity introduced a new chronic environmental stressor into the environment, which was probably responsible for the epidemic of diseases of civilization that continues to this day. The initial source of dirty electricity was brush arcing in his "Jumbo" generators. Brushed generators and motors still generate dirty electricity. In the 1970 s, with the advent of computers and other devices with nonlinear loads that generate dirty electricity, the existing utility-neutral return wires were unable to handle the high frequencies returning to the substations due to the so-called skin effect. It takes a larger diameter wire to conduct high-frequency currents, because they travel on the outside or skin of the wire. Because of wire fires, building codes were changed to require thicker return wires in buildings, but the utilities did not change the grid neutrals. Instead, they connected the neutral return wires to the earth by running a wire from the center tap of their transformers to the ground to use the earth as a primary neutral

return to the substations. In some areas of the USA, 80% of delivered electricity returns to the substation via the earth. These dirty currents get into houses and buildings on conductive water and sewer pipes and through ground rods. In rural areas, these currents called “stray voltage” cause serious health problems to farm animals and farm families. To compound the electrical exposure problems, the proliferation of cell towers and cell phones, terrestrial transmitters, WiFi and WiMax systems, broadband Internet over power lines and deployment of smart meters have caused an exponential rise in radiofrequency radiation and dirty electricity especially in urban areas. There truly is no place to hide from or to escape these chronic electrical stressors.

[Selye \(1955\)](#) is considered the father of stress research and described how the body responds and adapts to stressors of various types. His 1955 paper shows how chronic stress leads to disease. Chronic psychic stress has long been linked to a variety of morbidity and mortality end points. The initial fight or flight reaction causes increased sympathetic nervous system activity and the adrenal glands release epinephrine and norepinephrine into the bloodstream. The adrenal glands also release corticosteroid hormones. Digestion stops, blood pressure and pulse rate increase and the heart pumps more blood to the muscles. Blood sugar levels increase. If stress is chronic, epinephrine and norepinephrine levels decline, but corticosteroid secretion continues at above-normal levels. Chronic disturbance of the catecholamine system inevitably results in disease. *In vitro* studies of cellular stress show that heat shock or stress proteins are induced in cells by non-thermal EMFs ([Goodman & Blank, 2002](#)). EMFs cause single and double strand DNA breaks ([Lai & Singh, 2005](#)), increase permeability of the blood–brain barrier ([Salford et al., 1994](#)) and cause efflux of calcium from cells ([Blackman et al., 1985](#)). A 4.5 million dollar Air Force-supported study of pulsed 2450 MHz microwave radiation exposure of germ-free rats at the University of Washington showed midlife immune system changes and an increase in benign and malignant tumors in the exposed rats ([Chou et al., 1992](#)). In cows, the persistent, intermittent electrical shocks associated with stray voltage produce a typical stress syndrome characterized by increase of blood adrenal hormones and cortisol ([Drenkard et al., 1985](#); [Lefcourt, Kahl, & Akers, 1986](#)). A recent study in mice shows that exposure for 1 h a day for 14 days to extremely low-frequency magnetic fields (ELF-MF) caused hyperactivity lasting for 3 months and activation of the dopaminergic D1 receptor in the brain for 1 year ([Shin et al., 2011](#)). ELF-MF exposure measured for 1 day during pregnancy predicts asthma incidence in offspring up to 16 years later ([Li et al., 2011a](#)). Early life stress, particularly childhood maltreatment, predicts systemic inflammation and levels of proinflammatory cytokines like interleukin 6 in adulthood ([Carpenter et al., 2010](#)). Evidence that neurotransmitter abnormalities are associated with disease are the number of conditions for which drugs targeting neurotransmitters are used. These include but are not limited to depression, attention deficit hyperactivity disorder (ADHD), schizophrenia, Parkinson's disease, restless leg syndrome, eating disorders, anxiety disorders, insomnia and chronic fatigue syndrome.

Since there were only very low levels of microwave exposure in this library environment, we believe that the neurotransmitter changes in the Olympia library employees and in residents near the Rimbach cell tower were also caused primarily by cell tower dirty electricity. The gradual increase in urinary dopamine and PEA in the Olympia librarians after the dirty electricity cleanup is in sharp contrast to the decline in these neurotransmitters in the Rimbach population after exposure to dirty electricity and radiofrequency from the new cell tower.

The ADHD-like symptoms in the children in a classroom near a cell tower were changed by modifying dirty electricity exposure while cell tower microwave exposure was constant. Levels of a neuromodulator,  $\beta$ -PEA, are lower in urine of children with ADHD ([Matsuishi & Yamashita, 1999](#)). The mortality patterns linking EMF exposure to the diseases of civilization were evident long before the development of microwave transmitters in the 1940 s. An Egyptian group ([Eskander, Estefan, & Abd-Rabou, 2011](#)) has reported that plasma adrenocorticotrophic hormone and serum cortisol levels decreased over a 6-year period in people exposed to cell phones or cell phone base stations compared with controls.

A group from Nippon Medical School in Tokyo has recently reported that forest environments as compared with city environments reduce blood pressure, urinary adrenaline, noradrenaline and dopamine and increase natural killer cell activity and expression of anticancer proteins. They thought that these effects might be due to the presence of phytoncides like  $\alpha$ - and  $\beta$ -pinene in forest air ([Li, 2010](#); [Li et al., 2008, 2011b](#)). We believe that their findings are due to low levels of dirty electricity in the forest as compared with city environments. These results are evidence that the neuroendocrine and immune systems are linked and function in parallel.

The Old Order Amish (OOA) in North America live without electricity. They have less than half the cancer incidence of the US population ([Westman et al., 2010](#)) and about half the type 2 diabetes prevalence as other US citizens despite having the same body mass index ([Hsueh et al., 2000](#)). Cardiovascular disease ([Hamman, Barancik, & Lillienfeld, 1981](#)), Alzheimer's disease ([Holder & Warren, 1998](#)) and suicide ([Kraybill, Hostetler, & Shaw, 1986](#)) are reported to be less common in the OOA. A pediatric group practice in Jasper, Indiana, that cares for 800 Amish families has not diagnosed a single child with ADHD, and childhood obesity is almost unseen in this population ([Ruff, 2005](#)). Remarkably, the life expectancy of the OOA has been about 72 years for the past 300 years for both men and women. In 1900, the life expectancy of US males was 46.3 and 48.3 years for females (<http://gerontology.umaryland.edu/>, fall 2003. V6, No. 2). If the rest of the US population had the disease incidence and prevalence of the OOA, the US medical care and pharmaceutical industries would collapse.

The average urinary dopamine and PEA levels in these library workers increased gradually to levels above lab normals after the dirty electricity levels in the library wiring were reduced. We believe that neurotransmitters in blood and urine are biomarkers for dirty electricity exposure. Since most of the electrified populations of the world are exposed to dirty electricity, we think it is important to study those few remaining populations like the OOA, which are not exposed to or have low levels of exposure to dirty electricity, to learn what “normal” levels of neurotransmitters are.

Buchner and Eger's surmise that the morbidity and mortality associated with cell tower EMF exposure is mediated through a chronic stress reaction seems accurate and suggests that the body recognizes EMF as a foreign invader and mounts an acute stress response to it. With chronic exposure and stress, neuroendocrine and immune system dysregulation results in a wide spectrum of human morbidity and mortality. Our work shows that lowering of dirty electricity in an office environment results in increased urinary levels of dopamine and PEA in exposed persons. This is evidence that dirty electricity and probably other types of EMF exposure act as

chronic stressors, causing neurotransmitter changes and disease. Neurotransmitters may be biomarkers of dirty electricity and EMF exposures.

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## Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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