

# How Electromagnetic Fields Damage Your Health

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## STORY AT-A-GLANCE

- › Electromagnetic fields (EMFs) include electric, magnetic and higher frequency radio fields
- › While the literature discriminates between low- and high-frequency fields, microwaves, electric and magnetic fields, all of these have similar biological effects
- › Even low magnetic fields, such as 60 Hertz, can have drastic effects on cancer cells in culture. Effects begin around 20 nanotesla, and are fully developed around 50 nT
- › At levels over 160 nT, magnetic fields have been shown to affect sperm production
- › EMFs impair the flow of protons through ATP synthase. This increases mitochondrial membrane polarization, triggering a massive increase in reactive oxygen species. This oxidative stress causes most of the damage

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Electromagnetic fields (EMFs) have been shown to cause biological damage and even cancer, but exactly how does this happen? In this interview, Paul Héroux, Ph.D., a researcher and professor of toxicology and health effects of electromagnetism at the faculty of medicine at McGill University in Montreal, helps answer that question.

Originally trained as a physicist, he eventually ended up studying electrical power transmission lines, the topic of his Ph.D., and in the course of working for a power utility,

he started investigating the health effects associated with the fields emitted from power lines.

"I got involved in biology, followed courses in medicine and became, so to speak, a different person from what my supervisors initially would have expected me to be," he says. In time, he became a specialist on the effects of magnetic fields on the human body, and joined the Faculty of Medicine to help protect health and the environment.

## **Types of EMFs**

Broadly speaking, EMFs include electric, magnetic and radio frequency fields. While the literature tends to discriminate between low-frequency fields, high-frequency fields, microwaves, electric fields and magnetic fields, all of these have certain commonalities that allow you to lump them together, at least in terms of their biological action.

*"It's true that frequency influences the effects," H eroux says, "but basically ... I could, using an electric field or a magnetic field, produce the same effect in a cell. Most higher frequency signals have enough low-frequency components to have a lot in common with low-frequency components.*

*The practical aspect of this is that usually the fields have an effect maybe in one application, but they are mirrored in other applications as well. There's a type of great unifying view that you can have about these fields."*

## **Nonthermal Effects Matter**

It's important to realize that the damage EMFs cause has nothing to do with thermal effects. At typical exposures, EMFs do not create heat, which has been the telecommunication industry's main defense and argument for the safety of cellphone radiation. However, hundreds of researchers have in fact noted biological effects both at low and high frequencies.

*"Covering the whole spectrum, there is no doubt that there are biological effects," Héroux says, adding "There's no doubt there are substantial health effects that we have been experiencing for a long time, and that have been increasing our health bills.*

*Initially, I got into this field because a power utility asked me to design an instrument that would measure electromagnetic fields on the workers. I designed a dosimeter that was a very successful unit.*

*After that, I imagined maybe this would be followed up with basic work on the biology of the phenomenon, but obviously, the utility was not very interested in that. Essentially, about at that time, I went to McGill University ... and started to do research.*

*I had a student in the lab who was working on the toxicity of metals, who came to me one day and said, 'Why don't you give me a subject that would be a little more spectacular than the toxicity of metals?'*...

*This student started to work on magnetic fields. The results that came out of these experiments were quite spectacular. The effects were very, very strong. From then on, I felt I could not ignore this and that I had to bring this to the attention of the world."*

What they discovered was that even small levels of magnetic fields, such as 60 Hertz (Hz), can have drastic effects on cancer cells in culture. Research published as early as 1985 showed quite clearly that these fields were also able to suppress metabolism. Some 15 years later, Héroux duplicated those results, and was able to determine the mechanism behind it.

## **You're in Potentially Hazardous Fields Every Day**

In the research Héroux and his student did on cancer cells, using a field of 60Hz, effects began around 20 nanotesla (nT), which is 0.02 microtesla (mT) or 0.2 milligauss (mG),<sup>1</sup> and were fully developed around 50 nT.

At levels over 160 nT, magnetic fields have also been shown to affect sperm production – and male fertility declined by about 50% between 1973 and 2013. Research<sup>2</sup> also reveals prenatal exposure to power-frequency fields can nearly triple a pregnant woman's risk of miscarriage.

These are environmental fields that most people spend a majority of their time in. Based on my own measurements, a vast majority of people never actually leave these fields; they remain in them continuously. Simply living in a home wired for electricity makes it difficult to avoid these fields – unless you take remedial action, such as turning off your circuit breaker at night. As noted by Héroux:

*"Our environment is essentially filled with these disturbances to our metabolism. From the point of view of industry, this is wonderful because this contamination, being evenly spread and present everywhere, becomes the new normal. In other words, if you don't want to be caught [poisoning] the population, expose them all at the same time so that there is no reference population."*

Sam Milham, whom I interviewed on the topic of dirty electricity, did some amazing investigative epidemiological work showing radical differences in disease prevalence between rural and urban populations between 1900 and 1950. Once that rural population became electrified, their disease rates converged with the urban ones, to the point that they are now near-identical. "I strongly believe that to be one of the most important observations of this century," Héroux says.

## **Mechanism of Action – How EMFs Cause Harm**

The mechanism of action proposed by Héroux involves the enzyme ATP synthase, which passes currents of protons through a water channel (similar to current passing through a wire). The protons have to go through about 20 molecules of water to get through this channel. ATP synthase is extremely ancient and common to all living systems. It basically generates energy in the form ATP from ADP, using this flow of protons.

Magnetic fields can change the transparency of the water channel to protons, thereby reducing the current. As a result, you get less ATP, which can have systemwide consequences, from promoting chronic disease and infertility to lowering intelligence. Héroux explains:

*"When you impair the flow of protons to ATP synthase, you increase mitochondrial membrane polarization ... If you increase the polarization of the mitochondria by 14 percent, you will have a 70 percent increase in the reactive oxygen species coming out of complex one, which is the leading edge of the oxidative phosphorylation chain.*

*Essentially, my explanation is that by physical action on water, you can change the transparency of the most critical enzyme in the human body, modulate the amount of ATP, increase the escape of electrons from complex one; thereby explaining practically all of the observations related to EMF.*

*Of course, the moment ATP is perturbed in a cell, there are calcium signals being emitted all over the place, because calcium is possibly the most critical intracellular messenger."*

## **EMFs Trigger Massive Oxidative Stress**

Although slightly different from Martin Pall's work, which shows that EMFs activate voltage-gated calcium channels (VGCCs) in the outer membrane of the cell, it is consistent with increased oxidative stress and decreased ATP. Pall believes that when activated by EMFs, these VGCCs open up, allowing for a massive influx of calcium. This excess intracellular calcium and associated calcium signaling are responsible for most of the biological effects we see.

Héroux is not convinced that low fields can substantially alter the behavior of VGCCs or the behavior of calcium ions in solution. He believes it's not calcium ions that are being directly acted on.

Rather, what's being acted on are electrons and protons, which are far more sensitive to magnetic fields. Still, the outcome is the same. In a nutshell, what we're talking about here is the creation of excess oxidative stress, which in turn can damage cell membranes and proteins, and break DNA bonds.

It's not the energy in the electromagnetic frequency that catalyzes this process, rather it's secondary damage from the oxidative stress EMF triggers. According to Héroux, a lot of the free radical detoxification reactions involve the transfer of protons, and EMFs not only increase free radicals but also reduce our ability to get rid of them. Héroux explains:

*"The energy of the field itself is irrelevant, in a sense. The idea that you have to reach ionization potential [such as an X-ray] to create [damage] is totally wrong. You create damage because you're leaking electrons out of the phosphorylation chain. Perhaps more significantly, by altering metabolism and the production of ATP, you are confusing the programming of metabolism that has been developed over the last 2 billion years.*

*Our species can evolve and is successful in great part because we were successful at generating large amounts of ATP. If you touch that, you're going to have disturbances of metabolism that will occur over chronic exposure, which will result in increased rates of diabetes.*

*That is probably true for all types of electromagnetic radiation, be it power frequency, AM, FM or television signals. All of these have in common the property that they have fields that can affect these charges. The view that these electromagnetic fields are innocuous to biological systems is simply wrong."*

## **Killing Cancer Cells With Magnetic Fields**

While much of Héroux's research has revolved around validating the mechanisms of action, he's currently trying to design a technique using low frequency magnetic fields to kill cancer cells. "If I can do this in vitro, in a powerful way, then this should be

transferable fairly easily in animals," he says. "In the past, we were able to kill cancer cells within one day or two, simply by selecting the correct magnetic field."

Héroux believes this strategy should work on most cancer cells, but he's only tested the ability to suppress metabolism in two different types of cancer cells so far. Cancer cells have the peculiar characteristic that they have crests of very high demand for ATP, meaning at a certain point in their development, they require very high amounts of energy to keep thriving.

By suppressing ATP synthase, which produces 80% to 90% of the ATP in a cell, the cancer cell is not going to be able to survive. And, as mentioned, suppressing ATP synthase is what magnetic fields do. "If you add a little glycolytic suppression in there, this [cancer] cell will have practically nowhere to go," he says. If this turns out to be a viable strategy, it would likely be a far safer alternative to ionizing radiation or radiotherapy currently used.

Certain fields also have other beneficial uses. Pulsed fields have been successfully used to help regenerate bone, for example. PEMF devices also use either electrical or magnetic pulses.

*"The first people who looked for biological stimulation were using electric fields, but magnetic fields have substantial advantages because they penetrate the body fairly easily compared to electric fields," Héroux says.*

*"Usually, [PEMF devices] are designed to enrich in bandwidth the signal that is going into the biological system, because they are meant to alert ... biological systems that change is needed. Having pulses creates a wide bandwidth that solicits a lot of biological systems simultaneously."*

## **Practical Mitigation Strategies for Daily Exposures**

As mentioned, it's very difficult to get below 40 nT (0.4 mG) indoors, and even at this level ATP synthase is being suppressed which, again, produces oxidative stress. So, what can you do to mitigate this kind of exposure?

*"I think the damage is serious to cells and is extensive. I believe, like Milham does, that cancer rates have been influenced by these chronic exposures ... [T]he International Agency for Research on Cancer ... confirms a connection between childhood leukemia and fields of, say, 100 nT. So, if you have children, make sure they are not exposed to high magnetic fields a lot of the time.*

*In other words, make sure their beds are not near a baseboard heater. If you can, get an inexpensive instrument and make sure your young children are not at three- or fourfold risk of leukemia because of this uncontrolled agent that we have in your houses."*

As a general rule, magnetic fields are typically associated with electric fields, so if you have an electric cord coming out of your wall or a transformer (i.e., a charging device), you'll have pretty high magnetic fields in addition to electric fields, and you'll want to minimize both. Cellphone chargers, for example, are not grounded, which massively worsens the field, and you don't reach relatively safe levels until you're about 3 feet away from the charger.

As noted by Héroux, most all portable charging devices are designed to be very light and compact, and do not have any kind of electromagnetic shielding. This allows them to leak power, and for the devices they're powering, power leakage is not very important. "It's an engineering design based on the false information that these fields spewing into the environment don't matter," he says.

So, to avoid excessive exposure, charge your electronics in an area of your home as far away from where you spend most of your time as possible. Also make sure your cellphone and tablets are in airplane mode, and do not have Bluetooth or Wi-Fi activated, when not in use.

## **EMF Mitigation Is an Important Health Consideration**

The evidence that EMFs cause harm is both clear and convincing, and we all need to take precautions to protect ourselves. Héroux also believes we need to do more to



convince engineers to take the matter seriously and design devices and technologies that offer better protection. "Ultimately, we will have to convince them that these fields are dangerous," he says. "Otherwise, it will always be an individual effort, which will be very difficult to sustain."

Alasdair Phillips, an electrical engineer who runs Power Watch in England, is currently in the process of contacting a number of companies that make plugin transformers (device chargers) to create a grounded, shielded version. They just don't make them anymore, but they certainly can. We can go back to the old ones.

If there's a demand, as I hope to create through these educational efforts, companies will start to produce them. So, it's really just a matter of creating awareness, and continuing to ask manufacturers for grounded and shielded devices. Hopefully, this and my many other expert interviews have inspired you to take action to protect your health, and the health of your loved ones.

## Sources and References

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- [1 Conversion calculator](#)
- [2 Scientific Reports 2017; 7 Article number 17541](#)