AboutKidsHealth
*Trusted answers from The Hospital for Sick Children*

# Electromagnetic radiation and cancer fears

**Do power lines or cell phones cause cancer? For almost 30 years, scientists have been struggling to answer this question. It sounds simple, but it's not.**

In a suburban Denver neighbourhood in the late 1970s, a surplus of children with surgery scars and post-chemotherapy haircuts raised a mother's concerns. Casting about for a cause, her suspicions came to rest on nearby electrical power lines and the electromagnetic fields they generate.

Now, nearly 30 years later, the concern over electromagnetic radiation covers several wavelengths and many conditions, including brain tumours, early senility, autism, and inattention and learning difficulties.

One of the first epidemiological studies to indicate a health risk was a 1979 study by psychologist Dr. Nancy Wertheimer and physicist Ed Leeper. They found a two- to three-fold increase in cancer deaths among children living near high current power lines in Denver. The concern over mobile telephones, with their emission of radio frequency (RF) radiation, emerged much later, in the early 1990s. The two kinds of radiation are not at all similar, but the two issues are often grouped together. Almost thirty years after the questions were first raised, scientists in several fields are still trying to figure out whether these fears are justified.

*Illustration by Carey Sookocheff*

## Electromagnetic field exposure is growing

Everyone in today's society is exposed to some level of electromagnetic radiation. Toronto Hydro is planning to broadcast wireless internet data on radio waves around the city core, and Nicholas Negroponte's One Laptop Per Child project hopes to distribute millions of portable computers with wireless data capabilities, in the developing world. Meanwhile, power companies describe a persistent increase in electrical usage, resulting in greater exposure. Do these exposures affect our health, or the health of our children?

The Canadian Childhood Cancer Surveillance and Control Program gathers and distributes information on cancer in infants, children, and adolescents. Their figures for 2002 reveal approximately 250 childhood deaths attributed to cancer. "Few of these cancer cases are explained by known risk factors, like genetics or exposure to ionizing radiation. With some adult cancers, prevention has been very effective, but it's hard to prevent cancers if you don't know what's causing them," says Dr. Eric Bouffet, Neuro-oncologist and Director of the Paediatric Brain Tumour Program at The Hospital for Sick Children in Toronto.

On the face of it, 90% of childhood cancer appears to be due to a bad roll of the dice. But are these cancers truly random, or are they due to factors we don't yet understand? Could one of those factors be mobile phone use or electromagnetic fields from power lines?

So far, the scientific community is in disagreement. In one case, UK epidemiologist Dr. Helen Dolk found in 1997 that a large radio transmission antenna at Sutton Coldfield was increasing the rate of adult leukemia and skin cancer in residents living within 2 km. She then went on to study 20 very similar masts elsewhere in the UK and found that they had no such effect. Both studies were published in the same journal at the same time, providing an encapsulation of the ups and downs of this contentious field of study.

## Fighting words: Electromagnetic radiation

"Electromagnetic radiation" sounds both frightening and complicated. Actually, the phrase simply means "light and everything like it." Starting from our familiar visible colours of light, the increasingly blue direction means the light waves are shorter, leading to ultraviolet, X-rays, gamma rays, and cosmic rays. Each decrease in wavelength brings greater energy and destructive potential. In the opposite, increasingly red direction, the energy decreases, and the radiation is called infrared, microwave (or radio frequency), then low frequency and extremely low frequency (ELF).

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Across this spectrum, the energy of the radiation is carried in tiny bundles called photons. X-ray photons, a known carcinogen, are about a million times more energetic than RF radiation, which carry about a thousand times more energy than ELF radiation, produced by power lines. To see it another way, imagine:

- a 1 tonne subcompact car hits you at 60 km/h. Ouch!
- a 1 g dragonfly hits you at its top speed, also 60 km/h.
- a 2 mg mosquito flits into you at 15 km/h.

The energy difference between these impacts is equivalent to the difference between single photons of x-ray radiation, radio, or ELF radiation.

## Mechanism lacking

One reason for the controversy around RF and ELF radiation is the lack of a biological mechanism, a description of exactly how either one could harm living things.

Dr. Mark Greenberg, a paediatric oncologist at The Hospital for Sick Children, has studied a group of Toronto-area children with acute lymphoblastic leukemia, or ALL, a bone-marrow cancer. As reported in *Cancer Causes and Control*, exposure to stronger magnetic fields was associated with a two-fold increase in risk of developing ALL.

Dr. Greenberg explained at the time that although the association was worrying, "We don't know what it means, however, because there is no good biologic explanation for how such exposure might work."

So far, no one can explain convincingly how these photons, carrying less energy than visible light, could hurt the body's cells. It's a little like a murder trial in which the prosecutor has to convince a jury that the victim was fatally attacked with cotton balls.

Fortunately, experiments like Dr. Greenberg's can detect and raise concern about possible risks even when the mechanism isn't understood.

## Measuring real-world risks

Experiments based on observing a real population, some of whom are exposed to a potential hazard, are called case-control studies. They work like this:

- Find a similar number of volunteers who have and do not have a specific illness, such as ALL. These are the cases and the controls.
- Gather information about their exposure to your suspected cause by asking them questions, or measuring the presence of the hazard in their homes.
- Then divide them into lower and higher risk groups based on their exposure.
- Now, if exposure doesn't actually increase the risk of disease, there will be just as many control subjects as there are cases in the high and low risk categories. Your "high risk" group wasn't actually risky.
- On the other hand, if exposure is a serious risk factor, then there will be fewer unaffected controls in the high risk category, and fewer cases in the low-risk category.

Researchers have to make sure that cases aren't exposed to more cigarette smoke than controls, along with many other confounding factors. Much of the long-running argument about RF and ELF studies is about finding control subjects who won't tilt the experiment one way or the other.

## Interpreting epidemiological statistics: Playing the odds with confidence

The outcome of these experiments is usually summed up as an "odds ratio." This number means that someone in a high risk category is, for instance, about twice as likely to develop ALL as someone in a low risk category; that's an odds ratio of 2. While that might sound alarming, many risk factors are actually much more powerful than this; for instance, smoking raises your risk of getting lung cancer to about 30 times the risk for someone who never smoked.

An odds ratio of 1.0 means no effect. So if the researchers are 95% sure that the odds ratio is between 0.9 and 3.0, their study does not provide statistically significant evidence that the "hazard" investigated is real.

Some studies of high levels of ELF radiation conclude that it poses a statistically real risk of ALL in children, approximately doubling the odds a child will battle this cancer. A somewhat larger number of studies say radiation from power lines, house wiring, and electrical appliances is not a significant risk factor. Other cancers were pursued as well, but the answers with skin, breast, brain, and other kinds of bone marrow cancer were mostly negative.

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## Measuring and estimating electromagnetic fields

Electrical current flowing back and forth through a wire 60 times per second creates electrical and magnetic fields around it. When the concern over electromagnetic fields from power lines began, there were no portable meters sensitive enough to detect the strength of these fields. As sensitive meters became available in the late 1980s, researchers started to measure fields as well as estimate them based on power line distance and current. In most studies where exposure is measured rather than estimated, the effect of the fields seems to drop, and children with higher measured exposures are often not significantly more likely to develop cancer.

This is vexing for researchers, especially when in the same studies, with the same children and the same homes, the estimated field strengths still seem to increase a child's risk of cancer.

Epidemiologists are also used to seeing a relationship between dose and response, because generally more exposure makes more people sicker than less. This expected relationship has only sometimes seen with electromagnetic fields, whether they were measured or estimated.

## Children are different

Large studies of adult cell phone users in Denmark, Sweden, and the UK were published in 2005 and 2006. These inquiries concluded that RF radiation from mobile phones is not a cause of glioma, a cancer of the brain's supportive glial cells. But it's not quite time to consider the controversy over. Children are not small adults, and several differences could be important in the way they are affected by ELF and RF radiation:

- Hormones are at work, causing their bones, brains, and muscles to grow. Growing tissues are at greater risk of cancer, which is basically uncontrolled growth.
- They have thinner bones, especially their skulls, which may allow more radiation to penetrate.
- Children spend more time outdoors than adults.

In late 2005, a large body of research on RF radiation from mobile telephones and ELF radiation from power lines was reviewed in several articles in a supplement to the journal *Bioelectromagnetics*. The scientists involved mostly indicated that there was no convincing evidence that either type of radiation was doing harm to fetuses or children, but they left the door open by identifying numerous ways that future research could be more sensitive to possible effects.

## The scale of the problem

Prof. Anders Ahlbom, a Swedish epidemiologist whose studies are frequently quoted by industry critics demanding changes in how power lines are deployed, has put the issue in perspective this way: "We're debating whether or not at most one childhood leukemia per year out of [Sweden's] 70 might be attributed to high voltage power lines." This is because few children are exposed to high levels of ELF radiation. In Canada, all childhood leukemias combined cause about 55 deaths each year, most of them far from power lines. All brain tumours combined kill about 50 children under 15 each year. These numbers are certainly not trivial, but they also don't justify the alarmist headlines that often surround these issues.

## Saving lives by the numbers

So what should parents or soon-to-be parents do? The Motherisk program at Toronto's Hospital for Sick Children allows researchers to explore the risks posed by drugs, chemicals, disease, and environmental factors during pregnancy and lactation, and offers counselling based on their findings and expertise. Dr. Gideon Koren, the program's director, suggests pregnant women "Avoid smoking and drinking. Eat appropriately and take folic acid." And he offers another caution you might not have heard: "Don't take a sauna or a hot whirlpool bath. Raising your core body temperature risks damage to the fetus' central nervous system." Electromagnetic fields are not on Dr. Koren's high priority hit list.

Once children are safely born, cancer is a smaller risk than what we all call "accidents," especially traffic accidents. Safe Kids Canada estimates that about 900 children and youth die each year from accidents that are avoidable. One big risk factor is not having proper restraint inside a car: child car seats reduce the risk of injury by 70%. You might also want to avoid talking on your cell phone while driving.

Another life-saver is the simple bike helmet. A four year study published in Pediatrics compared provinces with and without helmet laws. The conclusion was that 170 hospitalizations for head injuries to child cyclists could be prevented each year, if the other provinces would join BC, PEI, Nova Scotia and New Brunswick. These provinces require all cyclists, adult and child, to don protective headgear. How does adult behaviour influence child injury? A study led by researchers from The Hospital for Sick Children found that children were about 100 times more likely to own and use a bicycle helmet if their parents used a bicycle helmet themselves. No matter how you look at the risks, that is a huge protective factor. It's also much easier than moving your house away from those power lines.

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## Resources

Motherisk offers evidence-based advice on exposure to drugs, chemicals, disease, and environmental factors during pregnancy and lactation.
http://www.motherisk.org

Surveillance and Risk Assessment Division, Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada.
http://dsol-smed.phac-aspc.gc.ca/dsol-smed/cancer/index_e.html

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