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Weak Kilohertz Electric Fields Kill Tumor Cells

Current EMF Paradigm at Risk

It's become axiomatic that wide acceptance of non-thermal effects will come from developing biomedical therapies rather than from studying potential hazards. The health effects work is mostly sponsored by those who don't want to find any. And they usually don't (cf: the USAF, EPRI, CTIA, FGF, MMF etc.) So no one should be surprised that the latest advance comes from a small high-tech Israeli company, **NovoCure**, which is looking for innovative ways to treat cancer. It's a breakthrough—most likely a major breakthrough.

NovoCure uses weak 100-200 kHz electric fields—the company calls them tumor treating fields or TTFields—to stunt the growth of cancer cells, either by slowing down their proliferation or by killing them off entirely. The company has now demonstrated this in four different cancer cell lines. Even more impressive is that tumor growth has been curtailed in mice, rats and, in a small pilot project, ten human patients with recurrent brain tumors (glioblastoma).

In the human clinical trial, the median overall survival time more than doubled compared to historical controls. One patient was tumor-free after treatment, and the cancer had not reappeared ten months later. Details on the *in vitro*, *in vivo* and human studies appear in a **paper** published on June 12 in the *Proceedings of the National Academy of Sciences* (*PNAS*). (The complete paper is available at no charge. An earlier **paper** on the *in vitro* work, published in *Cancer Research*, is also available for free. Both journals are highly prestigious.)

"It's very exciting," Abe Liboff, the coeditor of *Electromagnetic Biology and Medicine*, told *Microwave News*. "The *in vitro* results are fascinating, but the *in vivo* results are really spectacular."

The intensity of the applied fields was relatively low, on the order of 200 V/m. The observed effect is clearly non-thermal, according to the NovoCure team. (For comparison, the IEEE exposure guidelines at these frequencies allow workers to be exposed on the job to 1,842 V/m.)

Among the team's other findings are:

• The observed effect is frequency dependent. The growth of a particular cell type is most affected at a specific frequency. For instance, mouse melanoma cells were optimally disrupted at 100 kHz, while the maximum inhibition of rat glioma cells was at 200 kHz. A similar dependency was found in live animals: rats with intracerebral glioma were unaffected by 100 kHz TTFields,

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but 200 kHz signals "cause significant inhibition of tumor growth."

• Only the growth of dividing cells was inhibited. Non-proliferating cells were unaffected. (This should limit possible side effects.) The NovoCure team explains that the applied field is uniform in quiescent cells, but not during cell division. The asymmetry of the applied forces during cell division leads to the observed effect. (Back in 1990, Robert Liburdy's lab at the Lawrence Berkeley Laboratory **showed** that there was a greater EMF effect for activated cells than for dormant cells. But like so many other leads, this one was never followed up.)

• The orientation of the field is a critical variable.

Much of what NovoCure had found experimentally flies in the face of the prevailing dogma in EMF health research. The company is well aware of this. In the *PNAS* paper, the team noted that " it is generally believed that AC fields of 100 kHz or above have no meaningful biological effects," other than heating at much higher levels. If the NovoCure results win acceptance, it would force a complete reappraisal of the nature and extent of EMF biological effects.

"For too long, EMF/RF dogma has regarded a human being as a bag of water and the only effect of electromagnetic energy is to raise its temperature. This new work illustrates how more realistic models can lead to striking and important results," Allan Frey, a well-known RF researcher based in Potomac, MD, told *Microwave News*.

In an interview, Jerry Phillips, a member of Ross Adey's lab at the VA Hospital in Loma Linda during the 1990s, recalled that he had sent NIH a grant proposal to study changes caused by applied fields during various cell processes. The study was not funded because, he was told, "The scientific basis was at best soft." Phillips said that NIH staff routinely advised him to withdraw proposals that went against the grain of what they said was mainstream science, in general, and EMF science, in particular.

NovoCure predicts that "there is a high probability that TTFields may prove to be an effective and safe therapeutic modality to a large number of human cancers." This would be huge. But Liboff thinks this is just the beginning: He sees the Israeli research as a harbinger of major changes for the entire field of electromagnetic medicine. "This is a real victory," he said. "This paper will help take the field to the next step."

To learn more, check out the following:

" **Can an Electric Hat Fight Tumors?**" on *Science* magazine's Web site;
" **Tin-Foil Hats Are Good for Something?**" on the " Angry Toxicologist" Web site;
NIH Web site on Novocure's **ongoing clinical trial** to treat brain tumors;
A **video** of a presentation by a NovoCure representative;
A **NovoCure video** showing what happens to a cell when it attempts to divide in the presence of a kHz field.