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FOR WHOM THE CELL TOLLS

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Why your phone may (or may not) be killing you
By Nathaniel Rich

On April 28, 1995, the day that changed his life forever, the day “God slapped me in the head with a two-by-four and said, ‘Would you pay attention here?’” Lloyd Morgan had lunch with a colleague at a strip-mall Indian restaurant in Milpitas, California. The two men were discussing office politics when Morgan suddenly tilted sideways in his banquette, the fake-leather seat rising to slap his cheek. In the moment before he lost consciousness, he saw his colleague standing over him in an awkward, bent position, saying, “Lloyd? Lloyd? Lloyd?” For the next forty-five minutes, Morgan convulsed like a man in an electric chair, the victim of a grand mal seizure. Every muscle in his body clenched and unclenched, his bowels emptied, and he cracked a tooth.

At the hospital, a doctor explained to Morgan that his seizure had been caused by a brain tumor the size of a large peach. The good news was that the tumor, a meningioma, was benign

Nathaniel Rich is the author of The Mayor's Tongue. He is at work on his second novel, which is about worst-case scenarios.

and could be removed. (Morgan loathes the term “benign.” “It’s sloppy language. As far as I’m concerned, there’s no such



thing as a benign brain tumor. Anything will kill you if it grows forever.”) The bad news was that the tumor was stuck “like epoxy” to his sagittal sinus vein, meaning that the slightest slip of the surgeon’s knife and Morgan would be dead. But over the course of the twelve-hour operation the surgeon did not falter, and less than two weeks later Morgan was home.

Yet throughout the four months of his convalescence, Morgan couldn’t stop thinking about a conversation

he’d had with his neurosurgeon during his hospital stay. The doctor had remarked, offhandedly, that in recent

years he had seen an unusually high number of brain tumors.

“So what’s going on?” asked Morgan. “Why did I get this?”

“If I knew that, I’d win the Nobel Prize.”

“But if you had to guess, what would you say?”

“Perhaps,” said the neurosurgeon, committing what must surely be a violation of the Hippocratic Oath, “electromagnetic fields.”

Morgan had never heard anything like this before. As soon as he was well enough to read, he

hunted down every paper he could find about the effect of electromagnetic fields, or EMFs, on human health. He came across one study in *Risk Analysis* that showed a partial correlation between electromagnetic radiation and the risk of leukemia. An article in a German journal, *Radiation and Environmental Biophysics*, indicated “a marginal association between all cancer diagnoses combined and EMF exposure.” And a meta-analysis in the *Journal of Occupational and*

Environmental Medicine showed that workers with high exposure to EMFs had a 10 to 20 percent increased risk of brain tumors. Where other observers—including many of the authors of these studies—detected mathematically insignificant results, routine fluctuations in data, Morgan saw incontrovertible evidence that something cataclysmic was occurring. He believed that he had made a horrifying and monumental discovery.

“Looking back,” says Morgan today, “that tumor was the best thing that ever happened to me.”

Morgan was in the vanguard of what, fifteen years later, is a growing movement of activists who believe we are witnessing the advent of a catastrophe: a brain-cancer epidemic that would be the largest public-health crisis in the history of the human race. Since Morgan’s “eureka” moment, the market for cell phones—which emit low-frequency electromagnetic radiation—has grown to 4.1 billion people, more than 60 percent of the earth’s population. This figure continues to rise, thanks to recent expansion in two high-growth sectors: the developing world and children under eleven. Fears about EMF safety have been the subject of two recent congressional hearings and have spurred the European Parliament to pass, with a near-unanimous vote, a resolution urging stricter exposure limits on mobile-phone radiation; France has gone so far as to propose outlawing the sale of cell phones to children. Since these measures have provoked derision from physicists and biologists across the globe, a brief review of the science is in order.

Electromagnetic radiation is as old as the universe. We spend our lives immersed in it. Until the twentieth century, the greatest emitter of electromagnetic radiation known to man was the sun. Today, however, man-made EMFs overwhelm natural ones in developed areas. Every object that generates an electric charge creates an electromagnetic field. Radio and television signals are forms of electromagnetic radiation. Whenever you walk down the street you pass through innumerable overlapping

fields, as obliviously as a bird crosses national borders or an airplane passenger enters new time zones.

Electromagnetic radiation is not only everywhere; it is forever. It diminishes in strength the farther it travels from its source, but it never disappears. Long after the sun devours the earth, man-made electromagnetic waves will continue their march through the universe at the speed of light. At the time of this article’s publication, for instance, Orson Welles’s 1938 *War of the Worlds* radio broadcast will be streaming over the star Epsilon Cygni, seventy-two light-years away.

Not all radiation is created equal. High-frequency electromagnetic radiation—nuclear radiation, X-rays, even the ultraviolet rays of a tanning booth—is powerful enough to break chemical bonds, creating highly unstable atoms called ions. Ionizing radiation harms the cells of living tissue: it damages DNA and increases the risk of cancer. These facts are no longer disputed, though it took sixty years of poorly regulated X-ray use, and corresponding spikes in cancer-incidence rates, before scientists fully understood the dangers involved.

Today’s controversy focuses on the lower part of the electromagnetic spectrum. These waves—frequencies below 300 GHz—are considered too weak to damage human tissue. If they indeed cause biological damage, then they must do so in ways unexplained by conventional science.

First in 1976, and then in 1989 and 1990, *The New Yorker* published a series of chilling articles by Paul Brodeur presenting evidence that exposure to extremely low-frequency electromagnetic radiation—from power lines, radar antennae, and video-display terminals—increased the risk of cancer. The mainstream medical and scientific community dismissed these studies, and Brodeur himself came under attack. Yet there was a turning point in 2000, when a team of eminent epidemiologists concluded, based on the studies to date, that high exposure to these EMFs doubled the risk of childhood leukemia. The following year, the International Agency for Research

on Cancer (IARC), an arm of the World Health Organization, made the decision to classify extremely low-frequency EMFs, such as those emitted by power lines, as a Group 2B agent: a possible human carcinogen. This was a major triumph for those concerned about such radiation. It is worth noting, however, that Group 2B also includes such agents as carbon black (an ingredient of photocopying toner), acetaldehyde (produced when the body metabolizes alcohol), pickled vegetables, and coffee.

The farther one is from the source of a field, and the less time one spends in it, the weaker its effect. So anyone worried about exposure to low-frequency radiation could avoid buying a home situated near a power line, stand away from the microwave oven, sit at a reasonable distance from the television, and avoid resting a radar gun on one’s lap. But by the late 1990s, it had become increasingly difficult to avoid direct exposure. In fact, it became common practice to press an EMF emitter to your brain for many minutes, and even hours, every day, for the rest of your life.

Cellular phones emit radiation at a frequency between 450 and 2700 MHz. This is significantly higher than the extremely low-frequency EMFs (50–60 Hz) that concerned Paul Brodeur, but still two orders of magnitude below the level at which radiation can heat human tissue (300 GHz). A cell phone gives off roughly the same frequency of radiation as a microwave oven; scientists sometimes describe cell-phone radiation as microwave radiation. In the past decade, hundreds of experiments have been conducted to determine whether cell-phone radiation might have any effect on human health. Here are some of the findings:

- Exposure to cell-phone radiation hampers one’s ability to fall asleep.¹ Exposure to cell-phone radiation makes one sleepy.² Exposure to cell-phone

¹ Hung et al. (2007).

² Mann and Roschke (2004), Loughran et al. (2005).

radiation has no effect on sleep patterns.³

- Cell-phone radiation slows one's cognitive reaction time.⁴ It makes one think faster.⁵ It has no effect on cognitive ability.⁶
- Cell-phone radiation reduces sperm count and sperm motility and increases the number of abnormal sperm.⁷ Cell-phone radiation does not harm the testicles.⁸
- Exposure to cell-phone radiation leads to single- and double-strand breaks in DNA and to numerous other forms of genetic damage.⁹ Exposure has no significant effect on DNA.¹⁰ The negative (no effect) studies outweigh the positive, and the reason the incriminating studies showed anything at all was that they were poorly, even incompetently, designed.¹¹
- The brain of a child absorbs a much greater amount of radiation from a cell phone than does the brain of an adult.¹² No, it does not.¹³ The absorption rate is twice as high, but only for children under eight.¹⁴
- The majority of studies on cell phones and human health have received funding from the telecommunications industry. Industry-funded studies are significantly more likely than independent studies to show that cell phones are safe.¹⁵

³Wagner et al. (2000), Huber et al. (2000).

⁴Cao et al. (2000), Maier et al. (2004).

⁵Koivisto et al. (2000a, b), Jech et al. (2001), Lee et al. (2001), Edelstyn and Oldershaw (2002), Keetley et al. (2006).

⁶Haarala et al. (2003), Basset et al. (2005), Russo et al. (2006), Terao et al. (2006), Cinel et al. (2007).

⁷Dasdag et al. (1999), Erogul et al. (2006), Yan et al. (2007), Subbotina et al. (2007), Agarwal et al. (2008), De Luliis et al. (2009), Mailankot et al. (2009).

⁸Dasdag et al. (2003, 2008), Ozguner et al. (2005), Aitken et al. (2005), Ribeiro et al. (2007), Pourlis (2009).

⁹Phillips et al. (1998), Tice et al. (2002), Diem et al. (2005), Gandhi and Anita (2005).

¹⁰Li et al. (2001), Hook et al. (2004), Aitkens et al. (2005), Stronati et al. (2006).

¹¹Brusick et al. (1998), Meltz (2003), Vijayalaxmi and Prihoda (2008).

¹²Gandhi and Kang (2002).

¹³Schönborn et al. (1998).

¹⁴Wuart et al. (2008).

¹⁵Huss et al. (2008).

Most epidemiological studies of regular cell-phone use for less than ten years have yielded no evidence that the phones cause brain tumors.¹⁶ (There has been one notable,¹⁷ if disputed,¹⁸ exception.) Recently there have emerged the first studies to follow regular cell-phone users for longer than ten years. In these studies, the findings remain inconsistent—except in one category: When a person is accustomed to holding his phone to one side of his head, he has an increased risk of tumor incidence on that same side of his head.¹⁹

Numerous international and U.S. agencies—the WHO, the European Commission's Scientific Committee on Emerging and Newly Identified Health Risks, the National Institutes of Health, the Federal Communications Commission, the Food and Drug Administration, the American Cancer Society, and the National Cancer Institute—have reviewed the evidence and concluded that cell-phone radiation does not present any health risks. Several of these agencies have recommended further experiments to evaluate the effects of long-term use.

Yet a loose network of private citizens, who share an acute distrust of what they call "mainstream" science, has declared war on cell phones and other forms of low-frequency EMFs. They communicate by land line and email, exchanging new information and gossip daily. They read specialized newsletters, particularly Louis Slesin's *Microwave News*, which since 1981 has followed the EMF controversy with a degree of scrutiny and comprehensiveness that must be seen

¹⁶Advisory Group on Non-Ionising Radiation, United Kingdom Health Protection Agency (2003); Moulder et al. (2005); Krewski et al. (2007); Scientific Committee on Emerging and Newly Identified Health Risks, European Commission (2009); Ahlbom et al. (2009).

¹⁷Hardell et al. (1999, 2001, 2002, 2005).

¹⁸Rothman (2000), Elwood (2003), Boice and McLaughlin (2006).

¹⁹Hardell et al. (above), Lönn et al. (2005), Hepworth et al. (2006). *The risk of a tumor on the side of the head of a reported phone user increases in these studies anywhere from 24 percent (Hepworth) to 400 percent (Hardell).*

to be believed (it reported on this very article, for instance, nearly a year ago, soon after I received the assignment). They work from home offices in Berkeley, Tucson, New York, and Santa Barbara, but rarely do they meet in person. Only in the past two years have their efforts begun to gain momentum: the two congressional hearings on concerns over cell-phone radiation, as well as efforts by local politicians in Maine and San Francisco to put warning labels on phones, have received national press attention. These EMF activists have devoted their lives to exposing the perils of this new technology before it is too late. That, however, may be understating the case. Most of them believe it is already too late.

“You can't say there's no evidence,” Lloyd Morgan shouted at me, in his Berkeley apartment. “There is evidence.” Morgan's bright blue eyes twinkle whenever he says something particularly menacing, though his attitude is always avuncular, kindly, enthusiastic; when making his arguments he has the giddiness of a mathematics professor explaining an unusually elegant proof or an archaeologist unearthing a biblical relic. Even when he pronounces his direst predictions—“In about fifteen years, we're going to have a pandemic of brain cancers that will be the worst pandemic we've ever seen, worse than the Black Plague”—he appears less frightened than awed. Morgan doesn't see himself as a crusader, but there is a spiritual intensity to him. He converted to Judaism not long after his tumor was removed, and on this day, the Sabbath, he wears a blue kippah that matches the color of his eyes. Why Judaism? “In American culture, if you disagree with somebody, you are seen as personally assaulting them. If you have fifty people in a Torah study, you have seventy-five points of view. I was attracted to that intellectual process.”

Morgan's office, which he calls “Action Central,” is the size of a large closet. It is packed with filing cabinets, spreadsheets dense with numbers, archived copies of the *Bioelectromagnet-*

ics Newsletter, and a well-thumbed paperback titled *Congress at Your Fingertips*. There are two computers: a PC, on which Morgan does his daily statistical analysis, and an ancient Macintosh Performa, which stores data collected during the Nineties. On the wall hangs a framed pencil sketch of Don Quixote and Sancho Panza: “The symbol for my work life.”

The office was too small for two people, so we sat in his living room. Out the window the Richmond BART train clattered by every few minutes. Almost as often, Morgan leaped out of his chair to find a book from his shelf to hand to me: David Michaels’s *Doubt Is Their Product: How Industry’s Assault on Science Threatens Your Health*, Nassim Nicholas Taleb’s *The Black Swan: The Impact of the Highly Improbable*, Western Electric Company’s 1956 *Statistical Quality Control Handbook*.

Morgan’s obsession with probability and statistics makes sense, because brain tumors are a highly improbable occurrence: 19 in 100,000 Americans will be diagnosed with one in any given year. When Morgan began his research, he first tried to determine whether his neurosurgeon’s observation reflected a larger trend—whether brain tumors like the one cut out of his own head were, in fact, becoming more common. He discovered that most states did not keep records on the incidence of benign (or non-malignant) tumors, so he helped to write a bill that required the collection of this information, and he petitioned state representatives to bring it before the California legislature. After it was signed into law, Morgan fought for its passage on the national level, and in 2002, Congress passed the Benign Brain Tumor Cancer Registries Amendment Act.

The resulting data has been ambiguous. The incidence of non-malignant tumors in the United

States increased every year between 2000 and 2004, at a rate the Central Brain Tumor Registry of the United States called “significant.” Yet during the same period, the overall rate of brain tumors declined, and between 2004 and 2006, the incidence of non-malignant tumors held steady. (More recent years have yet to be reported.)

Morgan is now lobbying for a more ambitious bill. (Disliking the term “lobbyist,” he calls himself “Chief Cheerleader.”) If passed, the National

improbable singularities. After graduating from Berkeley with an electrical-engineering degree, he found jobs during the Seventies and Eighties as a design engineer at computer companies—Qantel, Castelle, Northstar, and, later, Lucasfilm. He learned that a device that tests perfectly in a limited run begins to show flaws once you produce it in gigantic quantities. Morgan’s job was to investigate these flaws. Why did a microchip malfunction one out of every billion cycles, causing an entire



Childhood Brain Tumor Prevention Network Act would provide funding for and mandate further research into the origins of childhood tumors. Brain tumors—having recently edged out leukemia—are now the leading cause of death from cancer for children under the age of fourteen, but we still don’t know what causes them. Morgan signs every email he sends with the tag IF WE DON’T LOOK, WE CAN’T FIND.

This work comes naturally to Morgan. Long before he retired in 2002 to study brain-tumor statistics full time, he had made a career out of burrowing through mountains of data in the hope of finding highly

computer system to crash? “It was the most esoteric kind of troubleshooting,” said Morgan. “But the stakes were high. The fate of the company was on the line.”

Whenever a new paper on brain tumors is published, Morgan creates a set of spreadsheets on his computer. Into these spreadsheets he enters every piece of data from the study. He checks the calculations himself—the odds ratios, the confidence intervals, the specific absorption rates—making sure that the paper’s authors did their math correctly. “You’d be surprised at how often there are errors,” he said.

If he finds that any calculations were omitted, he does them himself

and enters the results in a new column, in red type. After spending six to eight hours on each report, he ends up with pages of numbers, unrolling in red and black columns. These numbers usually describe the paper's results more comprehensively than its own authors thought necessary. What he believes he is doing is "having a conversation with the data." And he refuses to read the researchers' summary until he is done. Often Morgan finds that he has reached different conclusions than the scientists did. And when this happens, he gets angry.

He was particularly upset that morning about the Interphone survey. This was not especially surprising, since nearly everyone I had spoken with about cell phones, regardless of their feelings about the issue, was upset about Interphone. Interphone was intended to be the largest and most rigorous study to date of cell phones and cancer. Coordinated by the IARC at a cost of \$30 million, Interphone employed fifty scientists in thirteen countries (the United States did not participate). It was hoped, by all parties concerned, that this mega-study would settle the matter once and for all. The results were to be announced in 2005. They still have not been published.

In exasperation, scientists in eight of the countries have gone ahead and released their findings. Taken together, the results are bizarre. Although the numbers are inconsistent, they seem to indicate a connection between cell-phone use and tumors—just not in the way one might expect. According to Morgan's analysis of the Interphone results, cell-phone use appears to *decrease* one's chance of getting a tumor.

Given the scope and complexity of the Interphone study, it is likely that these odd results were caused by methodological errors. Morgan published a piece last year in a medical journal, *Pathophysiology*, listing eleven flaws in the Interphone study that he says would have caused the risk to be underestimated. Were it not for this skewing, Morgan thinks, the risk numbers would be significantly higher across the board.

The day before our meeting, the director of the IARC announced that Interphone would finally publish a paper on brain-tumor risks from cell-phone use. It would include only results on certain types of brain cancers, however, and according to a report in *Microwave News*, it would not address the issue of tumor location relative to the regions of the brain exposed to cell-phone radiation. Morgan was beside himself about these omissions. "It's outrageous. It's deliberate. It's criminal!"

I asked him whether he enjoyed the endless calculations, the exhaustive analyses of small fluctuations in data. The hopelessness. "I'm blessed," he said, his blue eyes narrowing. "I know enough people who haven't been so lucky. I've had a brain tumor. I know what they do. You disappear as a person."

Did it occur to him that, as a brain-tumor victim, he might be ever so slightly biased?

"Yes, I have a bias because of my experience," he said, edging forward in his seat. "But I want the data. And I want it to be convincing."

The portable cellular phone was born on September 21, 1983, when the FCC approved the Motorola DynaTAC 8000X. It took ten hours to recharge, weighed twenty-eight ounces, and cost \$3,995, or \$8,700 in today's dollars. For the next dozen years, the cell phone was seen as merely a status symbol, an accessory for the rich like remote-control blinds or a personal robot. In Oliver Stone's film *Wall Street*, when Gordon Gekko strides down the beach talking on a phone the size of a football, that is a DynaTAC 8000X.

Between 1996 and 2001, the number of cell-phone subscribers in the United States nearly tripled, to 128 million. The cell phone became an essential possession, more common than the personal computer. Since then it has become more than a possession: it is now a part of who you are, a reflection of your personality. You are prodded to customize your phone to your own specifications, choosing from a wide range of applications, accesso-

ries, and ring tones. It is no coincidence that the most popular model of phone today is called the "I" phone. There are now 276 million U.S. cell-phone subscribers; the entire U.S. population is 309 million. The elderly have cell phones. Young children have cell phones. Thanks to text messaging, even the deaf have cell phones.

Advancements in handset technology have had much to do with this ubiquity. But in order for the cell phone to have any usefulness, it was necessary first to construct, very quickly, a national network of cellular towers. The telecom industry lobbied heavily for the passage of the Federal Telecommunications Act of 1996, which eliminated numerous regulations, allowing media conglomerates to absorb independent companies with ease and increase the fees charged to consumers for the use of cable television and the Internet. Buried deep in the bill, in Section 704, was a clause stating that no local government could prevent the construction of a cell tower "on the basis of the environmental effects of radio frequency emissions," so long as the emissions complied with FCC regulations. "Environmental effects" included effects on human health. The bill ensured, preemptively, that no citizen or local government could bring a lawsuit against the telecom industry due to health concerns over cell towers.

Soon after the bill's passage, Libby Kelley, a former public-health analyst at the Department of Health and Human Services, learned that a cell tower was going to be erected on the steeple of the church where her adopted son attended preschool. Church officials assured her that the tower was safe. But she was skeptical; she knew a thing or two about EMFs. They were, after all, in her genes.

Her father, Floyd Goss, spent his whole career in electricity, beginning when he worked construction on the Hoover Dam. As an undergraduate at Berkeley (where, like Lloyd Morgan, he studied electrical engineering), Goss worked as a lineman in the Mojave Desert. At

night he slept high up in the air, on wooden pallets suspended just feet beneath the transmission lines. He later became the acting general manager of L.A. Water and Power during the shadowy *Chinatown* era, when the utility was the largest and most powerful in the nation. His idea of a family vacation was to drive to the Hoover Dam, where he'd photograph his children in front of the massive electric generators. They laughed when the static electricity from the high-voltage lines made their hair fly up.

"He started working on the power lines before he conceived children," Kelley told me. "Looking at the health status of my family and the kind of illnesses we have, I realize now that we could have had a genetic effect from my father's exposure to electromagnetic fields." She can't prove anything, but her three siblings suffered from asthma, her father had abnormally high blood pressure, and she is infertile—all conditions that she believes may be connected to EMF exposure. Her father died of lung cancer and emphysema. I asked whether she believed his death was caused by electromagnetic fields. No, she said. He was a heavy smoker.

But she was haunted by her father's career, and when she learned that the church-steeple tower was part of the first wave of a massive new cell-phone infrastructure, she took action. Arguing that the "nefarious paragraph" in Section 704 violated the states' rights granted by the Tenth Amendment, she helped organize a lawsuit that was joined by citizens groups and the Communication Workers of America, the nation's largest communications union. Working from her kitchen, a fax machine propped on her stove, Kelley issued press releases and raised money for court fees. Almost overnight, she became the voice of the anti-EMF movement. But she

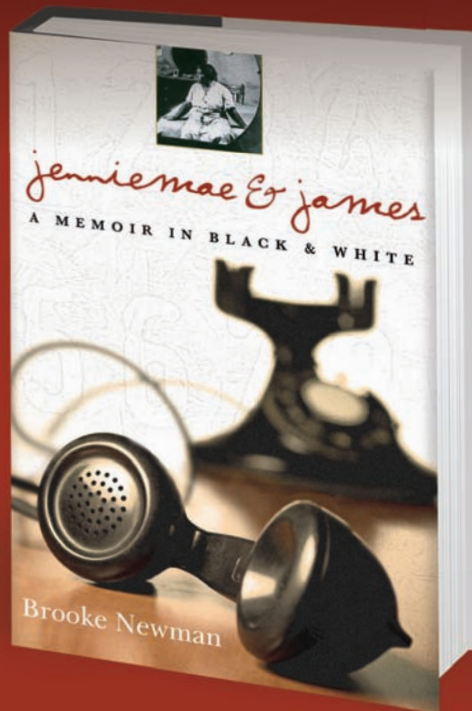
was outmatched by the FCC, which received legal support from the telecom industry. The case ultimately advanced to the Supreme Court, where, in 2001, it was denied further appeal without comment.

Kelley might have returned to her public-policy career at this point were it not for the peculiar things that began happening to her. Unmarked vans lurked in front of her house, her security alarm blared at odd hours, her home was broken

into and files relating to her cell-phone research were stolen, and a man threatened her son in public. This all began around the time she started speaking publicly about cell-phone towers.

If these things really happened, I asked her, what sinister force was responsible? She could not say, but she supposed it could have been the telecom industry, her local government (which profited from cell-tower contracts), or even the military, which

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conducts most of the U.S. research on the biological effects of EMFs (electromagnetic radiation being a crucial component of modern weaponry and surveillance). "I've been hesitant to talk about this," she said, "because I don't want to draw attention to myself. But these types of things do happen."

Today, Kelley continues to work on the congressional hearings and to wage international and local campaigns. She sends regular bulletins to hundreds of email subscribers with such subject lines as "LA County Supervisors Call for Repeal of Cell Tower Health Pre-emption" and "Portland, Oregon, USA, First US City to Challenge the Health Impact of the Federal Telecommunications Act of 1996." She speaks at EMF conferences and produced a video about cell-phone use among teenagers. She allows her son, now a teenager, to own a phone, but he can use it only for text messages.

The closest thing the anti-EMF movement has to a manifesto is the BioInitiative Report, published in 2007. Part summary of data, part call to action, the 610-page document is a compilation of essays by twelve scientists and two activists who believe that low-frequency electromagnetic radiation may damage health. The report's authors make a point of including studies that find no correlation between low-frequency EMFs and human health. But many of these findings are dismissed due to their funding sources (Big Telecom or the military) or perceived procedural error.

Although the report prides itself on being "a benchmark for good science and public health policy planning," it has come under attack for its lack of objectivity. A review published by the Health Council of the Netherlands criticized its "selective

use of scientific data" and concluded that it is "not an objective and balanced reflection of the current state of scientific knowledge." Kenneth R. Foster, a professor in the Department of Bioengineering at the University of Pennsylvania, who studies non-ionizing electromagnetic radiation and teaches a course on scientific ethics, told me, "You have, at this point, a large body of epidemiological data that is overwhelmingly negative but with little blips here and there. Whether these represent health risks or some technical errors



in the study is a matter of inference, not a self-evident conclusion." He argued that the positive findings in the ten-year studies are consistent with reporting bias. And most physicists will say that even if cell phones have not been definitively proved to be safe, it is often almost impossible to prove a negative.

Yet the report has spurred some governments to act. Health ministries in Finland, Canada, and Russia

have urged restrictions on cell-phone use by children, and recently Israel banned the marketing of certain Wi-Fi devices for the home. Liechtenstein has passed into law the report's recommendation to decrease the maximum limit for cell-phone radiation by 90 percent in the next four years. This was done over the complaints of Swisscom's spokesman, who warned that the new radiation limit would effectively force Liechtenstein to do without cell phones altogether.

France has taken the most aggressive stance on the issue. Last year, the government proposed a ban on the use of cell phones in primary schools, the sale of cell phones designed for children under six, and the advertising of phones to children under twelve. (Since 2006, the telecom industry has marketed phones directly to children aged five to twelve, both as toys and as classroom educational tools. There are now, by some estimates, more than 9 million users under the age of nine in the United States alone, generating \$1.6 billion in revenue.) France has lowered radiation limits and mandated that every cell phone be sold with a headset. During the Christmas shopping season, the city of Lyon launched an advertising campaign to dissuade parents from buying cell phones for their children. One poster shows two children speaking through tin-can telephones; the caption

reads, LET'S KEEP THEM HEALTHY AND AWAY FROM MOBILE PHONES!

In the United States, the issue received the most attention when it inspired Ronald Herberman, the director of the University of Pittsburgh Cancer Institute, to send a lengthy email to three thousand colleagues, urging them to take a precautionary approach to cell-phone use. Herberman, along with David Carpenter, the director of the

Institute for Health and Environment at the University of Albany and a co-editor of the BioInitiative Report, was called to testify at a hearing before the House subcommittee on domestic policy. (Not one telecom-industry representative agreed to appear.) It was the first time Congress had entertained any form of inquiry into the potential effects of cell-phone radiation on human health. Larry King devoted an entire program to the issue, and Carpenter appeared on national morning talk shows. A second hearing was held in the Senate several months ago, requested by Senator Arlen Specter, a brain-cancer survivor. The epidemiologist Devra Lee Davis, a colleague of Herberman's, argued in her testimony that "public discussion in the U.S. about potential cell-phone risks remains obscure because of well-honed efforts by some in the cell-phone industry to keep us confused." "We just don't know what the answer is," concluded Specter. "Precautions are not a bad idea. They may not be a good idea, but they are not a bad idea. And the issue of children is something we should look at a little more closely." No member of Congress has proposed any concrete measures, but the authors of the BioInitiative Report believed that finally their message might be heard.

A common criticism of the BioInitiative report is that Cindy Sage, a co-editor and its leading spokesperson, is not a scientist. She is the director of a Santa Barbara-based firm, Sage Associates, that does public-policy research and consulting on EMF-related health issues. In 1982, Sage worked as a consultant on a seminal lawsuit dealing with electromagnetic radiation—a case in which a California court ruled that the fear of electromagnetic radiation could be the basis for compensatory damages. Soon after that, Sage Associates began to offer EMF-detection services. Over the past twenty years, she has consulted for law firms, banks, fire departments, Hollywood moguls, country clubs, golf courses, and public

schools; clients have included the Santa Barbara Zoo and the cities of Montebello, Torrance, and Ojai. Tom Cruise, on a referral from his production partner Paula Wagner, hired Sage to survey two of his homes. Sage told me that one of them, due to faulty construction, had "excessively high EMF levels," and that she oversaw the massive rewiring and rebuilding of the home.

Sage is a slender woman with hard eyes and beach-brown hair. She dresses elegantly, in a striped jacket, white slacks, and a pearl necklace, and speaks in full paragraphs, as if from a teleprompter. She sounds much like a spokesperson for a nonprofit charity—which, in a sense, she is. At her suggestion, we met at the open-roofed restaurant of the Biltmore Four Seasons. A gray sky hung low over the coastline. She said that the haziness was normal for May and that the famous Santa Barbara sun would burn it off by afternoon. Over lemonade, her prediction came true.

I asked whether she thought her EMF consulting created a conflict of interest for her work on the BioInitiative Report. She gave me a firm shake of her head.

"We don't sell EMF-blocking gizmos." She was referring to the burgeoning market of stickers, patches, and necklaces available online, such as the EarthCalm Scalar Home Protector-EMF Blocker (\$159), which promises to bring its customers a "sense of calmness and peace" and a "deeper connection to the earth." For Sage, as well as for Lloyd Morgan, such devices pass some boundary of common sense: they are hooey; they inspire needless anxiety and fear.

"We don't make a profit off of this work—in fact, it's the reverse," she continued. It had taken nine months for Sage to prepare the BioInitiative Report; she couldn't afford to sacrifice any more time. "No individual scientist would have or could have done the work. They needed someone like me. I have experience assembling teams of scientific experts and producing large projects. I did it because it was the right thing to do." She credited the Internet with the report's wide-reaching suc-

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cess. "Journalism is dead in the U.S. The amount of advertising power that the cell-phone industry has in this country has a major impact in silencing the debate. And the industry can no longer claim to be ignorant of the science. They know they're killing people."

Sage keeps a file she calls "the obit list": well-known tumor victims (not all of them dead) whose maladies she traces to cell-phone exposure. It includes Ted Kennedy (glioma), famously a cell-phone addict; Johnnie Cochran (glioma), whose own neurosurgeon suggested that the lawyer's cell-phone usage might be responsible for his tumor; Diane von Furstenberg (salivary-gland tumor); Siskel (glioma) and Ebert (salivary gland). "I'm sorry to say it," said Sage, "but until a lot of public people get brain tumors, we won't have visibility for the subject."

Brain cancer is one of the rarest forms of cancer. Sage's worst-case-scenario figures may be terrifying, but they lose some of their impact when considered alongside all the other things we do every day to hasten our own deaths. One's odds of developing a brain tumor are about 1 in 165. By comparison, prostate cancer afflicts 1 in 6 men; breast cancer, 1 in 8 women; 1 out of 85 people dies in a car crash. A person would still be more likely to die from the common flu (1 in 63), and almost as likely to be murdered. And considering the technology's prodigious benefits—not just for iPhone users in the States but also for people in the developing world, many of whose cell phones serve as their only link to health care, banks, even education—does the risk really outweigh the reward?

"If EMFs function both as a carcinogen and a neurotoxin," said Sage, "then it's not just brain tumors and brain cancers. It's also testicular cancer, breast cancer, leukemia, lymphoma, Alzheimer's, Parkinson's, and a range of cognitive and behavioral problems. Is that pie big enough?"

I asked Sage whether there were any theories about EMF-related illness that she rejects. She paused for a full minute.

"Bats and honey bees." (Some

have blamed man-made EMFs for the mysteriously sharp declines in the populations of these species in recent years.)

What about human beings? Were there any theories of EMF-related health effects that she rejected? She did not have a response at the Biltmore, but in an email later that week she said she was unsure whether EMFs caused autism. She would not rule it out; she just thinks the science "isn't there yet."

On the way out of the restaurant, a high-pitched rattling sound—the kind made by the crank of a jack-in-the-box—came from Sage's jacket. She stopped in her tracks.

"They must have Wi-Fi," she said.

The chirping accelerated as she approached the hostess station, where there was a desktop computer. The hostess, a pretty young suntanned woman with blond hair pulled back in a ponytail, looked up with a perplexed smile.

"Wi-Fi?" asked Sage, gesturing to the computer.

The girl nodded.

"I just want you to know that you are in an elevated-radio-frequency zone," replied Sage, smiling like a concerned mother.

The hostess laughed. "Maybe that's why my voice is so hoarse today."

"It's just good that you have to walk around a lot."

"Thank you," said the hostess, who did not seem particularly concerned. "Enjoy your day."

There is something gratifyingly diabolical about the notion of man growing reliant on a technology that fosters a feeling of interconnectedness and sophistication at the same time it is destroying the brain. The question now being asked by European governments is not whether cell phones cause cancer but at what point it is sensible to enact precautionary laws, just in case the worst comes to pass. The U.S. government plans for nuclear attacks, the poisoning of the water supply, and the outbreak of exotic sub-Saharan diseases. It installs life-guards at public beaches, issues advisories on the hazards of mold, and rates the sanitation levels of cruise

ships. When does it make sense to order cell manufacturers to supply a headset with every phone? Or to ban such products as the Disney Mobile and the Firefly GlowPhone?

The answer is not obvious. Some of these precautionary measures come at significant cost—initially levied on the telecom industry, but ultimately passed on to consumers. Far greater, perhaps, is the cost of fear. Imagine the public (let alone political) response should, say, the Obama Administration endorse the position that every cell tower and Wi-Fi console, and in fact every electronic device—for it is impossible to single out cell phones, even if they might pose the greatest risk—increases, to some degree, your odds of getting cancer and dying. This would give new piquancy to the old aphorism "Everything kills you." It would at least prompt a revision: "Everything emits invisible waves, which kill you."

The existence of killer waves would, however, explain a lot. We'd have a much more comprehensive understanding of how and why we get cancer, for starters. We'd also understand why we sometimes get headaches after using a cell phone for a long period of time; why it seems like we know a surprisingly large number of young people with unusual cancers; why we struggle to remember incidental facts; why we used to be able to do the Sunday crossword but can now make it only through Friday; why our children have so much difficulty sitting still and reading books and speaking in complete sentences; why we get sad for no reason; why sometimes, when we look at our loved ones, for a bizarre split second we don't recognize them; why it can seem that our lives are guided by some dark, implacable force; and why, when we sit up straight in the middle of the night and can't go back to sleep, we feel a dizzying sense of panic at the hopelessness of it all.

Think, too, how satisfying it would be to eradicate the electromagnetic menace from our daily lives. Effective headsets, the longer the cord the better, would be only the beginning. Buy only phones

with low SARs (specific absorption rates), such as Samsung's Eternity and Blue Earth models. Set the phone across the room while you sleep. Don't carry it in your front pocket. Eschew phone conversations altogether, and spend more time speaking face-to-face with the people closest to you. Hire a professional EMF consultant to map your home's electromagnetic profile, so you can make certain that your bed is not in a high-radiation zone or that your children are not playing too close to high-EMF sources, such as your flat-screen television or your Wi-Fi router. If you enjoy the rigors of green living, you will love EMF-free life. And if these measures seem insufficient, leave the city altogether, or, even better, establish your own EMF-free refuge—such as the one recently erected by the EMF-activist organization Next-Up in a wooded area of southern France, where “electrosensitives” live in metal-shielded trailers and wear metal-fiber shawls to defend against invisible waves.

The first generation of regular, or obsessive, cell-phone users has now been at it for ten years. The latency period for brain tumors may be as long as thirty years. So by the late 2020s, the debate should be resolved to the satisfaction of all parties: we will either see a stunning increase in the rate of brain cancer or we will shift our paranoia to new worst-case scenarios.

The clattering in Sage's pocket at the Biltmore was emitted by a device that detects the presence of EMFs. This particular model, the MicroAlert, sells for \$95 and is manufactured by a Salt Lake City company called AlphaLab. Seeing my fascination, she suggested I borrow it for a few weeks. She didn't need it for work, after all—for professional purposes she uses a far more sophisticated sensor, the \$2,200 Gigahertz Solutions' RF-Analyzer HF-59B high-frequency meter. “You'll have so much fun,” she said, with a mischievous smile, as she placed it into my hand.

She was right: it *was* fun. The MicroAlert chirped on the highway

whenever I drove by a cell tower; it pulsed in regular bursts when I set it beside my laptop and activated the Wi-Fi; it let out an agonized shriek when I passed the AT&T building on Church Street in lower Manhattan. As I walked down the aisle of an airplane it chirped at certain rows, alarming passengers who looked around to see what malevolent device had been smuggled aboard. Sometimes the MicroAlert would sound for no apparent reason. A few seconds would elapse. Then, without fail, my cell phone would ring.

I took the EMF meter out on weekends and conducted my own experiments. Bars, dates, dinners: the MicroAlert is an excellent party trick. Friends would test the electromagnetic radiation of their phones, iPods, and BlackBerries. Men used the meter to administer full-body EMF tests to reluctant women—passing it slowly over their clothes like an airport security guard with a wand. (These tests yielded no positive findings.)

People opened up to me about their secret fears. One friend, an attorney at a major international law firm, disclosed a private theory of his: ever since the first radio broadcast, man-made waves have been making our species stupider; but since all of humanity was equally stupider, no one could tell the difference. Another friend admitted she had begun to use a headset a year ago, when she noticed that her phone was giving her headaches. She thought about buying one of those anti-EMF necklaces, but she didn't think the available models were particularly stylish.

An orthopedic surgeon, highly skeptical of the whole business, asked me sarcastically whether these cell-phone alarmists I'd met believed that sending text messages could cause brain cancer. I explained that as long as you didn't hold the phone directly against the side of your head, the radiation was thought unlikely to affect your brain. Laughing, he fired off a text message. My MicroAlert chirped. Then he dropped the phone back into his pants pocket, where it came to rest next to his testicles. ■



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