

Cellular Phones: Medical Menaces of a Modern-Day Convenience

*A State-of-the-Science Literature Review
As of 2009*



Dr. Ronald Klatz, M.D., D.O.

and

Dr. Robert Goldman, M.D., Ph.D., D.O., FAASP



www.worldhealth.net



www.waaam.net

**Cellular Phones:
Medical Menaces of a
Modern-Day Convenience**
A State-of-the-Science Literature Review
As of 2009

Dr. Ronald Klatz, M.D., D.O.
and
Dr. Robert Goldman, M.D., Ph.D., D.O., FAASP



www.worldhealth.net



www.waaam.net

IMPORTANT – PLEASE READ

The content presented in the *Cellular Phones: Medical Menaces of a Modern-Day Convenience* is for educational purposes only. *Cellular Phones: Medical Menaces of a Modern-Day Convenience* does not prevent, diagnose, treat or cure disease or illness.

While potentially therapeutic pharmaceuticals, nutraceuticals (dietary supplementation) and interventional therapies are described in the *Cellular Phones: Medical Menaces of a Modern-Day Convenience*, this work serves the sole purpose of functioning as an informational resource. Under no circumstances is the reader to construe endorsement by A4M of any specific companies or products. Quite to the contrary, *Caveat Emptor*. It is the reader's responsibility to investigate the product, the vendor, and the product information.

Dosing of nutraceuticals can be highly variable. Proper dosing is based on parameters including sex, age, and whether the patient is well or ill (and, if ill, whether it is a chronic or acute situation). Additionally, efficiency of absorption of a particular type of product and the quality of its individual ingredients are two major considerations for choosing appropriate specific agents for an individual's medical situation.

Furthermore, anyone with malignancy should consult their physician or oncologist prior to beginning, or continuing, any hormone therapy program.

Finally, please be mindful that just because a product is natural doesn't mean it's safe for everyone. A small portion of the general population may react adversely to components in nutraceuticals (especially herbal products). A complete inventory of interventions utilized by a patient should be maintained by physicians and health practitioners dispensing anti-aging medical care.

Cellular Phones: Medical Menaces of a Modern-Day Convenience is not intended to provide medical advice, and is not to be used as a substitute for advice from a physician or health practitioner. If you are a consumer interested in any of the approaches discussed in these chapters, it is absolutely essential that you have a thorough discussion with your physician to understand all benefits and risks.

For those individuals interested in the diagnostics and/or therapies described in *Cellular Phones: Medical Menaces of a Modern-Day Convenience*, A4M urges that you consult a knowledgeable physician or health practitioner, preferably one who has been Board Certified in Anti-Aging Medicine. You may find one by utilizing the Online Physician/Practitioner Locator at the A4M's educational website, www.worldhealth.net, or you may call our international headquarters in the USA at (773) 528-4333.

Cellular Phones: Medical Menaces of a Modern-Day Convenience

Copyright © 2002, 2007, 2009 by The American Academy of Anti-Aging Medicine.

First Edition 2002; Second Edition and E-Publication 2007; Third Edition and E-Publication 2009.

1510 West Montana Street; Chicago IL 60614 USA.

All rights reserved.

Electronic and/or print reproduction, storage in an electronic and/or physical retrieval system, or transmission by any means (electronic, mechanical, photocopying, microfilming, recording, or otherwise) requires the advance written consent by the publisher.

TABLE OF CONTENTS

FOREWORD	4
CHAPTER 1. Human Health & Environmental Exposures	6
Cellular Phone Popularity	6
High Stakes	8
Propaganda versus Principle	11
Proceeding with Caution	16
Chapter Closing Remarks	17
CHAPTER 2. Basics About Electromagnetic Fields and Cellular Phones	18
Electromagnetic Fields	18
Cellular Phone Basics	23
Chapter Closing Remarks	28
CHAPTER 3. Possible Biological Effects of Cellular Phone Radiation	29
Mechanisms of Damage	29
Cancer	33
Brain Function	37
General Malaise	40
Headache	41
Sleep	41
Immune System	43
Male Sexual & Reproductive Issues	43
Additional Concerns	44
Special Populations	45
Chapter Closing Remarks	50
CHAPTER 4. Minimizing Your Exposure to Cellular Phone Radiation	51
Practical Prevention	51
Accessories	54
Chapter Closing Remarks	57
CHAPTER 5. You Make the Call	58
APPENDIX A. Table of Cellular Phone Radiation Levels	60
BIBLIOGRAPHY	61
ABOUT THE AUTHORS	71
Dr. Ronald Klatz, M.D., D.O.	
Dr. Robert Goldman, M.D., Ph.D., D.O., FAASP	
ABOUT THE AMERICAN ACADEMY OF ANTI-AGING MEDICINE (A4M)	72

FOREWORD Physicians with a Duty to Educate the Public

“Some technology that we use today carries a risk. The question is not if we use it, but how we use it.”

– Dr. Siegal Sadetzki, Tel Aviv University,
commenting on International Interphone Study findings, 14 February 2008

“For the first time in history, we are holding a high-powered transmitter against the head. When you talk on your mobile phone, [you use radiation in] a range that’s right in the middle of microwave territory.”

– Dr. Ross Adey, one of the world’s most respected and senior research scientists, interview with
PC Computing Magazine, Nov. 30, 1999

“There is a significant and increasing body of evidence for a link between mobile phone usage and certain brain tumors.”

- Prof. Dr. Vini Khurana, interview with *The Independent* (United Kingdom), 30 March 2008

"Anyone who uses a [cellular] phone extensively runs a risk of adverse health effects. We estimate that 10 percent of the population may be at risk of milder effects such as headaches and loss of concentration."

– United Kingdom consumer advocacy group Powerwatch,
– interview with *The Express* (London), April 4, 2000

“When you have 200 million people who are being exposed to cell phones, you can’t wait around for the slow scientific process to work.”

–Dr. George Carlo, public health expert and head of the cellular phone industry’s
Wireless Technology Research program, interview with *Wired Magazine*, June 21, 1999

Humankind is at the most important crossroads between environmental influences and health that it has ever faced. History is replete with examples where health hazards demonstrating an association with an external, controllable exposure have been raised based on what seemed, at the time to be unconvincing and inadequate scientific study, only years later to become well recognized triggers for disease, robbing thousands of people of their lives or compromising the quality of the lives of those exposed. From asbestos and lung cancer, to lead paint and stunted intellect and behavior in children, to contaminated beef and mad cow disease, to perhaps the most notorious case to-date of all – smoking and lung cancer and heart disease, each of these associations received dubious skepticism and rejection initially, only to be proven true in the final analysis.

The notion that cellular phone radiation emissions might result with adverse health effects is the 21st century’s first great environmental challenge. By most admissions from experts and advocates on both sides of the issue, the introduction of broad-scale public exposure to radiofrequency and microwave radiation by the use of cellular phone technology represents uncharted territory.

As physician founders of the American Academy of Anti-Aging Medicine (A4M), a non-profit medical organization dedicated to the advancement of technology to detect, prevent, and treat aging related disease and to promote research into methods to retard and optimize the human aging process, we maintain a keen interest in emerging risk factors that compromise either the quantity or quality of the human lifespan. Anti-aging medicine is a healthcare model promoting

innovative science and research to prolong the healthy lifespan in humans. As such, anti-aging medicine is based on solid scientific principles of responsible medical care that are consistent with those applied in other preventive health specialties. Anti-aging medicine has accelerated the pace of advancements in health promotion and prevention, and is the most important new model for health care for this new millennium.

In this work, it was our goal to make available to interested readers a survey of the scientific literature relating to the possible health effects of exposure to cellular phone radiation. On this subject, we recognize that studies to-date are equivocal, there is a minimal proactive involvement by the government and regulatory agencies, and that the media tends to incite public frenzy and confusion. Thus, we also include a discussion of these issues in the regard of their possible unintended influences on the public perception of the risks involved in cellular phone use.

We are firm believers that knowledge is power. The public and those who they trust with their health – their physicians – have, by and large, been left to scramble up a coherent review of this subject. We wish to make you aware that this work is not a comprehensive, in-depth analysis, but should rather be considered as a first-line resource for cellular phone users. Moreover, because new information on the subject is being made available on a near-daily pace, ongoing interpretation of the science is appropriate.

Consumers should be given the opportunity to know what potential health consequences they may experience as a result of using cellular phones, and by all rights should have the opportunity to make informed judgements as to whether they wish to continue such risk-related use. In the words of Dr. George Carlo, public health expert, "We're now in a gray area that we've never been in before with this. When we're in a gray area, the best thing to do is let the public know about the findings so that they can make their own judgment."

Chapter 1 Human Health & Environmental Exposures

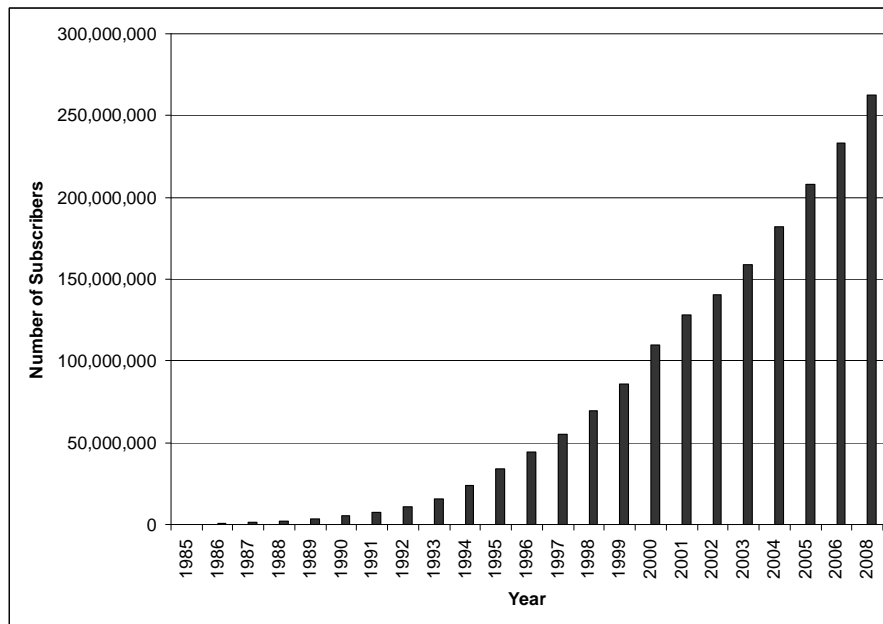
Cellular Phone Popularity

Trends in Adoption and Usage

The past few decades have been a time of unprecedented technological development that is increasingly altering the way we live, work and communicate. The uses of electronic communications among the general public first began with the introduction of personal paging systems in the 1970's, Internet and e-mail in the 1980s, and – most recently and prominently, cellular phones arrived on the scene. We now live in a world of continual connectivity.

According to The World Factbook 2009, there 2.2 billion cellular phone users worldwide in 2005 (the latest year for which such data is available). This number has skyrocketed since the advent of low-priced phones and service plans became widely available to the general public in the mid-1990s. Global cellular phone subscribership outstrips the sales of cars and PCs combined. Cellular phones more popular in European countries than they are in the United States: more than 60% of Europeans own a cellular phone, compared to 40% of Americans.

In the United States, in 2008 there were an estimated 262,700,000 cellular phone subscribers, rising nearly 100-fold since 1985, when the phones began to achieve public popularity:



At the same time, this technology is now giving rise to important questions about possible long-term health consequences of cellular phone use. Because of the immense numbers of present and future users, some scientists and public health experts are worried that even if only a small percentage are adversely affected, that could still equate to a public health issue of epidemic proportions.

Targeting Our Youth

Cellular phone faceplates adorned with cartoon characters. Large toy store chains selling theme phones like the "South Park" phone. "Junior" mobile phones with only three buttons that can be pre-programmed with three phone numbers. Pre-pay cards promoted as "great back to school items."

Australia has been the terrain where the scientific community and the cellular phone industry have vehemently clashed on the matter of targeting the youth to become heavy and life-long cellular phone users. In an advertising blitz in 2001 produced by the same transnational public relations corporations that gave us big tobacco's "Joe Camel" cartoon character, the Australian Communications Authority (ACA), a promoter of telecommunications technology that is closely allied with mobile phone industry, sent out to every school in that nation a pamphlet titled "Mobile phones" Your health and regulation of radiofrequency electromagnetic radiation." Written not by scientists or medical experts but instead by public relations (PR) professionals, the only mention of possible adverse health effects states that "The weight of national and international scientific opinion is that there is no substantiated evidence that using a mobile phone causes harmful health effects." This "scientific opinion," however, lacks credibility upon an in-depth inspection. Relying solely on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines for radiofrequency/microwave exposure, the pamphlet fails to mention that those guidelines were based on high level-short term animal exposure studies, conducted to determine exposure limits set to avoid immediate hazards to health (specifically, the thermal effect associated with the heating of body tissue) from high-level exposures. The ICNIRP did not examine the possibility of non-thermal, low-dose, long-term exposure, such as that which occurs from using a cellular phone for years. (See Chapter 3, Mechanisms of Damage). As such, the ICNIRP "opinion" is scientifically irrelevant, but from a PR standpoint it makes for impressive-sounding proclamations.

The cleverness and proliferation of marketing ploys and PR campaigns that clearly are aimed at promoting usage of cellular phones by children and teenagers is of great concern to radiation experts and public health officials around the world. There is evidence that cellular phone radiation penetrates the skulls and brains of children and teenagers more deeply, leading to speculation about adverse effects on the developing brain (see Chapter 3 – Special Populations, Children).

Dr. Ross Adey, a widely published radiation researcher, has stated that "Children categorically should not, be encouraged or allowed to use' cell phones." Swedish neuroscientist Dr. Ollie Johansson has urged that "Already in 1996, I started to warn in public of the effects on microwave irradiation on children through their use of mobile telephones. The debate has also very much focussed on the responsibility regarding ads and products directly aimed for children, and here in Sweden great alarm has been raised around the propositions to even develop and sell cellphones for the ages up to 5 years." In countries around the world, most notably the United Kingdom, Australia, and Sweden, radiation experts and public health officials are engaging in aggressive campaigns to compel governments to establish strict regulations relating to the sale of cellular phones by their nation's use, and Bangladesh has imposed a ban on the use of these devices to children under the age of 16.

Instead of discouraging cellular phone use in children and teens, in the US we have seen some phone manufacturers skirt the issue, addressing the fear factor by launching yet another marketing ploy. Hands-free kits, an accessory that distances the user's head from the cellular phone antenna and handset (see Chapter 4), have not caught the interest of the youth because they're not "cool."

Fashion designers have come to the rescue: jewel-encrusted earbuds for some of the most widely used cellular phones can be had for about the same price as a leather jacket.

In the end, our children may pay the price for a costly battle involving ideology, economics, and semantics. Every parent today who is tempted to purchase a cellular phone for their child(ren), or to permit the unrestricted use of the device by their child(ren), is old enough to have witnessed at least part, if not all, of the big tobacco drama that unfolded in the 20th century (see next section). If today's suspicions relating to possible health hazards of cellular phones prove to be true, could you as a parent bear that you knowingly permitted your child to expose themselves to the risks?

High Stakes

History Repeating Itself

The rich and famous do it. Celebrities can't get enough of it. Soon, everyone will do it, and no one will be able to stop. What is "it"? We are talking about the "great age" of cigarette smoking of the 1950s, but the same descriptions could be applied to modern-day cellular phone use. In that regard, we take a short stroll along the 50-year history of cigarette smoking, which shares eerie similarities to the short history to-date, and may hint at a possible future, for the modern era of the cellular phone.

In the middle of the 20th century, cigarette advertising pervaded every form of media – newspapers, magazines, radio, television, and even billboards on our favorite roadways. Slinky models and rugged outdoorsmen, sexily snatching or puffing at a cigarette, were the epitome of glamour. Doctors routinely advised patients to take up smoking to aid in weight control. The public was at the mercy of tobacco companies making their self-touting self-promoting claims, in complete absence of governmental regulation. Yet, a small group of scientists and public health experts began to worry that inhaling cigarette smoke could be harmful. The public had to choose between believing their doctors, the government, the media, and some of the nation's "best" corporate citizens of the time, or believing the opinion of a tiny, barely noticeable minority that hadn't yet collected an irrefutable body of scientific evidence. Money and influence quickly and easily won the public's favor, and the anti-cigarette movement was branded as alarmist and unfounded.

It took just less than two decades afterwards for the consequences of cigarette smoking to become painfully evident. By the 1970s, lung cancer, emphysema, and smoking-related heart disease rose to become among the leading causes of death and disability. Smoking, both directly and passively, is now universally recognized as deadly. In 1998, the Master Settlement Agreement between 46 states and the tobacco industry arranged for an unprecedented \$206 billion payout by cigarette manufacturers to compensate for the health expenses born by insurers, the states, and the public for treating sick smokers. Today, the US Department of Justice seeks to recover the federal government's multi-billion costs of smoking-related illnesses. Hundreds of lawsuits filed by individuals are attempting to recover compensatory and punitive damages from tobacco companies, which so far have been nearly 100% successful in winning these cases or overturning judgements in favor of the smokers.

What were we thinking, 50 years ago? Were we that naive a public that we put our collective health at risk for the allure of glamour, fleeting vanity, and transient hedonistic pleasures? Today, radiation experts and public health officials are worried that a similar course of events may plague cellular phone users. As the research continues and the health effects mount relating to cellular phone radiation, some suspect that cellular phone litigation in the 21st century will easily overtake the record-setting payouts of the history-making 20th century tobacco settlement. As playwright George Bernard Shaw remarked, "If history repeats itself, and the unexpected always happens, how incapable must Man be of learning from experience."

In the Courts

When Australian researchers found (1997) that mice exposed to cellular phone radiation for a period of 9 to 18 months had twice the tumor rate as unexposed mice, the cellular phone industry was quick to respond by employing "The Hockett Defense," which was named after the chief Tobacco Institute scientist who advised his executives to repeat endlessly, "men aren't rodents." The scientific community rebutted that "DNA is DNA" and at the most basic of cellular levels, human and animal cells act quite similarly.

Repeatedly, as with the tobacco industry, cellular phone industry officials and trade associations downplay that research which potentially may cause a negative economic impact. The results of respectable science is often challenged or spun, in favor of commercial interests (see Cellular Phone Industry Propaganda below). The risks of litigation, and the immense financial risk of losing such lawsuits, are at the core of this response.

Until 1995, Steve Corney was employed as a British Telecom engineer starting in 1986. In the course of his normal workday, he used a digital phone for up to 5 hours at a time. In 1996, Mr. Corney took a three-month sick leave, but by 1999, he was permanently out of work, suffering from memory loss and speech problems. He file a lawsuit against British Telecom for 100,000 British Pounds alleging that his health problems began when he started using the digital phone as part of his work. During testimony for the case, Mr. Corney reported that his head would become hot around his ear while he was using the phone, and that when he finished conversations he "often felt punch drunk." The case was subsequently dropped because of insufficient scientific evidence to prove a direct cause-and-effect relationship. British Telecom's argument that hundreds of BT engineers were healthy despite working in the same conditions as Mr. Corney prevailed.

To-date, about ten lawsuits alleging that cellular phones caused brain tumors have been filed in the US. Although no case has so far succeeded, they have set the stage and raised safety questions in many people's minds. The first of these suits was filed by David Reynard in 1992 in the state of Florida. The case argued that Mr. Reynard's wife, Suzie, died of a golf-ball size tumor behind her left ear. The Reynards' neurologist, Dr. David Perlmutter, presented clinical observation that Mrs. Reynard's brain tumor was located in an area where radiation from her cellular phone antenna would be deposited. Dr. Perlmutter's hypothesis was founded on studies conducted by Dr. Stephen Cleary of the Medical College of Virginia, Richmond, showing that cultured tumor cells grew when exposed to RF radiation. However, at that time, prevailing scientific opinion was only heating from radiation could cause cellular changes, and so the low power associated with cellular phone signals could not be reconciled with the only accepted mechanism for RF damage of that time (see Chapter 3, Mechanisms of Damage). To make things worse, because Dr. Cleary's study was not able to quantify the degree of heating in his experimental system, skeptics suggested that his findings were artifacts due to the uncontrolled heating of the tumor cells. Lacking a biological basis, Dr. Perlmutter's observation that Ms.

Reynard's tumor was located adjacent to the cellular phone antenna was discredited. While this case was dismissed from the courts, it was prominent enough to catch the attention of Congress and the public. As a result, the wireless industry founded the Wireless Technology Research (WTR) program (see In Search of the Truth below), and funded it with \$27 million, a portion of which resulted with two studies that cast further doubt on the safety of cellular phone radiation (see Chapter 3, Cancer).

In August 2000, a Maryland (USA) neurologist, Dr. Chris Newman, filed an \$800 million lawsuit against cellular phone industry giants Motorola, Verizon Communications, Bell Atlantic, Bell Atlantic Mobile, SBC Communications, alleging that the cellular phone industry knew of the health hazards posed by radiation emitted from their devices, but failed to protect its consumers. The suit also named the industry trade groups the Telecommunication Industry Association and the Cellular Telecommunications and Internet Association, accusing them of falsely portraying cellular phones as safe. Dr. Newman's case alleges that years of cellular phone use caused cancerous tumors to grow behind his right ear. The growths were first discovered in March 1998, and, according to Dr. Newman's attorney, he used his hand-held cellular phone on the right side of his head for several times a day starting in 1992. On the litigation, an official from the National Brain Tumor Foundation commented that "We don't want to unduly alarm the public, but some of the information we have read is very compelling." Dr. Newman's lawsuit gained major momentum and even more attention when in January 2001 Mr. Peter Angelos filed as co-counsel in the case. The majority owner of the Baltimore Orioles professional baseball team, Mr. Angelos has previous experience in successfully litigating on other environmental exposures, winning multi-million dollar class action lawsuits against tobacco and asbestos companies. His representation of the state of Maryland against cigarette manufacturers that won a \$4 billion settlement lends credibility to Dr. Newman's claims regarding the impact of cellular phone radiation on human health. In September 2002, the US District Court rejected the expert testimonial evidence submitted on behalf of Dr. Newman, stating that none of it was substantial enough to warrant proceeding to trial. Additionally the judge noted that findings from other studies conflict with the results from the primary study on which Dr. Newman's case was hinged. Subsequently, the defendants have filed a motion to dismiss the case.

This decision may harm related litigation activity initiated in other states by Dr. Newman's attorney, Mr. Angelos. These class action lawsuits against Motorola, Verizon Wireless, and 23 other wireless companies in Maryland, Pennsylvania, New Jersey, and New York—~~These suits do~~ not allege that cellular phones cause brain cancer, but instead contend that manufacturers have know of health risks but have failed to address them.

Litigation in the state of Louisiana filed by a man alleging that at the time he purchased a cellular phone, he was not told the product was safe received a bolster of judicial support when in January 2001, a federal court upheld the suit after it was previously dismissed in district court. According to the man's attorney, Mr. Michael Allweiss, the suit is based on the premise that the wireless phone industry does not know if its technology is safe, and that companies are not doing enough to warn consumers of the possible risk. In response, the defense argued that in 1996, Congress gave the Food and Drug Administration (FDA) the power to set safety standards and to preempt any legal actions to regulate wireless phones. However, federal court Judge Ivan Lemelle reviewed talk papers from the FDA and found that they "had inconsistent statements, with some of them saying there was no risk with cell phone use and some saying that there was a small risk," and thus the defense's argument as to preemptive action was overruled. At the time of this writing, Mr. Allweiss was preparing to initiate a class action suit aiming to determine what the cellular phone industry has done with regard to warnings raised by scientific experts and public health officials.

These legal actions suggest a growing and prominent trend that the public is placing the cellular phone industry, and its trade groups, in direct responsibility for its product. The public is not willing to accept a denial of responsibility or an ignorance of the scientific evidence. Perhaps we will learn from previous mistakes that have not only cost dollars, but lives.

Risky Business

The risks associated with cell phones are being considered too risky even by the biggest risk takers in the insurance industry. Lloyds of London has refused to issue product liability coverage for manufacturers and retailers of cellular phones. The underwriting group Stirling cites "fears that mobile phones will be linked to illnesses such as cancer and Alzheimer's" to refuse to cover cellular phone manufacturers against the risk of being sued if the devices turn out to cause long-term damage."

Insurers are also worried about cellular phones used in the workplace. Employers are generally required to provide a safe system of work. A number of employers expect their employees to carry out their duties and responsibilities using cellular phones for hours at a time. If scientific evidence unequivocally determines that cellular phone radiation poses human health risks, these employers could be implicated in insurance claims or legal action by employees alleging they were subjected to an unsafe workplace. Indeed, a number of cases have already been settled out of court but details have been scarce due to confidentiality arguments of those settlements. Dr. George Carlo, public health expert and head of the cellular phone industry's Wireless Technology Research program (see Industry Propaganda – The Search for Truth below), has cautioned that "CEOs need to ensure that their companies' employees operate cell phones and other wireless devices in a manner that reduces health risks associated with [cellular phone] radiation – or face the consequences."

Reasonable technological advances which could decrease risk are being implemented by employers who require cellular phone use in the course of employee work. As a result, the risk of future litigation increases if the precaution is not taken to provide a safe workplace. Europe's third-largest manufacturer of electrical appliances, Merloni Elettrodomestici SpA, has decided to supply its employees with phones that can be used without placing the device up to the head, yet admittedly doing so may place other parts of the body at similar or increased risk (see Chapter 4, Simple Precautions – Carrying the Phone). As a consequence, the matter of both remedying and avoiding future potential safety issues associated with use of cellular phones in the workplace is complex.

Industry Propaganda vs. Intellectual Principle

Most of the public takes the words uttered by television anchorpersons and reporters or published in newspapers, magazines, and now on the Internet, as fact. In reality, however, many of these "newsworthy" topics are fed to newsmen in pre-prepared finished form, by those who wish to have the topic disseminated verbatim to the public. Often, these sources are controlled by industry, holding an enormous economic stake in the public perception of their products and companies. Even when the science is clean and factual, it can be "spun" and refocused, to divert attention towards the point that is sought to be conveyed. In this regard, it is important to understand that many of the PR firms now working for the telecommunications industry previously worked (or still do) for the tobacco industry, responsible for perfecting what is known

today as "Tobacco Science": emphasize what the client wishes to share with the public, without distorting the real findings.

The Spin

We have previously mentioned that the Australian Communications Authority (ACA) relied on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines for radiofrequency/microwave exposure to suggest the safety of cellular phone radiation. Knowing that the ICNIRP's findings were irrelevant to demonstrate a "national and international scientific opinion" finding no evidence that using a mobile phone causes harmful health effects, the clever PR agents hired by ACA ignored several aspects of the ICNIRP guidelines as admitted by the organization itself:

- The ICNIRP states that "Most of the established biological effects of exposure to RF fields are consistent with responses to induced heating" – this is a problem, given that scientific experts now are concerned about the non-thermal effects of the radiation (see Chapter 3, Mechanisms of Damage).
- The ICNIRP also states that "Most studies [assessed] adverse ... outcome following acute exposure to relatively high levels of RF fields." Cellular phone radiation exposure is of low power and long-term, characteristics not included in ICNIRP studies.

In essence, telecomm's spin doctors ignored that the ICNIRP studies were not comprehensive and relevant enough to give an assurance of safety for cellular phone use.

Indeed, in the early years of the controversy regarding cell phones, the industry developed a huge and expensive public relations effort. In 1993, following the filing of Mr. Reynard's lawsuit, Mr. Paul Staiano, President of Motorola General Systems stated, "Forty years of research and more than ten thousand studies have proved that cellular phones are safe." This quote was, however, an exaggeration of the research to-date at the time, as in actuality the "ten thousand studies" were largely on radiowaves outside the cellular frequency, or at exposure levels that are different from those experienced by cellular phone users. In 1994, Louis Slesin, editor of *Microwave News*, commented that "The industry hasn't told the public the full story about how there has been very little research on biological effects at low level exposures, similar to those of handheld phones."

It is interesting to note that with the increase in the number of scientific studies indicating a potential for human health hazards of cellular phone emissions, there has been an associated increase in the patent activity for radiation-reducing technologies by cellular phone companies, most notably of which include:

- In 1996, Ericsson GE Mobile Communications was issued US Patent #5,524,275 for "a radio transmitter output power controller which automatically restricts the maximum transmitting time ... A warning signal may be generated to inform a user that the maximum permitted power output is being approached."
- In 1998, Nokia was issued US Patent #5,854,970, for "a device ... including a shielding layer which under operating conditions is between the antenna and the user. The shielding layer reduces electromagnetic irradiation of the user."
- In 2000, Motorola was issued US Patent #6,166,707, for "an antenna shroud use for covering an antenna element ... is used to protect a user from coming into direct contact with radio frequency energy radiated by the antenna element."

When the paper "Cellular Telephones and Cancer – a Nationwide Cohort Study in Denmark" by Dr. Johannsen and colleagues was published in February 2001 in prestigious *Journal of the National Cancer Institute* (USA), the industry promoted the study (which it funded) as the final proof that cellular phones were safe to use. In Denmark, home country of the study, one major newspaper headline read "Go and use your mobile phone - nothing to worry about now". In an Australian report on the study, a newspaper proclaimed "Mobiles Get Clean Bill Of Health." Yet, the media ignored two major facets of the study:

- While the study included over 420,000 subjects, drawn from all Danish mobile phone users from 1982 to 1995, only several thousand had used mobiles for more than 10 years. The majority of those studied had only used them for about 3 years.
- The report also questions the reliability of its own measurements of mobile phone use, and the authors themselves caution that: "our study may currently have too few heavy users to exclude with confidence a carcinogenic effect on brain tissue following intensive, prolonged use of cellular telephones."

Additionally, a Danish panel chaired by Dr. Albert Gjedde, a respected brain specialist, said the study was inconclusive and recommended that a proper study be undertaken, using better protocols. Specifically, Dr. Gjedde remarked that the group in the Danish study was not compared with a control group of people who had brain tumors. Dr. Michael Repacholi, head of the World Health Organization's International EMF Project (see Chapter 2, EMF – International Studies) also made the same observation and commented that because the Danish study was not conducted according to WHO rules, the study was inconclusive.

The Suppression

Motorola had contracted some of the world's leading radiation researchers to carry out experiments. In a May 24, 1999 article published in *The Express* (United Kingdom), two researchers reported that multinational telecommunications companies tried to influence the results of their research:

- Dr. Ross Adey, a biologist specializing in radiation effects, had his funding withdrawn by Motorola before completing research that showed that cellular phones affected the number of brain tumors in animals. "Motorola has been manipulative of research that we and others have reported to them," said Adey. "Essentially they cut us off because we were too inquisitive."
- Dr. Henry Lai, who has been studying the biological effects of electromagnetic fields for 20 years, was asked three times to change findings on how they caused DNA breaks in rats. "Control of the research programmes have passed to managers and lawyers. This is exactly what happened in the tobacco industry." said Dr Lai, who also described the industry's interference as "unpleasant and intolerable."

Both of these scientists have been involved in academic, military and other research projects throughout their lives. Many of their observations on the health effects of EMFs have been used in increasing the military's understanding of these potential weapons applications.

The Express solicited for comment on these allegations by other experts in the radiation field. Simon Best, editor of consumer bulletin *Electromagnetic Hazard & Therapy*, remarked "Any interference affects the credibility of the results. It's a basic principle in research that the investigator has the responsibility of producing and interpreting the results." Continuing, Mr. Best said: "I find it amazing that proper research was not done before mobile phones went on sale. The telecoms industry should be involved in these studies only in as much as they provide the money because it is they who are making the profits."

The Search for Truth

In 1992, the Wireless Technology Research (WTR) program was founded by the wireless (cellular phone) industry. Operating for a period of 7 years, at a funding commitment of \$27 million paid by the industry itself, the WTR sought to "provide objective scientific information upon which to base public health decisions regarding wireless phones, encompassed independent peer review coordinated through the Harvard Center for Risk Analysis at the Harvard School of Public Health, strict adherence to both Good Laboratory Practices (GLP) and Good Epidemiology Practices (GEP), and the input of over 100 scientists and physicians worldwide." The WTR commissioned two studies, conducted at Stanford University and Integrated Laboratory Systems in Research Triangle Park, which subjected animal cells to 46 tests for cancer-inducing genetic damage. WTR also reviewed and commented on research conducted by other scientists on the subject of health effects of cellular phone radiation.

The wireless industry selected Dr. George Carlo to be WTR's Chairman. Dr. Carlo had a longstanding, highly respected involvement in epidemiology and public health, which included studies addressing risks from the environment and consumer products, as well as the safety and efficacy of pharmaceuticals and medical devices. Holding university faculty positions and serving as an advisor to various government agencies, Dr. Carlo's credentials were extensive and impressive.

But in 1999, Dr. Carlo and WTR dropped what amounted to an atomic bomb on the cellular phone industry. In the WTR-funded study conducted by Dr. Dreyer and colleagues, the rate of brain cancer mortality in hand-held cellular-phone users, as compared with car phone users (antenna is physically detached and located outside the rear of the car), was nearly three times greater. The second WTR-funded study, conducted by Dr. Joshua Muscat and colleagues at the American Health Foundation (New York USA), studied data collected on newly diagnosed cases of brain cancer from five hospitals across the United States, and analyzed the duration and frequency of cellular phone usage in these patients. The researchers identified a statistically significant increase in risk of neurocytoma – a type of brain tumor that grows from the outside edges of the brain inward – with cellular phone use. Additionally, those patients who reported using their phone on the right side of the head had a significant increase in tumors on that side of the head.

In releasing the study findings, at first Dr. Carlo took a conservative approach in his findings but his concerns were clear: precaution might be required. The studies suggested a correlation between cellular phone use and cancer. Dr. Carlo encouraged further research on the subject. With a sincere interest in public health, Dr. Carlo felt that the industry should pay attention and pursue the research.

To say that the industry was not pleased is an understatement. They considered Dr. Carlo's words as heresy, especially since they had spent \$27 million and were fully expecting an opposite, industry-friendly outcome. According to Dr. Carlo, the industry then sought out on another multi-million dollar quest, one in which they attempted to discredit him.

In an Oct. 16, 1999 article published in *The Express* (United Kingdom), Dr. Carlo claimed that cellular phone manufacturers failed to take "the appropriate steps to protect consumers. They have shown total disregard for mobile phone users."

A now-famous letter that Dr. Carlo, in his capacity as Chairman of WTR, wrote to the CEO of AT&T, has serious legal implications for mobile phone manufacturers who have claimed that there is no evidence for adverse health effects from mobile phone use. With the letter widely circulated in the industry, making that claim now could possibly expose them to litigation in much the same way as what happened to the tobacco industry, where it was shown that industry knowingly misled the public as to the hazards of smoking. Dr. Carlo's letter to Mr. C. Michael Armstrong, Chairman of AT&T Corporation, presented the following highlights of the WTR-commissioned scientific studies:

- "The rate of death from brain cancer among handheld phone users was higher than the rate of brain cancer death among those who used non-handheld phones that were away from their head
- The risk of acoustic neuroma, a benign tumor of the auditory nerve that is well in the range of the radiation coming from a phone's antenna, was fifty percent higher in people who reported using cell phones for six years or more, moreover, that relationship between the amount of cell phone use and this tumor appeared to follow a dose-response curve;
- The risk of rare neuro epithelial tumors on the outside of the brain was more than doubled, a statistically significant risk increase, in cell phone users as compared to people who did not use cell phones;
- There appeared to be some correlation between brain tumors occurring on the right side of the head and the use of the phone on the right side of the head;
- Laboratory studies looking at the ability of radiation from a phone's antenna to cause functional genetic damage were definitely positive, and were following a dose-response relationship."

Dr. Carlo also explained in his October 1999 *Express* interview that he had indicated that "while the WTR overall study of brain cancer occurrence did not show a correlation with cell phone use, the vast majority of the tumors that were studied, were well out of range of the radiation that one would expect from a cell phone's antenna. Because of that distance, the finding of no effect was questionable."

Since the disbanding of WTR at the end of 1999, Dr. Carlo has chronicled what he considers to be tricks and deception that he believes the cellular phone industry uses globally to confuse the science and distort the evidence. Citing a prevailing interest in public health, Dr. Carlo has remarked that the cellular phone industry has chosen to give the illusion that promised research in the coming years helps consumers today, and, according to Dr. Carlo, falsely claim that today's regulatory compliance means safety in the future. Dr. Carlo warns that "The most important measures of consumer protection are missing: complete and honest factual information to allow informed judgment by consumers about assumption of risk; the direct tracking and monitoring of what happens to consumers who use wireless phones; and, the monitoring of changes in the technology that could impact health." As a result of his seven-year experience, and to continue his work on cellular phone radiation exposure as a public health issue, in March 2002 Dr. Carlo launched the Mobile Telephone Health Concerns Registry (MTHCR). Seeded from a \$250,000 partial settlement of an Illinois class action lawsuit that started in 1995, the Registry is a "passive reporting system that tracks and counts information voluntarily provided by cellular phone users, particularly those who believe they are experiencing health effects associated with wireless phones." Cellular phone users register and take surveys at the MTHCR website, www.health-concerns.org. MTHCR states that participation in the Registry is strictly confidential. Once the database is fully established, the MTHCR plans to turn over its data to "appropriate public health officials for them to operate."

Proceeding With Caution

"Better safe than sorry." "Erring on the side of caution." These are phrases that have been codified into a concept known as "the precautionary principle" by the Maastricht Treaty (1999), and it forms the basis of both the Economic Union's and United Kingdom's regulation in the area of assessing risks to the public from exposure to radiofrequency/microwave radiation. In the UK, the concept has been summarized as follows:

"We must act on facts using scientific information. That does not mean we must sit back until we have 100% evidence about everything. Where the public health is at stake, the risks can be so high and the costs of later corrective action so great, that prevention is better than cure. Where there are significant risks of damage to public health, we should be prepared to take action to diminish those risks, even when the scientific knowledge is not conclusive, if the likely balance of costs and benefits justifies it."

In the practical application of "the precautionary principle," measures are taken to minimize known risks and alertness to the emergence of unknown risks must be maintained. Hence, in Europe, they have approached the possibility that human health hazards exist for cellular phone radiation emissions very seriously.

In contrast, the US government has lagged behind in taking a proactive position on this issue. On October 31st, 1996, the US National Academy of Sciences, National Research Council (NAS/NRC) issued a review of the EMF literature, in which they stated that 'there is no conclusive and consistent evidence showing that exposure to residential electric and magnetic fields produces cancer, adverse neurobehavioral effects, or reproductive and developmental defects'. Of significant importance are the words, "conclusive and consistent." Like the more familiar phrase in law, "beyond reasonable doubt," "conclusive and consistent" implies a certain standard of evidence that warrants more serious action. Using that type of reasoning, the NRC Committee concluded that research results do not show that EMF exposure at a residential environmental level causes adverse health effects."

This was followed by a February 8, 2000 report by the FDA that: "There is currently insufficient scientific basis for concluding that wireless communication technologies are safe or that they pose a risk to millions of users. A significant research effort, including well-planned animal experiments, is needed to provide the basis to assess the risk to human health of wireless communications devices." In 1996, Congress passed the Telecommunications Act [P.L. 101-104, 110 Stat. 56(1996)], in which Section 704 of the act amends the Communications Act by making the establishment of regulations on cellular telecommunications and radiation emissions levels the jurisdiction of the federal government, thereby preventing state and local communities to adopt more stringent protections, even if they felt that the federal regulatory authorities failed to protect the public.

As a result, the US has not adopted "the precautionary principle," instead our policies have been described by some radiation experts as "head in the sand." The US has, instead, implemented a *de facto* policy of "post-sales surveillance" with respect to cell phones. That means cell phones can be sold to the public, and only after years of use will there be studies to characterize what health consequences, if any, have arisen as a result.

Chapter Closing Remarks

The public health battles waged during the 20th century over environmental exposures of large segments of the US population, most notable of which involved cigarette smoking and the unprecedented \$206 billion settlement with 46 states, the question has always boiled down to whether the arguments by scientists and public health officials urging a "precautionary approach," or the insistence of a strict application of "scientific proof" by industry, prevail among government regulators and courts. Unfortunately, this debate often requires decades to take its course, during which the damage could be done to the unwitting public.

Perhaps then, on the issue of the possible health hazards of cellular phone radiation, it is up to each of us as individuals to adopt the precautionary approach in our daily lives. To effect this, cellular phone users require knowledge. We offer the following chapters to educate cellular phone users on some of the basic science (Chapter 2) and scientific evidence (Chapter 3) that we urge you to become familiar with, so you may make an educated determination as to your personal potential for risks to health, and, if appropriate, to take protective measures (Chapter 4).

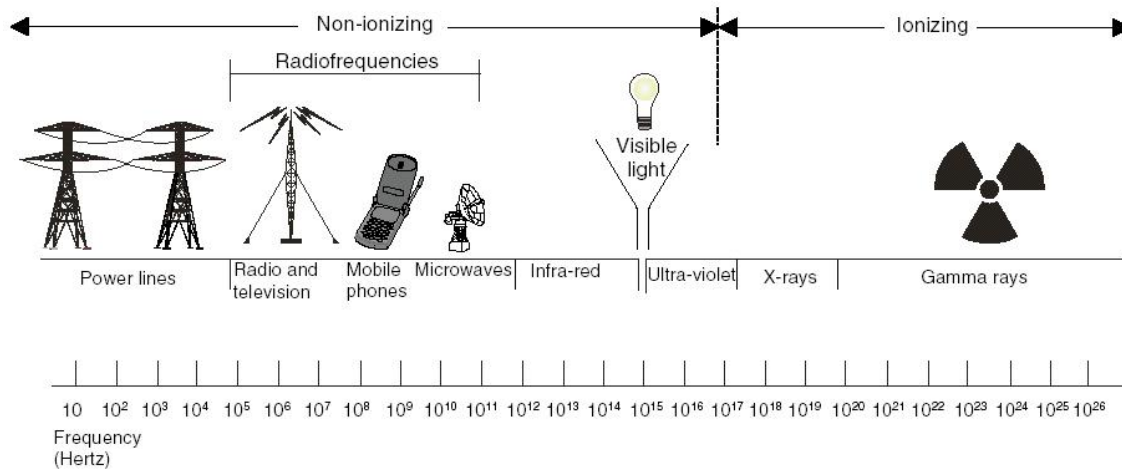
Chapter 2 Basics about EMF and Cellular Phones

Electromagnetic Fields

Electromagnetic fields (EMFs) are waves of electric and magnetic energies that travel together, at the speed of light, and they permeate the world around us. Electromagnetic fields represent one of the most common and fastest growing environmental influences, and exposure in all populations of the world will continue to increase with the advancing availability of technology.

EMFs are categorized by their frequency, which is a measurement of the number of oscillations (cycles) occurring in the wave per unit time, measured in the unit known as the hertz (1 Hz = 1 cycle per second). Additionally, scientists measure the wavelengths of EMFs – the distance traveled by the wave in one oscillation. Together, the frequency and wavelength define the nature of the field.

There are many different frequencies of EMFs, which collectively make up the electromagnetic (EM) spectrum:



The EM spectrum groups radiation into two types:

- "Ionizing" – having energy levels sufficiently high enough to strip electrons from atoms and molecules (a process known as "ionization"). Scientists agree that exposure to ionizing radiation can cause serious biological damage, including the production of cancers.
- "Non-ionizing" – of an insufficient energy to cause ionization.
 - Within the "non-ionizing" portion of the EM spectrum, radiofrequency (RF) radiation includes bands used by radio and television, cellular phones, and microwaves. RF, particularly at the high end of the cellular phone band (see About Cellular Phones below) and in the microwave band can rapidly heat biological tissue. This heating ("thermal effect") can cause harm by increasing body temperature, disrupting behavior, and damaging biological tissue. Early in the short history of cellular phones, scientists suspected that the radiation caused damage by heating, but subsequently "non-thermal" effects have become of greater concern (see Chapter 3, Mechanisms of Damage).

As we have increased our exposure to both chemicals and EMFs in the last three decades we have seen certain brain cancers increase in all age groups by 1% a year. Since 1980, brain cancers in the 65+ age bracket have increased 2.5% a year. Among those 85+, the increase has been as much as 500% since 1973.

Indeed, EMF is such a potent form of energy that it is giving rise to a new type of weapon. With just a few hundred dollars' worth of hardware readily available from home improvement and electronics stores, a few car batteries, and some ingenuity, researchers were able to build an electromagnetic pulse (EMP) "bomb" that fit comfortably in the passenger seat of a vehicle and could cause computers behind walls 80 feet away to shut down. American officials are, given the combination of heavy reliance of businesses and government on computers to store information, and the nervousness of the post-911 era, greatly worried. The potential exists for a single EMP weapon to cause mass information destruction.

ELF EMF

EMFs with low frequencies up to 300 Hz also are characterized by extremely long wavelengths (600 km [420 miles] at 50 Hz). These EMFs are often referred to as "extremely low frequency" "electromagnetic fields," or ELF EMF. ELF EMF is associated with the generation, transmission, and use of electrical energy. Common sources of ELF EMF include:

- Community: Equipment involved in the generation and delivery of electrical energy, including generating stations and substations, transformers, and overhead transmission lines.
- Home: Configuration of household electrical wiring, use of household appliances.
- Workplace: Greatest occupational exposure by those who do field or plant work in the electric utility industry and welders. Additionally, office workers are exposed to substantially smaller fields when using equipment such as copy machines and computer monitors.

ELF EMF interacts with living tissues by inducing electric fields and currents. There have been conflicting studies relating to changes in brain function, reproduction and sleep patterns, and suspicions correlating ELF EMF with increased risk of cancer. The US National Institute of Environmental Health Sciences (NIEHS) conducted a five-year long study on possible health implications of ELF EMF. In the International Working Group convened by NIEHS in June 1998, the panel was troubled by the "appearance of consistency in epidemiological studies suggesting residence near power lines resulted in an apparently higher risk of leukemia (cancer of the white blood cells) in children. The working group also found limited evidence for an increased occurrence of chronic lymphocytic leukemia in the occupational setting." As a result, NIEHS classified ELF EMF as a "possible human carcinogen." According to the World Health Organization (WHO), this classification "means [that] limited credible evidence exists suggesting that exposure to ELF [EMF] may cause cancer. Continuing, WHO states that "... it cannot be excluded that ELF field exposure causes cancer from available evidence."

RF

Radio frequency (RF) fields are used in many facets of everyday life, such as radio and television transmission, mobile telecommunications – namely pagers and cellular telephones, some medical diagnostic and treatment equipment, and in industry for heating and sealing materials. The biological effects of RF are not well understood because the prominence of this form of radiation is a relatively new addition to our everyday EMF landscape.

"Cellular telephones are the most radiative appliance we have ever invented apart from the microwave oven and people are putting them by their heads – arguably the most sensitive part of the body," stated bio-electromagnetics scientist Roger Coghill. Cellular phones emanate

microwave radiation, and human brains may absorb up to 60 percent of that energy.” Indeed, the cellular phone is, essentially, a low-powered radiotransceiver (combination transmitter and receiver). With the widespread public adoption of cellular phones, there has been a particular focus of attention on potential problems associated with "near field RF exposure" – namely, exposure to the head from the phone.

Western Definitions Insufficient

While most of the public concern with cellular phone use focuses on the possibility of increased risk of brain cancer, a far different picture is seen in the former Soviet Union (USSR) medical literature, where a condition of "Microwave sickness" has long been accepted by many scientists.

During World War II, the USSR became concerned that their military personnel were being subjected to health hazards from working with radar. In the cold Siberian winters, servicemen commonly stood in front of the radar antenna as a way to keep warm, but a debate ensued as to whether radar could cause infertility.

In the 1940's various American military and government agencies also began investigating the possibilities of health hazards being induced by radiofrequency and microwave radiation. While they claimed to have found no evidence of hazards they did recommend that radar and radio operators should avoid prolonged exposure as a precautionary measure.

In the late 1940's and early 1950s several new studies raised the possibility of health hazards involved with the use of microwaves. In 1948, two US studies reported a possible link with cataract development and testicular degeneration in dogs. These studies were mostly ignored, largely because the companies that had developed microwave technology for the military were worried about spoiling consumer potential for microwave applications. These decades were the great age for civilian radar and microwave ovens, hailed as great applications of technology for the public audience.

When the Cold War began in the 1950s, increased military uses of radar and microwave equipment were seen as critical to maintaining national defense. In the Western world, research on human effects of these technologies was suppressed. However, in 1953 a study of workers at Hughes Aircraft Corp. found excessive amounts of internal bleeding, leukemia, cataracts, headaches, brain tumors, heart conditions and jaundice in those employees working with radar. As a result, the US military was forced to initiate the first 'open and public' investigation into the biological effects of microwaves. The aim was to establish 'tolerance levels' for both single and repeated exposures. Since little research data of this kind existed at that time, it was decided that the known ability of microwaves to heat up tissue (its "thermal effects") would be the main criteria, defined by the field levels that the human body could withstand without causing a 1°C rise in body temperature. Adding a safety margin, this definition has been, and remains, the foundation of all Western safety standards on radiation exposure. Establishing this definition quietly avoided the possibility that low-level, non-thermal biological effects without tissue heating existed.

The "thermal school of thought" quickly became the accepted norm with Western standard setting organizations. As a result, the vast majority of research was directed at short term, high level exposures. Research into prolonged environmental level exposures that did not cause tissue heating was not encouraged, because it was conflicted with the growth of future development of radiofrequency and microwave technologies.

In the USSR however, a vastly different political and economic system permitted their scientists with greater academic freedom and funding than that found in Europe and the US. With the Soviet military exempt from having to comply with exposure standards, scientists were able to establish the lowest EMF standard worldwide. It was designed to protect against both acute thermal as well as prolonged low-level non-thermal exposures.

In fact, Russian researchers carried out extensive studies of humans in which they exposed the subjects to non-thermal EMF. This research on actual human exposure, led to the recognition of a condition called "Microwave Sickness," characterized by symptoms including:

- Agitation and emotional outbursts
- Nervous exhaustion
- Fatigue
- Muscle weakness
- Reduced intellect
- Deficits in concentration
- Increased sensitivity to sight and sound triggers
- Altered sleep patterns and disturbed dreaming
- Headaches
- Dizziness
- Unstable gait
- Circulatory problems
- Heart problems
- Breathing problems
- Hormone irregularities

"Microwave Sickness" is alarming because today's cellular phones expose the caller to microwaves that can be in the range of the exposures reported to cause this condition (see About Cellular Phones below). Powerwatch, a consumer group monitoring the cellular phone industry in the United Kingdom, reports receiving increasing numbers of reports from cellular phone users who are experiencing headaches, loss of concentration, skin tingling or burning or twitching, eye "tics", very poor short-term memory, buzzing in their head at night, and other effects. They describe the typical report as:

Headaches often come first and/or skin effects. Then concentration and short-term memory tends to deteriorate. At first it can be missing the turning off a motorway that you intended to take. Then it is forgetting appointments. It usually firstly affects learning or remembering new facts, similar to early signs of dementia. Things you learnt long ago are still usually there, but new things just don't seem to go in to your memory any more.

Users also report excessive tiredness.

Powerwatch submits that the symptoms of cellular phone users bear a close resemblance to those reported in a study (Balode et al 1996) of a Latvian pulsed radio location station. Dr. Balode and colleagues found that children living in front of the station had less developed memory and attention, their reaction time was slower and their neuromuscular endurance was decreased, when compared to a group of matched controls. Exposed children also had red blood cells with abnormalities that could have affected cell growth and division.

Complexity of the Potential Health Hazards

Noted electromagnetic radiation expert Dr. Hyland of the University of Warwick (United Kingdom)/International Institute of Biophysics (Germany) reported (2000) to the European Union that "even if the body's thermoregulatory mechanism succeeds in maintaining the temperature at

the pre-irradiation value, a certain stress still develops, which, if sustained for a prolonged period, can of itself result in adverse health effects. It is thus possible that the current guidelines fail to afford an adequate level of protection."

The body has to be seen in the context in which it operates. The body is not a closed system but, rather, an open one which exchanges energy with all of the forces around it. The human body seeks equilibrium or its own balance. Energy interaction requires a corresponding action from the body. On an energetic level this results in chemical changes, system stress and other interactions which can be either healthy or not so healthy. Dr. Hyland speculates that cellular phone communications interfere with some essential processes that take place at the cellular level, but the impact of this influence is highly variable from person to person. He suggests that non-thermal effects are largely dependent on the "aliveness" of the irradiated organism, which in the context of the subject of this book would be the metabolic robustness of the cellular phone user. Dr. Hyland likens the situation to the varied susceptibility of different people to the same virus: "even in the case of an epidemic not everyone is affected!"

Continuing, Dr. Hyland urges that "whilst the occurrence of heating itself is not dependent on aliveness – and can thus be predicted to occur with certainty (i.e. it is a linear effect) – the consequence of this heating for human health is dependent on the aliveness of the heated organism, and thus cannot be uniquely predicted; for example, a rise in the temperature of the human body by 10 C can be life saving or lethal, depending on the state of the body at the time it is irradiated." With safety guidelines commonly requiring that effects of radiation be based on reproducible effects, such contingent health effects of radiation cannot be standardized. Dr. Hyland's report continues that "Whilst this admittedly makes them [non-thermal effects] more difficult to regulate against, it is not a licence either to neglect them, or to deny that they might initiate adverse health effects. Accordingly, the philosophy underlying current safety guidelines must be considered to be fundamentally flawed!"

International Studies Several Years Away

In 1996, The World Health Organization established the International EMF Project in recognition that "even a small health consequence from EMF exposure could have a major public health impact," and that "it is highly desirable that the mistakes made with commonly available carcinogens, such as cigarette smoke, ionizing radiation and asbestos, should not be repeated."

The International EMF Project seeks to assess the scientific evidence of possible health effects of EMF, dividing the EM spectrum into four ranges:

- static (0 Hz)
- extremely low frequency (ELF, >0-300 kHz)
- intermediate frequencies (IF, >300Hz to 10MHz)
- radiofrequency (RF, 10 MHz-300 GHz) fields

The project will not be completed until 2007 (its scheduled date).

The International Agency of Research on Cancer, WHO's specialized cancer research agency of the World Health Organization, has begun a ten-country epidemiology study – the US is noticeably absent from the selected nations, because the IARC chose only those nations with highest prevalence of mobile phone use in people age 20-50 as of ten years ago). The study, named INTERPHONE, seeks to assess whether cellular phone radiation exposure is associated with cancer risk. Nearly 10,000 cellular phone users diagnosed with brain cancers will be

interviewed and compared with an equivalent number of age- and sex-matched controls. A monumental undertaking, INTERPHONE will not be completed until 2005.

The obvious and disparate difference between Western and Soviet approaches to EMF, along with the irrefutable similarity of symptoms between "Microwave Sickness" and cellular phone user complaints, set the stage for legitimate concern about the biological effects of cellular phone radiation. Additionally, with widespread public use of cellular phones at its five-year mark, many scientists are worried that we are half-way to the "latency" associated with cancer, because it typically takes 10 years from initial exposure to the early disease state. Any recommendations produced from the WHO's International EMF Project may arrive too late for many cellular phone users. It thus becomes important for cellular phone users to take the initiative in educating themselves on the scientific evidence regarding health effects of such use (Chapter 3), and evaluate the suitability of adopting interventions to modify their exposure to cellular phone radiation (Chapter 4).

Cellular Phone Basics

How Cellular Phones Work

Terminology

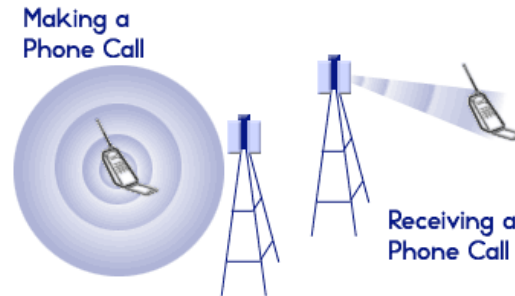
For purposes of this book, we establish these definitions for types of telephones:

- "corded telephones" – units in which the handset is connected by a wired to a base, which in turn is connected by a telephone jack that is wired to local telephone service.
- "wireless telephones" — four types, namely:
 - "cordless telephones" –the handset and base unit transmit and receive radiofrequency signals between themselves, with the base unit connected by a telephone jack that is wired to local telephone service.
 - "transportable" (bag) telephones operate with equipment stored in a small carrying case; the antenna of the bag phone usually extends from the carrying case. Use of transportable phones has declined sharply since the advent of cellular phones.
 - "mobile" (car) telephones have their antenna mounted on the outside of a car—on the window, fender, roof, or trunk, with the handset used inside the car.
NOTE: In Europe, the phrase "mobile phone" is the equivalent of the US phrase "cellular phone."
 - "cellular"("cell") phones are one-piece wireless devices where the antenna and handset are one piece, and the unit receives and transmits radiofrequency signals to a base station located on the ground.

Technology

Cellular phone technology works on a system of geographically separated zones called "cells." Each cell has its own "base station" that both receives and emits radio waves. When a call is placed from a cellular phone, a signal is sent from the cell phone antenna to that cell's base station antenna. The base station responds to the cellular phone signal by assigning the phone an

available radio frequency channel. When the RF channel is assigned, modulated radio signals are simultaneously received and transmitted, allowing voice information to be carried between the cell phone and the base. The base station transfers the call to a switching center, where the call can be transferred to a local telephone carrier or another cell phone.



There are three types of cellular phones, categorized based on the radiofrequency at which they transmit and receive.

- Analog cellular phones: operate at frequencies between 824 MHz and 894 MHz; produce a signal with a strength or frequency that can vary over a defined range, but the wave is continuous. With analog phones, voice messages are sent by varying either the wave's height or the number of waves per second. As energy hogs, analog phones beam eight times as much energy into the user's head as digital phones do.
- Digital cellular phones: operate at frequencies between 800 and 900 MHz; produce a signal with a strength or frequency that can vary in discrete steps. With digital technology, voice messages are sent in a series of rapid bursts or pulses to enable a greater density of users.
- Digital PCS (personal communication system) phones: in the US, PCS operates in the range of 1850 MHz to 1990 MHz; units conduct phone calls and also offer additional "personal communication" services such as paging, caller ID and e-mail.

NOTE: Global System Mobile (GSM) is the digital standard that operates worldwide outside of the United States. It operates at 900 and 1800 MHz in Europe and Asia, and at 1900 MHz in the US.

From a health perspective, the signals from each of these technology types are more similar than different in terms of potential biological impact.

The amount of radiation emitted by cellular phones depends on a number of factors:

- The manufacturer and model of the cellular phone (see SAR below).
- Number of "cells" in a geographical area, which depends upon the cellular phone traffic in that area. Large cities may have many cells per square mile, whereas a less-populated, rural area may have a single cell stretching over several square miles. The farther away a cell phone antenna is from its base station, the higher the power level needed to maintain the connection. Very small cells are therefore associated with much lower exposures.

Lennart Hardell, from University Hospital (Orebro, Sweden), and colleagues have found that users of cellular phones in rural areas may be at increased risk for developing brain tumors, as compared to residents in urban settings. The team studied (2005) 1,400 Swedish men and women, ages 20 to 80, who had been diagnosed with a malignant or benign brain tumor, and compared them to healthy counterparts living in the same area. Those rural residents who used cellular phones were three-times more likely to develop a brain tumor, with the risk being eight-times higher for a malignant tumor in rural residents (as compared to urban study subjects). The researchers posit that the cause of

the increased risk may be due to higher emissions from phones in rural areas, as a result of base stations being located further apart.

- Each geographical cell has a different number of available channels. Cellular phones operate ideally with the least amount of interference from neighboring channels. To help achieve optimal operation, cellular phones automatically step down to the lowest power level available that still maintains a connection with the base station. On the other hand, any physical obstacle, such as buildings or trees, interfering with the connection between base station and cell phone forces the base station to increase the power sent to that phone. Therefore the amount of power sent from a base station to a particular cellular phone can vary, even within a single call.

Note that for all types of cellular phones, the emissions are highest when the device is attempting to establish a connection (initialization), followed by when it is attempting to receive or transmit signals. "Stand-by" mode is generally associated with lower radiation emission.

Various research indicates that between 20% to 60% of the energy emitted from a mobile phone is absorbed by the user's head. The percentage absorbed depends on the design of the phone, type of aerial or antenna (the stubby ones which you can not extend are worse because they concentrate energy into the user's brain), and how far it is to the nearest base-station (the weaker the base station signal, the more the phone will power up to maintain contact with the network).

SAR

Development of Safety Guidelines

Various organizations and countries have developed standards for maximum limits of exposure by humans to cellular phone emissions. These standards recommend safe levels of exposure for both the general public and for workers in settings that have greater exposures (such as at base stations).

In the United States, the Federal Communications Commission (FCC) has issued safety guidelines for RF environmental exposure since 1985. Be mindful that the FCC, however, maintains that its guidelines are not safety regulations, because FCC is not a health and safety agency. The FCC guidelines for human exposure to RF electromagnetic fields are derived from the recommendations of two expert organizations, the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers (IEEE). In both cases, the recommendations were developed by scientific and engineering experts drawn from industry, government, and academia after extensive reviews of the scientific literature related to the biological effects of RF energy.

Many countries in Europe and elsewhere use exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The ICNIRP safety limits are generally similar to those of the NCRP and IEEE, with a few exceptions. For example, ICNIRP recommends different exposure levels in the lower and upper frequency ranges and for localized exposure from certain products such as hand-held wireless telephones. Currently, the World Health Organization is working to provide a framework for international harmonization of RF safety standards (see Electromagnetic Fields – International EMF Project above).

The NCRP, IEEE, and ICNIRP all have identified a whole-body Specific Absorption Rate (SAR) value of 4 watts per kilogram (W/kg) as a threshold level of exposure at which harmful biological effects may occur. Exposure guidelines in terms of field strength, power density and localized

SAR were then derived from this threshold value. In addition, the NCRP, IEEE, and ICNIRP guidelines vary depending on the frequency of the RF exposure. This is due to the finding that whole-body human absorption of RF energy varies with the frequency of the RF signal. The most restrictive limits on whole-body exposure are in the frequency range of 30 to 300 MHz where the human body absorbs RF energy most efficiently. For products that only expose part of the body, such as wireless phones, exposure limits in terms of SAR only are specified.

In the United States, the FCC requires that wireless phones sold comply with human exposure limit set by the FCC for cellular phones, which is based on the overall heating effects of radiofrequency energy (see Electromagnetic Fields – Complexity of the Possible Health Hazards above). The exposure limit was established by the FCC in 1996. Radiation levels are tested based on the specific absorption rate (SAR). The SAR is the amount of RF energy absorbed from the phone into the local tissues. In order to gain an FCC license, a phone's maximum SAR level must be less than 1.6 watts per kilogram (W/kg).

The European limit for cellular phone radiation is set at 2.0 W/kg. In May 2002, China drafted industry standards that set that nation's SAR at 1 w/kg – half of that in Europe and 60% lower than that in the US.

Measurement

In the US, every cell-phone model has to be tested and meet FCC standards confirming the SAR is less than 1.6 W/kg, before it is allowed to be sold. Testing is primarily done by the manufacturers themselves. Testing techniques vary somewhat, but are generally involve:

1. A mold shaped like a human head and torso is filled with a fluid mixture that is designed to simulate the electrical properties of human tissue.
2. The cell phone under review is placed on the outside of the mold.
3. A probe attached to a computer-controlled mechanical arm is inserted into the mixture at various locations.
4. The phone is made to transmit a signal at full power while the probe is moved through the mixture.
5. During the test, the phone's antenna is extended and retracted in order to check for any fluctuations in radiation that the phone might demonstrate in different configurations.
6. Phones are required to test below 1.6 W/kg averaged over 1 cubic gram of fluid.
7. The manufacturer is supposed to submit the highest SAR level measured during these tests to the FCC. Due to the lack of any industry-wide testing standard, the FCC must evaluate the individual procedures used by each manufacturer in certifying the SAR level of each new phone.



Your Phone's SAR

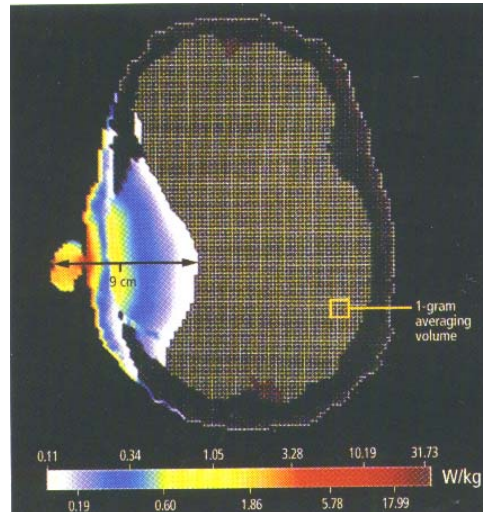
Information on SAR for a specific phone model can be obtained for many recently manufactured phones using the FCC identification (ID) number for that model. The FCC ID number is usually printed somewhere on the case of the phone. Sometimes it may be necessary to remove the battery pack to find the number. Once you have the ID number, go to the Internet address, www.fcc.gov/oet/fccid. On this page, you will see instructions for entering the FCC ID number. Type the FCC ID number exactly as requested (the Grantee Code is the first three characters, the Equipment Product Code is the rest of the FCC ID number). Then click on "Start Search." The "Grant of Equipment Authorization" for your telephone should appear. Read through the grant for the section on "SAR Compliance," "Certification of Compliance with FCC Rules for RF Exposure" or similar language. This section should contain the value(s) for typical or maximum SAR for your phone.

Phones and other products authorized since June 2, 2000, should have the maximum SAR levels noted directly on the "Grant of Equipment Authorization." For phones and products authorized between about mid-1998 and June 2000, detailed information on SAR levels is typically found in the exhibits associated with the grant. Once a grant is accessed, the exhibits can be viewed by clicking on "View Exhibit." Grants authorized prior to 1998 are not part of the electronic database but, rather, have been documented in the form of paper records.

The FCC database does not list phones by model number. Only as of 2000, the Cellular Telecommunications and Internet Association (CTIA; www.wow-com.com) began requiring phones it certified to provide SAR information to consumers in the instructional materials that come with the phones. In Appendix A, we present a Table of Cellular Phone Radiation Levels; up-to-date information may be found on the Internet at <http://reviews.cnet.com/cell-phone-radiation-levels/>.

Your Brain on Cellular Phones

This computer model of a human head in cross-section (see SAR Measurement above) shows the distribution of the energy absorbed from a cellular telephone handset radiating 600 mW at 835 MHz. Most of the energy is absorbed within the first 1 to 2 cm (0.4 to 0.5 in.) beneath the surface of the skull.



Chapter Closing Remarks

Current safety guidelines for cell phones assume no harmful effects, as long as the microwave radiation they emit does not cause heating of body tissue. Exposure limits are intended to protect us only from excessive temperatures caused by absorption of energy. However, living cells respond in non-thermal ways to the fields produced by cellular phones, and at intensities below the established safety threshold. In the concluding section of the United Kingdom's National Radiation Protection Board's "Doll Report" (1992), that organization remarks that "Animal studies conducted at frequencies above [just] 100kHz have provided some evidence for effects on tumour incidence..." of non-thermal effects of radiation.

A precedent exists for regulatory agencies to amend their maximum exposure limits years after they have been established. In the US, the government has lowered the maximum limits for lead in housepaint, as a result of data proving the health hazards became undeniable. What if, sometime in the future, our government recognizes that cellular phone emissions pose a health hazard due to effects other than heating, and consequentially lower the SAR or create a new limiting definition for cellular phone emissions? Millions of cellular phone users will have been lured into a false sense of security. Remember, too, that the agency that defines the SAR – the FCC – maintains that its guidelines are not safety regulations, because it is not a health and safety agency. We also cannot expect any insights from the Environmental Protection Agency, which had a critical presence in regulation of RF radiation, but, because of downsizing in the 1990s is no longer involved in this issue.

We urge you not to be complacent about your cellular phone radiation exposure. Carefully review the scientific literature on the biological hazards of cellular phone radiation (Chapter 3), and determine if your usage warrants taking protective actions to minimize your exposures (Chapter 4).

Chapter 3 Possible Biological Effects of Cellular Phone Radiation

As we have reviewed in Chapter 2, cellular phones emit low frequency electromagnetic fields (EMFs). Given that cellular phones only became broadly available to average consumers in the past five years, many scientific experts on the biological effects of EMFs warn that the full impact of cellular phone radiation may not be seen for another five years. Despite the suggestions by cellular phone manufacturers and their trade associations (Chapter 1) that their devices pose no human health risk, objective experts including government agencies acknowledge that there is a dearth of completed, reliable studies assessing the long-term implications of cellular phone use.

It is necessary for each of us who uses a cellular phone to become responsible users. We encourage you to become familiar with the body of scientific study on the biological effects of RF radiation, a segment of which is included in this chapter. By doing so, each of us is equipped with the information that allows us to make an educated determination as to our individual health risks and whether we may benefit from adopting techniques to minimize our exposures to cellular phone radiation (see Chapter 4).

Mechanisms of Damage

We need only reference past research on the history of research on the relationship between microwave radiation and human health (Chapter 1) on which to base a legitimate cause for concern for cellular phone emissions.

Cellular phone use can heat up brain structures. An Australian government discussion paper issued in March 1997 warned that "There is evidence that localized hot spots of energy deposition in the brain may occur as a consequence of internal reflections" that perpetuate the radiation after it enters the head. This "**thermal**" **biological effect** is characterized by irreversible damage to the most basic components in cells of living organisms: raising the temperature of cells by as little as a fraction of one degree (Fahrenheit) can be "**genotoxic**" – that is, cause **damage to cellular genetic material**. In the earlier years of cellular phone health hazards research, it was suspected that RF radiation caused DNA breakage. DNA breakage can cause problems with replication of the molecule, thus impairing cell division and causing problems to tissue and organs. More alarmingly, the DNA damage may show up as mutations that can be replicated and passed on to other cells, a mechanism that is suspected to contribute to cancer. The evidence on DNA damage triggered by cellular phone radiation dates back 15+ years:

- According to Dr. Garaj-Vhrovac (1992), cellular phone emissions increased the number of DNA aberrations in human lymphocytes (a group of white blood cells, responsible for the immune response).
- Noted EMF expert Dr. Henry Lai of the University of Washington (USA) has published several papers on DNA damage caused by microwave exposure. Dr. Lai (1995, 1996, 1997a, 1997b) observed that DNA damage occurred in the brain cells of live rats after only two hours of relatively low-level microwave exposure. The lowest intensity at which Dr. Lai identified DNA strand breaks was well within the range of the electromagnetic range of cellular phones, and most closely matched to that of the popular PCS-type phones.
- The Reflex study, funded by the European Union, found (2005) that electromagnetic radiation from cellular phones harm body cells and damage DNA. After exposing human and animal cells in the laboratory setting to electromagnetic fields typical of cellular phones, the

cells showed a significant increase in single and double-strand DNA breaks. In some cases, the damage was irreparable by the cell. Lead researcher Franz Adlkofer stated that: "We don't want to create a panic, but it is good to take precautions."

Recently, however, scientists have revised their suspicions relating to how cellular phone radiation causes genetic damage. A series of studies found that human blood cells could be damaged by the formation and accumulation of micronuclei – smaller versions of the cell nucleus (where genetic material is housed) that compete with the main nucleus, thereby altering proper cell function and division. Cells exposed to cellular phone radiation became unable to repair their broken DNA, thus producing micronuclei. In a compilation of research (1998) edited by Dr. Carlo of the Wireless Technology Research program, separate teams led by Drs. Donner, Tice, and Lai all have reported that genetic damage to human blood cells, manifesting as micronucleus formation, could "unequivocally" result from "all cellular phone technologies."

Based on more recent studies, scientists presently suspect that the temperature rises in cells induced by RF radiation typical of cellular phones can cause other types of **thermal stress**:

- Dr. Mason and colleagues reported (1997) that two areas of the brain – the hypothalamus (responsible for maintaining balance of the nervous and endocrine systems) and caudate nucleus (responsible for coordinating movement) – were particularly sensitive to thermal stress. In this study, the researchers observed that rises in the temperature of cells in the brain, resulting from cellular phone emissions, caused distinct alterations in levels of amino acids – building blocks of neurotransmitters, the chemicals involved in communications between brain cells and the brain and the nervous system.
- In its first major set of research findings, the Wireless Technology Research (WTR) research program reported (1999) that a test conducted at Stanford University (California USA) found chromosomal damage to human blood cells that were exposed to cellular phone radiation.

As a result, some scientists speculate that thermal stress causes impairments in the ability of cells to repair or regulate themselves.

It is important to be aware that the main biological effect of cellular phone radiation may not be in heating-related damage. Indeed, these "**non-thermal" biological effects** are mechanisms that may account for the role of RF radiation in diseases including cancer, respiratory ailments, and infertility. On this possibility, Dr. John Stather, the Assistant Director of the United Kingdom's National Radiation Protection Board (NRPB) remarked: "Until recently we believed any harmful effects from microwaves were due to their heating effects, which would be negligible at the low powers used by mobile phones. Now there might be another effect at work and we are much less certain."

Cells rely on the movement of ions (electrically charged molecules) across their membranes to generate energy for growth, development, and division. **The energy-generating ion transport process** is affected by EMF, and the changes include altered permeability of the cell membrane, altered signal transduction, and changes in the enzymes involved in ion transport. Microwave radiation at one-tenth of the United Kingdom's NRPB Guidance level have been shown to alter enzymes involved in the electrochemical energy generating process (Pershin 1994), as well as the flow of calcium ions across the cell membrane (Cleary 1992).

Cell growth is regulated by **gap junction intracellular communication** (GJIC), a process in which ions move from one cell to another across a passage at which the electrical resistance between them is low. Chemical messengers – including hormones – also move among cells via the GJIC. Dr. Chiang (1998) found that radiation in the range that is emitted by cellular phones suppressed GJIC, with pulsed (digital) emissions having a greater impact than continuous (analog). The extent of the suppression was correlated to the amount of exposure. Dr. Chiang's

work suggests that major body system including cardiac (relying on electrical impulses) and hormone (relying on chemical impulses) may be affected by cellular phone radiation.

An important type of non-thermal effect of cellular-phone type radiation involves the **blood-brain barrier (BBB)**. The BBB is a cell layer between the blood that circulates in the blood vessels of the brain and the actual brain tissue. A healthy BBB lets oxygen and nutrients into the brain, while keeping waste products out. Most importantly, a healthy BBB protects the brain from exposure to poisons including toxic agents. A weakened BBB is **permeable**, that is, unable to correctly screen the traffic of molecules in and out of the brain. Intelligence documents show that as early as twenty years ago, Western governments knew about Soviet experiments in which cellular-phone type radiation was used to cause brain damage. The uncensored documents reveal that Soviet military scientists had successfully used microwaves of the type used by cellular phones to weaken the blood brain barrier. In an interview by a London newspaper with Dr. Louis Slesin (1999), US Army scientists had succeeded in duplicating the Soviet experiments by 1977 – a full eight years before mobile phones began to become accessible by the general public. It is also interesting to note that at that time, the safety standards for exposure to RF radiation in the Soviet Union were almost 1000 times more stringent than United States standards. To this day, Russia has maintained its restrictive standard, refusing to back down as recently as a 1999 international conference on electromagnetic safety at which they expressed their concern over non-thermal effects and subjective (self-reported) symptoms.

Research from Lund University (Sweden) (1999) tracked the migration of albumin across the BBB in rats that were exposed to cellular phone radiation. Albumin is a protein that is naturally present in the blood but not in the brain; previous studies have shown that brain nerve cells that are exposed to albumin die. The researchers found that albumin leaked through the rats' BBB after cell phone radiation exposure. Even when the microwaves were not strong enough to heat up the rats' heads, the scientists detected the effect deep in the center of their brains. The researchers remarked that the length of time using a cellular phone was irrelevant, the BBB was opened at once upon exposure. Moreover, the albumin remained in the rat brains for several days. As a result of these findings, the team warned that their study indicates that molecules of equal or smaller size to albumin could also get into the brain. According to the researchers, this increased permeability could:

- allow certain proteins found in the blood to cross into the brain, causing autoimmune diseases such as multiple sclerosis
- result in damaged nerve cells that may be implicated in dementia, premature aging, and Parkinson's disease
- result in inflamed brain cells that may be indirectly be linked to Alzheimer's disease
- allow the brain to become exposed to medications not normally allowed past the BBB and thus possibly cause unexpected damage

Because the BBB of humans and rats are similar in function, medical experts urged for attention to this study. Professor Leif Salford, the lead researcher and a neurologist, remarked that: "We saw opening of the blood-brain barrier even after a short exposure to radiation at the same level as mobile phones. We're seeing extremely small amounts of protein and we don't know how dangerous it is."

Subsequent research at the University of Munster (Germany) (2000) found that radiation at the high-end of the range for cellular phones significantly increased the permeability of the BBB to sucrose, a sugar molecule that, like certain proteins, is safe in the blood but not in the brain. Additionally a report (1999) from Canada's Radiation Protection Bureau cautioned that RF radiation can "increase the permeability of the blood-brain-barrier and modulate the action of some psychoactive drugs."

Studies on the non-thermal effects of cellular phone radiation also have focused on **heat shock proteins (HSPs)**. While there are a wide range of heat shock proteins that our brains can make, they all perform a similar function – to bind to unfolded proteins, which are not useful to cells, and refold them. On a normal basis, the brain releases HSPs as a defensive mechanism in response to heat stress and chemical toxins, triggers that can cause proteins to unfold. The HSP response can be activated by a brief non-thermal radiation at RF and microwave frequencies, and can take a number of hours to disappear out of the system. This is disconcerting for heavy users of cellular phones for two reasons. First, some scientists suspect that heat shock proteins may be chronically present, and, over a number of years, may increase the risk of cancer. Secondly, some scientists believe that in heavy cellular phone users, repeated activation of the heat shock protein response causes the mechanism to shut down, making it unavailable when most needed. As a result, the normally protective HSP response can become a health problem, as indicated by the following studies:

- Microwaves at non-thermal power levels have been shown to elicit the heat shock protein response in organisms. (Daniells 1998, De Pomerai 1999)
- Fertility of organisms is altered by the HSP response (De Pomerai 1999, 2002) (see Special Populations – Pregnant Women below).
- Microwave radiation can cause physiological changes in brains and brain cells (see Brain Function below)
- In a review of research on heat shock proteins and their role in cancer, Dr. Jolly (2000) found evidence that repeated activation of HSPs could cause cells to become cancerous.
- Reporting on findings (2002) of a two-year long study, Dr. Dariusz Leszczynski at Finland's Radiation and Nuclear Safety Authority found that an hour of cellular phone exposure shrinks human BBB cells in culture, causing gaps between the cells through which toxins could enter the brain. Additionally, the activity of one HSP in particular – HSP27 – was markedly increased. Because HSP27 is associated with the proper functioning of the BBB, these findings are suggestive that RF radiation could promote permeability of the BBB through overactivity of a HSP.

Cellular phone-type radiation may alter the **shape of cells and** thereby promote radiation damage. Dr. French (1997) exposed human cells to radiation in the frequency of digital cellular phones for 20 minutes, 3 times a day for 7 days. At a low power density, Dr. French observed that the rate of DNA synthesis decreased, and the cells flattened and spread out. At higher power density, the cells became even more flattened and their membranes filled with actin, a protein fragment. New high-power magnification technology has discovered that human cells are not spherical in shape, but instead are cylindrical. As a result, Dr. Jose Luis Sebastian and team from the University Complutense (Spain) (2001) recalculated the impact of electric field transmitted by cellular phones on cells. Dr. Sebastian's calculations suggested that human cells may amplify cellular phone radiation.

Another non-thermal mechanism of cellular phone radiation effects suggests that it matches the **resonant frequency of some areas of brain cells**, causing them to vibrate. This is suggested to have a role in the changes in cognitive performance and headaches reported by some cellular phone users.

In 2008, Dariusz Leszczynski, from the Finish Radiation and Nuclear Safety Authority published data that clearly demonstrated specific molecular effects of cellular phone radiation. When the research team exposed 10 female volunteers to radiation from GSM cellular phones to simulate hour-long phone calls, amongst all the volunteers they found that the numbers of one protein

increased by 90% and another protein decreased by 32%. This study is the first to suggest that cellular phone radiation may negatively impact the expression of certain proteins in humans.

Clearly, much more research to fully elucidate all mechanisms through which cellular phone radiation may damage the health of our cells and tissues is necessary. Being aware of these mechanisms allows us to better understand the scientific studies that associate cellular phone radiation with disease.

Cancer

For decades, scientists, public policy groups, and government agencies around the world have been debating the role of environmental risk factors – influences in our surroundings – in causing or worsening diseases. The discussion is particularly heated with regard to a possible link between EMF and cancer. There has been a fair amount of respectable research documenting at least a weak association between prolonged and/or intense exposures to various types of electromagnetic fields and the onset of brain cancer, leukemia, and lymphoma.

According to the American Cancer Society, between 1973 and 1997, the number of brain cancer diagnoses rose 18% while brain cancer deaths rose 11%. Brain cancer is almost always fatal, as there are rarely any benign brain tumors found. Brain cancer typically does not spread to other parts of the body, rather it is a fast-moving cancer isolated to this very delicate organ. Each year, 17,000 Americans are diagnosed with brain cancer and another 13,000 die from it. Most brain cancers cannot presently be attributed to presently established risk factors.

Leukemia, a cancer of the white blood cells, will be diagnosed in about 30,800 Americans in 2002. Leukemia starts in the bone marrow and spreads to the blood, lymph nodes, the spleen, liver, central nervous system and other organs. It is known that significant radiation exposure is a major environmental risk factor in developing childhood leukemia. Acute myelogenous leukemia (AML, also called Acute nonlymphocytic leukemia – ANLL) affects children and adults. While smoking causes 20% of all cases of AML, environmental factors including long-term exposure to toxic chemicals and high-dose radiation exposure also can cause it. While most cases of leukemia are not related to EMF exposure, the possibility of it being a risk factor as raised by several reliable studies cannot be ruled out.

Lymphoma is a cancer that starts in the lymphatic tissue, which includes lymph nodes, the thymus (found behind the chest bone and in front of the heart), the spleen (on the left side of the abdomen next to the stomach), the tonsils and adenoids, in the bone marrow, and parts of the digestive and respiratory systems. Lymphoma cripples the ability for the lymphatic system to filter germs and cancer cells, as well as fluid, from the body. Lymphomas can spread to other organs. Lymphoma has two forms, of which the non-Hodgkin's type is more prevalent: about 53,900 Americans will be diagnosed with it in 2002. People exposed to high-dose radiation are at increased risk of non-Hodgkin's lymphoma. Because of this relationship with radiation, the possibility of EMF as a risk factor for lymphoma cannot be ruled out.

Overall, the data available to-date on RF radiation and cancer has been too inconsistent to establish a direct and indisputable cause-and-effect relationship. Research involving lab animals is ongoing, and now supplemented by numerous studies involving humans. Broad cross-population analyses ("epidemiological surveys") are just now beginning to produce results. The following brief review documents the major studies that, while occasionally conflicting, do, as a whole, present a body of evidence of association between cancer and cellular phone radiation substantial enough to raise concern.

The first laboratory study to associate cellular phone radiation with increased an rate of cancer was published by a team of scientists from Royal Adelaide Hospital. Dr. Repacholi and colleagues (1997) conducted an 18-month long study using 200 lymphoma-prone mice as highly sensitive detectors of possible cancer promotion over their lifespan. Half of the animals were exposed and half not, to pulsed digital phone radiation (GSM-type, see Chapter 2) at a power density roughly equal to a cellular phone transmitting for two 30-minute periods each day. Dr. Repacholi found that cancer rates doubled in the exposed group – lymphomas were the major type of tumor that occurred with increased incidence. It is interesting to note that Dr. Repacholi's study was funded by the Australia's national telephone carrier Telstra. Not surprisingly, the response by the cellular phone industry was that "men aren't rodents." Rebutted the scientific community, "DNA is DNA. At the level of normal cell growth processes, human and animal cells act very similar."

Extrapolating from the United Kingdom's National Radiation Protection Board figures, most GSM digital cellular phones put out between 10 to 30 times more radiation into the user's head than to which the mice in Dr. Repacholi's study were exposed. Many scientists agree that if there are cancer connections with the use of cellular phones, they are most likely to be expressed in adult leukemias, which typically take between 10 and 30 years to appear and be diagnosed. As a result, it is unlikely that the cancer trend will begin to appear for another three to five years, at the earliest. Extended period chronic exposure to radiation of the type emitted by cellular phones may be already wreaking havoc on the human organism.

Data on the effects of analog (Nordic Mobile Telephone [NMT]-type) cellular phones is expected to yield the first broad-based findings on possible cancer trends in humans. This is because the NMT technology was adopted in the early 1980s, giving it a ten-year head start over the now-preferred digital (GSM-type) system. In one of the first case-controlled studies of humans and cellular phones, studying residents of Sweden – one of the first countries to engage in widespread cellular phone use – Swedish cancer specialist Dr. Lennart Hardell and colleagues at the Orebro University Hospital found (1999) an increased risk of the occurrence of tumor in the temporal (side) or occipital (back) area of the brain, on the same side as the cellular phone had been used. Regardless which side of the head it was held against, the risk of a brain tumor increased by almost 2 1/2 times in analog phone users. In a follow-up case-control study with exposure assessed by questionnaires, Dr. Hardell (2000) again and separately determined that "use of a cellular telephone was associated with an increased risk in the anatomic area with highest exposure." On his findings, Dr. Hardell has commented that "there is a biological indication that there is a problem ... I think that until we have the definite conclusion, the definitive results of much larger studies, we need to minimize exposure to human beings."

Two studies commissioned by the industry-sponsored Wireless Technology Research program (see Chapter 1) produced compelling findings correlating cellular phone use to cancer. In the study conducted by Dr. Dreyer and colleagues (1999), the rate of brain cancer mortality in hand-held cellular-phone users, as compared with car phone users (antenna is physically detached and located outside the rear of the car), was nearly three times greater. Some controversy surrounded this study because the number of persons in this group was small, and the follow-up period was short (1 year).

The second WTR-funded study, conducted by Dr. Joshua Muscat and colleagues at the American Health Foundation (New York USA), is suggestive of potential risk. The team collected data on newly diagnosed cases of brain cancer from five hospitals across the United States, and analyzed the duration and frequency of cellular phone usage in these patients. The majority of the brain

cancers in the study were found to be outside of the 2- to 3- inch exposure pattern that is accepted as the depth of RF radiation penetration from a cellular phone (see Chapter 2). However, by cross-correlating the cellular phone usage interviews, the researchers identified a statistically significant increase in risk of neurocytoma – a type of brain tumor that grows from the outside edges of the brain inward – with cellular phone use. Additionally, those patients who reported using their phone on the right side of the head had a significant increase in tumors on that side of the head, which was independently confirmed by Dr. Hardell's work (1999) (see above). Unfortunately, skeptics of the study choose to highlight that the study found no evidence of increased risk of brain cancer when data from all the primary brain cancer cases and matching controls were amassed in a collective analysis, thus diluting the significance of Dr. Muscat's work and confusing the media and public.

A 20-year study of servicemen in Poland (2000) has established the strongest link yet between mobile phones and cancer. It correlated a high cancer death rate among soldiers exposed to microwave radiation – the same as that emitted by cellular phones. This research is widely acknowledged as the world's the first significant study to demonstrate a link between humans, microwave radiation and cancer. In the study, conducted at the Military Institute of Hygiene and Epidemiology in Warsaw and led by Dr. Stanislaw Szmigielski, the researchers reviewed the medical records of hundreds of thousands of servicemen, 3% of whom were exposed to the radiation, including at frequencies and modes similar to cellular phone emissions, between 1970 and 1990. It then compared their medical histories and death rates to a group of soldiers who were not. Researchers found those exposed – largely through using military equipment – were more likely to get some cancers. They were also more likely to develop a whole range of cancers 10 years earlier than those who had not been. There were higher death rates from cancers of the skin, brain, blood, digestive system, blood and lymphatic system among the exposed group. Exact statistics for the increased risk found in this study will not be available until the scientists have completed their work, in 2005.

Dr. W. Ross Adey from University of California (USA) (2000) reported that a pregnant rat's exposure to phone-like radiation at any of three power levels alters the activity of an enzyme – ornithine decarboxylase, associated with cancer onset – in the fetuses' brains. Dr. Adey suggests that the increased enzyme activity may explain tumors observed in rats exposed to RF energy for extended periods of time.

Noting that in adults, the flat bones of the skull contain active marrow and are in the direct path of RF radiation emissions from a cellular phone, Dr. Carlo recommended (2000) that adult-onset leukemia should be assessed as a possible outcome of RF radiation exposure. Additionally, several studies have repeatedly shown that a few minutes' exposure to cellular phone-type radiation can transform a 5% active cancer into a 95% active cancer for the duration of the exposure and for a short time afterwards.

A large-scale study in Denmark (2001) linked data on all of the 420,095 cellular phone users in that country between 1982 and 1995 to the Danish Cancer Registry. Study investigators, led by Dr. Johansen, did not find an increased risk of developing brain tumors overall. They also did not find that brain tumors occurred with greater frequency on the side of the head for which cellular phone users reported using the device. Additionally, Dr. Johansen and team did not find any significant association with other cancers, including salivary gland, eye, leukemia, and 22 other cancer types. However, this registry-based approach to brain tumor analysis came under scrutiny when Dr. Auvinen and colleagues from the Finnish Cancer Registry reported (2002) that this technique has "limited value in risk assessment of cellular phone use owing to lack of information on exposure."

In an epidemiological study by Dr. Inskip and colleagues (2001), the researchers compared 782 brain cancer patients diagnosed in Phoenix (Arizona USA), Boston (Massachusetts USA), and Pittsburgh (Pennsylvania USA) between 1994 and 1998, and compared them with age- and sex-matched controls. Dr. Inskip found no evidence of increased risk for people using cellular phones on any regular basis, and tumors did not occur at a greater rate on the side on which the phone was used. It is important to note that the method by which the researchers defined cellular phone use may have been somewhat flawed: the make and model of the phone was not collected, as the researchers believed that other variables that were more significant were not able to be collected, namely the distance of the users from the nearest base station at each time a call was made.

Dr. Stang and colleagues from the University of Essen (Germany) (2001) found that mobile phone use may be associated with cancer of the eye. The researchers conducted a hospital-based analysis of the relationship between uveal melanoma (a specific type of eye cancer) and occupational exposures to different sources of electromagnetic radiation. They interviewed a total of 118 men and women with uveal melanoma and 475 healthy counterparts. Dr. Stang found a significantly elevated risk for those people whose jobs involved heavy or extended use of radiofrequency/microwave transmitting devices such as radio sets and cellular phones. The team was able to rule out other sources of electromagnetic radiation (high-voltage lines, electrical machines, complex electrical environments, computer monitors, and radar units) as contributing to eye cancer.

Dr. Muscat and the American Health Foundation published (2002) a report that found no correlation between acoustic neuromas (tumors of the inner ear) and cellular phone use. However, a number of shortcomings with this study have been identified. First, the study only included infrequent cellular phone users, as opposed to individuals who use cellular phones more often and/or every day. Secondly, the study group consisted only of 90 cases, which, according to Dr. Carlo, is too small a group from which to extrapolate to make a public health statement.

Continuing on his works published in 1999 and 2000, Dr. Hardell and colleagues again found (2002) a higher incidence of brain tumors on the sides of heads most frequently involved in hand-held cellular phone use. The most frequently found tumor type of with this lateral association was acoustic neurinoma (cancers involving the auditory nerve).

Analog NMT cellular phones were found to place users at a noticeably increased risk of developing brain tumors than those who did not use the phones, according to a startling large-scale study (2002) conducted by Dr. Kjell Hanson Mild of the Swedish Institute for Working Life and Dr. Hardell of Orebro University Hospital (Sweden). The researchers studied data on 1,617 Swedish patients diagnosed with brain tumors between 1997 and 2000 and age- and sex-matched controls. Those brain cancer patients who used NMT cellular phones had a 30% higher risk of developing brain tumors. For people using the phones for more than 10 years, the risk shot up dramatically to 80%. As for the location of the tumors, the risk was 2.5 times higher for the same side as the phone was used, and specifically a 3.5 times greater risk was found for auditory nerve tumors to occur.

Fiorenzo Marinelli, from the National Research Council (Italy), and colleagues published (2002) findings that show electromagnetic radiation from cellular phones makes cancer cells grow more aggressively. When the researchers exposed leukemia cells in the laboratory to 48 hours of cellular phone radiation, they initially killed the cancer cells but made the surviving tumor cells replicate more rapidly. The team speculates that a survival mechanism was triggered, causing the remaining cancer cells to divide aggressively.

Kjell Mild, and colleagues from the Swedish National Institute for Working Life, studied (2006) mobile phone use in 905 people, ages 20 to 80, who had been diagnosed with a malignant brain tumor. The team found that nearly 10% of subjects with brain tumors were high users of mobile phones, making 2,000 hours or more of cellular phone calls in their lifetimes. In the high-user group, the risk was then calculated to stand at a 240% increased risk for a malignant tumor on the side of the head on which the phone is used.

In 2008, Dr. Vini Khurana, a top neurosurgeon who has reviewed more than 100 studies on the effects of mobile phones, drafted a devastating indictment of the health risks of may double the risk of brain cancer. While conceding that cellular phones can save lives in emergencies, Dr. Khurana urges that “there is a significant and increasing body of evidence for a link between mobile phone usage and certain brain tumors,” and that “this danger has far broader public health ramifications than asbestos and smoking.”

Also in 2008, Dr. Siegal Sadetzki, a researcher at Tel Aviv University (Israel), reported the most definitive data to-date linking cellular phone usage and the development of tumors. Publishing her results in the *American Journal of Epidemiology*, she and her colleagues found that heavy cell phone users were subject to a higher risk of benign and malignant tumors of the salivary gland. Specifically, those who used a cell phone heavily on the side of the head where the tumor developed were found to have an increased risk of about 50% for developing a tumor of the main salivary gland (parotid), compared to those who did not use cell phones. Additionally, the study also found an increased risk of cancer for heavy users who lived in rural areas; due to fewer antennas, cell phones in rural areas emit more radiation to communicate effectively. Comments Dr. Sadetzki: “I believe precautions should be taken in order to diminish the exposure and lower the risk for health hazards.” She recommends that people use hands-free devices at all times, and when talking, hold the phone away from one’s body. Less frequent calls, shorter in duration, should also have some preventative effect. (See Chapter 4).

Finally, it is important to point out that RF radiation can have a major adverse impact on the efficacy of radiotherapy, a common treatment for cancers. In 1974, Dr. John Holt, the first Medical Director of the Institute of Radiotherapy and Oncology of Western Australia, and colleagues found that RF radiation can radio-sensitize a malignant tumor, thus rendering it resistant to treatment with radiotherapy. Dr. Holt’s team found that some cancers had their radio-sensitivity increased by a factor exceeding 100 times. Moreover, every cancer tested by the researchers demonstrated an increase in sensitivity.

Brain Function

Scientists have shown that cellular phone-type RF radiation adversely affects the nervous system. As a specialized part of the nervous system, the brain is particularly sensitive to RF radiation. With reference to the preceding section, brain cancers have been on the rise in the past several decades, and there is some evidence that associates cellular phone radiation with that trend. Non life-threatening brain changes can also result from cellular phone emissions, namely cognitive alterations. It is important to be aware that changes in memory, learning, reaction time, etc. may persist well after the exposure itself. In a series of experiments with 24 volunteers exposed to RF radiation typical of cellular phones, Dr. Lebedeva and colleagues from the Russian Academy of Sciences (2000) found it caused direct stimulation of the cerebral cortex – the region of the brain responsible for consciousness and the complex thinking processes in humans – which continued even after exposure was stopped.

Dr. Leif Salford, from Lund University (Sweden), and colleagues published (2003) data showing for the first time an unambiguous link between cellular phone radiation and brain damage in rats. The team exposed 32 rats to 2 hours of electromagnetic radiation from GSM cellular phones. Fifty days after the exposure, the rat brains showed significant blood vessel leakage, as well as areas of shrunken, damaged neurons. The higher the radiation exposure level, the more damage was apparent. The researchers suggest that if human brains are similarly affected, "the damage could produce measurable, long-term mental deficits."

Dr. Paolod Rossini, from Fatebenefratelli Hospital (Milan, Italy), and colleagues studied (2006) 15 young male volunteers, using transcranial magnetic stimulation to check the brain function while each study subject carried on a 45-minute conversation on a GSM cellular phone. In 12 of the subjects, the team found that the cells in the brain's motor cortex (the region closest to the cellular phone when held to the head) were excited and did not return to normal activity levels until one-hour after the phone usage ended. The team warns that this may suggest that cellular phone use in epileptics may be counterindicated, as the additional excitability triggered may cause seizures.

Memory

A number of studies implicate cellular phone radiation in causing adverse memory changes. Dr. Rick Hold and colleagues from the Defense Establishment Research Agency (United Kingdom) (1998) discovered that cellular phone signals disrupt the part of the brain that controls memory and learning. The researchers found that the "signals made no difference in their measurements for a short time, but then readings plunged off the graph ... the effect would have caused sudden memory loss and confusion." Commenting on his study, Dr. Hold said, "this is the first real evidence that these sort of radio waves do have an effect on the brain."

In research conducted by Dr. Lai (2000), he found that microwaves similar to those emitted by cellular phones impaired long-term memory. Dr. Lai subjected 100 rats to a swimming maze in which they all learned to find hidden safety platforms in a pool of cloudy water. Afterwards, he exposed some of the rats to short bursts of low-level microwaves. When they were challenged to navigate the maze again, the exposed rats forgot the location of the safety platforms, while the unexposed rats retained their spatial memories. Dr. Lai remarked on his findings that "the long-term memory of virtually all the exposed rats appeared to have been affected. Short-term memory loss is just being unable to remember something which you have just done or glanced at. Long-term memory is something which has been learned or recalled and stored in the brain. The data from this latest study is certainly a cause for concern."

Dr. Kraus and colleagues from the University of Turku (Finland) (2000) found that high-frequency cellular phone radiation significantly modified several aspects of brain responses during a memory task.

Learning

Nitric oxide is a gas that mediates cell-to-cell communication in the brain. Nitric oxide is produced by an enzyme, nitric oxide synthase (NOS). Increased levels of NOS are released by the hippocampus and cerebellum areas of the brain to promote the learning process. A study by Dr. Ding and team found (1998) that the number of NOS neurons, as well as the extent of their activity, was decreased as soon as 1 1/2 hours after exposure to RF radiation. As a result, Dr. Ding observed that the rats' ability to learn was obstructed.

Reaction Time

In a British government-funded study, Dr. Alan Preece of Bristol University (United Kingdom) (1999) tested the memory and reaction times to visual stimuli. Thirty-six university volunteers were exposed to 20 to 30 minutes of mobile phone type radiation, then asked to make decisions that relied on the visual cortex – the part of the brain involved in processing visual cues. RF emissions from both digital and analog signals correlated with a reduction in the time it took users to answer simple questions. The improvement was small, just 15 milliseconds. A separate study, conducted in Finland, also recorded a similar drop in reaction time among people during RF exposures. Dr. Preece proposes that the quickened reaction times demonstrate that cellular phone emissions are biologically active, suggesting that the RF radiation stimulates production of heat shock proteins (see Mechanisms above), and therefore bloodflow, in the angular gyrus – the area of the brain that is involved in decision making. Dr. Preece cautions that the short-lived benefit to reaction time is not considered to outweigh the potential damage caused by repeated or chronic stimulation of the HSP mechanism.

Joshua Cohen, from the Harvard Center for Risk Analysis (United States), and colleagues studied (2003) the risks of using a cellular phone while driving a vehicle. The researchers found that the use of cellular phones while driving may increase the number of crashes by about 6%. The risk of accident was the same whether using a handheld cellular phone or a hands-free set, as the team cited distractions of having a conversation as a major culprit.

Completion of Tasks

Much alarm has been given to the dangers of driving an automobile while using the cellular phone. The National Conference of State Legislatures estimates 600 to 1,000 such needless tragedies occurred in 2001, and that as many as 2,000 motorists could be killed annually by 2004 by distracted drivers. Nationally, officials believe up to 30% of crashes are caused by driver distractions that include mobile communication devices. The National Highway Transportation Safety Board reported that in 1995, when there were 33 million cellular phone subscribers in the United States, an estimated 3,837 car crashes were the result of drivers using hand-held cellular phones. The idea of being "driven to distraction" may have a partial biological basis. Two studies support this notion:

- Dr. Eulitz and colleagues reported (1998) that pulsed (ie, digital) cellular phone emissions altered the brain's response to auditory stimuli (sound triggers). The effect manifested when human volunteers were asked to complete tasks involving sound, while being exposed to cellular phone radiation. The effect was more pronounced with increasingly higher digital frequencies.
- Dr. Freude (1998) found that exposure to cellular phone radiation caused a significant decrease in the activity of certain regions of the brain. The effect manifested when human volunteers attempted to complete a complex visual task involving thinking skills, while being exposed to cellular phone radiation. Subsequent research by the same group (2000) reconfirmed the earlier study data, stating that there is "a selected EMF effect on particular aspects of human information processing."

Automotive giant General Motors has taken the issue of driver distraction quite seriously. In August 2002, they announced a collaboration with the Brain Imaging Research Division of the Wayne State University School of Medicine (Michigan USA) to examine the underlying physiological causes of driver distraction. In this project, the researchers will use functional MRI (magnetic resonance imaging), brain scans, human performance data, virtual reality simulation, and state-of-the-art computing technologies to study driver performance and potential distractions. In particular, the fMRI is anticipated to enable a better understanding about how

people process sound, sight, and other sensory information – which, as the two studies mentioned above indicate, may be affected by cellular phone radiation exposure.

Brainwave Alterations

The EEG is a diagnostic device that allows measurement of brainwaves, which indicate the electrical activity of the brain. One of the most important EEG measurements is that of alpha wave activity: alpha waves are the brainwaves we exhibit during consciousness, creativity, and thought. Drs. von Klitzing (1995) and Dr. Reiser (1995) separately have shown that the alpha wave power density is delayed in the awake EEG of adults exposed to radiation from a cellular phone. When humans are exposed to RF radiation of the cellular phone-type, scientists have found alpha wave activity to be altered extremely, both during exposure and continuing after exposure for several hours (Klitzing 1995). The same biological effect may contribute to Alzheimer's Disease (Sobel 1996). Additionally, it is important to note that researchers could induce this biological effect with RF frequencies lower than international limiting values established for cellular phones. As a result, some scientists warn that even greater alpha wave interruptions may result from using the higher-frequency digital GSM and PCS cellular phones.

Noted electromagnetic radiation expert Dr. Hyland of the University of Warwick (United Kingdom)/International Institute of Biophysics (Germany) reported (2000) to the European Union that an adult woman with no previous history of epilepsy in either herself or her family began suffering from Grand Mal seizures (the most severe type, involving the entire body) immediately following intensive use of a cellular phone.

When the TETRA system in the London Underground was introduced in order to allow cellular phone communications in the subway system, scientists became very concerned. According to Dr. Hyland, TETRA operates at 17 Hz. This is the frequency of beta brainwaves in humans. It is also the frequency at which a flashing visible light can induce seizures in photosensitive epileptics. As a result, experts including Dr. Hyland have recommended that low-frequency modulations, including that at which cellular phones operate and fall in the range of human brainwaves including alpha and beta, be excluded as an acceptable telecommunications transmission signal.

General Malaise

Europe has led the world in the adoption of cellular phone technology. Even a decade ago, when US cellular phone use was a rarity, 10 percent of Swedes had already gone wireless. In 2000, 40% of Danes, 50% of Norwegians and Swedes, and almost 60% of Finns used cellular phones. So when data on the role of cellular phones in human health in these three countries is released, the world takes notice. By all estimates, this is the population from which many experts expect to see the first long-term definitive studies to originate. The Swedish National Institute for Working Life has taken an important role in coordinating these studies. In the first of these, Dr. Monica Sandstrom (2000) unveiled data on 5,000 cellular phone users in Norway and another 12,000 in Sweden. The findings form a compelling argument against excessive cellular phone use:

- One-quarter of the Norwegian users feel warmth on or behind the ear when they use their phones. The same trend was observed in Sweden, with slightly lower incidence reported.

- Twenty percent of the Norwegian participants linked frequent headaches and recurring fatigue to cellular phone use. The same trend was observed in Sweden, with slightly lower incidence reported.
- At least one of the symptoms noted, which include dizziness, concentration difficulties, memory loss, and a burning sensation, showed up in 47% of people who reported using cellular phones for an hour or more daily.

Dr. Sandstrom also reported that "people using analog phones reported more symptoms and more sensations of all kinds."

Allen H. Frey, a Washington, D.C.- area consultant who has conducted cellular phone studies, encourages serious consideration on the findings in Dr. Sandstrom's study. He warns that headaches, nausea, and reports of warming "could be merely the most obvious symptoms that something else is going on. There are some real indications of a hazard here."

Headache

Numerous studies have reported a link between headaches and cellular phone use. Microwave research conducted in the 1960s by Dr. Frey may suggest a partial basis for this link. Forty years ago, Dr. Frey's study subjects were reporting headaches from microwave energy exposure at roughly the same frequencies and modulations as that present in today's cellular telephone emissions. This research ultimately contributed to a concept that became known as "microwave hearing," or the act of creating audible signals inside the head without a physical connection to a device. According to Dr. Frey (1998), cellular phone transmitting frequencies fall in the most sensitive band for the microwave hearing effect. Additionally, the transmitting frequencies for cellular phones are also in the band that has maximal penetration into the head. Further, when the head is shielded from the microwave energy, the area of the head that needs to be exposed to the microwaves in order for people to perceive the effect is in proximity to the antenna of present day cellular telephones. To sum up his impressions, Dr. Frey warns that "these current reports of headaches may be the canary in the coal mine, warning of biologically significant effects."

Dr. Bruce Hocking, at one time the Chief Medical Officer of Australia's national telephone carrier Telstra, reported (1998) on examinations of 40 cellular phone users who complained of unpleasant sensations such as a burning feeling or a dull ache mainly occurring in certain areas of the head (temporal [side], occipital [back], or auricular [around the ear]). The symptoms often began minutes after beginning a call, but could come on later during the day. Symptoms usually ceased within an hour after the call, but sometimes persisted until evening. Symptoms did not occur with a non-cellular phone handset, and were different from ordinary headaches encountered by the subjects. Additionally, there were several reports suggested effects that were intracranial (deeper in the brain). Three respondents reported symptoms despite wearing their cellular phones on their belts. Dr Hocking concluded that "cranial and other diverse symptoms may arise associated with mobile phone usage. Physicians and users alike should be alert to this."

Sleep

Sleep is an essential function for all mammals, including humans. A good night's rest has a profound effect on our alertness, mood, and emotions. While different species – and individuals within them – all require varying quantities of sleep, we know that in humans cannot survive when sleep deprived. Sleep allows our body systems – from the nervous to the endocrine,

immune to digestive – to rest and prepare for the next round of activities. [For more about sleep, please read our booklet titled *Sleep Smarts: From Rest to Rejuvenation.*]

Fairly low levels of electromagnetic radiation have been shown to alter the human body's sleep rhythms. Dr. Mann (1996) showed that in asleep volunteers, cellular phone radiation exposure can shorten the stage of REM sleep. REM sleep is the stage most crucial to our psychological well-being. When Dr. Borbely and colleagues (1999) exposed healthy young men and women to alternating 15-minute on/off intervals of digital-frequency cellular radiation during an overnight sleep, they experienced an increase in non-REM sleep and a reduction in the amount of waking time after sleep. Taken together these studies indicate that cellular phone radiation modifies the brain patterns associated with sleep. Such alterations may impact learning, given that the loss of REM sleep and increase in non-REM sleep may reduce attention and increase fatigue.

A world-renowned sleep laboratory at the University of Zurich reported (2000) that using cellular phones just before going to sleep can disturb the normal sleeping EEG patterns. The researchers found that exposing volunteers to digital GSM-type cellular phone radiation for 30 minutes while awake significantly alters their EEG activity after they fall asleep, compared to unexposed controls. In an accompanying editorial, Dr. Michael Petrides notes that "the currently available literature suggests that some aspects of cognitive function and some direct measures of brain physiology may be affected by exposure to electromagnetic fields of the type emitted by cellular telephones."

Melatonin

One of the wonder hormones of anti-aging, melatonin controls our body clocks, helping to regulate sleep. Melatonin is also a potent antioxidant, immune booster, and cancer fighter. Melatonin is produced in the dark, while we sleep, and levels wane upon daybreak.

Cellular phone radiation may depress levels circulating levels of melatonin. In the case of people living near cellular phone masts (see Special Populations – Base Stations below), the effects on sleep can be dramatic. The University of Berne studied (1995) residents near the Schwarzenburg (Switzerland) short-wave radio transmitter. The transmitter operated in continuous mode at a frequency and modulation that approximated today's cellular phone transmitting masts. The researchers found that even the most modest doses of radiation exposure caused changes in sleep quality – which then adversely affected learning abilities. These effects were reversed when the mast was not operating for several days. Additionally, cattle living near the radio transmitter were found to have significantly elevated levels of melatonin when the mast was not operational. Since there was no reason to suppose that human nocturnal melatonin levels were not similarly reduced when the transmitter was operating, and that scientists know that peaks in nocturnal melatonin levels correlate to quality sleep quality, the researchers suggested that human sleep was degraded by the radio transmitter. Because melatonin is considered to be an important cancer-fighting hormone, the reduced nocturnal melatonin levels also led the researchers to become concerned that the residents of Schwarzenburg could have been at increased risk of cancers. In 1997, transmissions at the Schwarzenburg were ceased, and the tower was closed the following year.

Dr. Burch and team reported (1997) that people who used cellular phones as little as once a day had lower levels of melatonin than people who did not use a cellular phone or used it less than once a week. Those with occupational exposure to cellular phone radiation (see Special

Populations – Occupational Exposure below) were also found to have reduced levels of melatonin production during the daytime.

Immune System

The immune system is the body's major defense mechanism against infection, toxins, and other external stresses. A healthy immune system captures and destroys invaders such as bacteria, viruses, parasites, chemicals, and other offenses.

Low level microwaves have been shown to alter the immune response. Dr. Takashima (1979), Dr. Lyle (1983), and Dr. Nageswari (1996), and Dr. Coghill (1999) each found that low frequency microwave radiation – comparable to that emitted by digital GSM cellular phones – lowered the ability of lymphocytes to mark cancer cells and to depress the ability of other lymphocytes to destroy the marked aberrant cells.

Equally troubling is the finding by Dr. Bastide (1997), that radiation of the type emitted by cellular phones severely depressed the immune and endocrine responses of young chicks.

Mast cells are cells in connective tissue that produce histamine, a key chemical involved in the allergic response. Dr. Donnellan and colleagues (1997) exposed mast cells to digital cellular-phone frequency radiation for 20 minutes, 3 times a day for 7 days. Beginning on the fourth day and continuing forward, the researchers observed increases in the rates of DNA synthesis and cell replication that altered the structure and shape of the cells. As a result, the ability of mast cells to secrete histamine was increased, possibly implicating cellular phone radiation in dysregulation of the function of these cells.

Male Sexual and Reproductive Issues

Men take heed: using a cellular phone could drastically reduce levels of testosterone – the male hormone associated with sex drive. British researchers (2000) exposed rats and mice to low-frequency microwave radiation (simulating GSM and PCS-type cellular phone emissions). They discovered that exposed rats had far less testosterone in their blood stream than the animals that were unexposed. Moreover, the higher the dose of radiation, the less testosterone was released by the body's glands.

Research by Dr. Dasdag (1999) investigated the effect of cellular phone radiation on the reproductive system of male rats that were confined in cages, with cellular phones placed 0.5 cm (1 1/4 in.) underneath. At the end of the month-long experiment, Dr. Dasdag found pronounced changes in the testicular tissue in rats that were exposed to active cellular phone transmission for 3 times per minute over a period of 2 hours. Specifically, Dr. Dasdag observed a reduction in the diameter of the seminiferous tubules (the ducts that carry semen).

Imre Fejes, from University of Szeged (Hungary) found (2004) that men who carry a cellular phone in hip pockets or a holster may cut their sperm count by nearly 30%. The researchers surveyed 221 men on their use of cellular phones, and analyzed their sperm. They found correlation between the use of the phones, even in standby mode, and sperm concentration and quality.

Dr. Ashok Agarwal, from Cleveland Clinic Foundation (Ohio, USA) and colleagues presented (2006) data involving 364 men, finding a link between heavy cellular phone use and damaged

sperm. The team found that those men who used their phones for more than four hours a day had the lowest sperm counts, as well as the least healthy sperm. Men who used their phones for between two and four hours a day also had reduced sperm count and quality. As the decrease in key markers of sperm health represent a decrease in fertility, the team warns that “people use mobile phones without thinking twice what the consequences may be.” (See Chapter 4, “Carrying Your Phone.”)

Additional Health Concerns

Dr. Khudnitskii and team from Russia (1999) examined the influence of cellular phone radiation on the central nervous and cardiovascular systems. They noticed temperature changes in the heads of cellular phone users. The team reported that "ultrahigh [microwave] frequency radiation induces significant changes in local temperature and in physiologic parameters of central nervous and cardiovascular systems."

Exposure to radiation typical of cellular phones also causes changes in human blood pressure. Dr. Braune and colleagues in Germany found (1998) that exposure of the right hemisphere of the brain to RF radiation for 35 minutes resulted in an increase in resting blood pressure. While the increase was nominal – between 5 and 10 mm Hg, the study does indicate that vasoconstriction (closing up of the veins) can occur with cellular phone use.

Some scientists warn that constant cellular phone use causes premature aging. Dr. David De Pomerai and team from Nottingham University’s School of Biological Sciences (United Kingdom) (1999) found that low level radiation from the phone heated the cells of the body, causing damage to the skin and making the cellular phone user looked lined and haggard. Commenting on the study, Dr. De Pomerai remarked: "Gradually, cells don’t work properly, so the life process becomes less efficient." Dr. De Pomerai likened constant cellular phone users to heavy smokers – both groups "expose themselves to cell-damaging toxins without allowing the body time to repair the harm.”

Red blood cells can be damaged by exposure to radiation at levels found in GSM digital and PCS-type cellular phones. Dr. Savopol (1995) and Dr. Sajin (1997) both found that radiation at cellular phone frequencies caused an increased permeability of the membrane of red blood cells that led to leakage of hemoglobin. In a study by the European Research Institute for Electronic Components (Bucharest Romania) (1999) involving just 10 to 60 hours of exposure to cellular phone radiation, and at frequencies lower than those emitted by mobile phones, the cells leaked hemoglobin. Hemoglobin is an iron molecule that is responsible for transporting oxygen throughout the body by travelling in red blood cells. Left unchecked, a build up of hemoglobin in the bloodstream can cause heart disease and kidney stones. In separate findings, Bo Sernelius, from Linkoping University (Sweden), and colleagues analyzed (2004) the effects of cellular phone electromagnetic radiation on red blood cells using a mathematical theory. The team found that the radiation altered the alignment of the molecules of the cells, and increased the force between the cells by eleven-fold. These findings suggest a potential mechanism for tissue damage, in that the altered attractive forces may cause blood cells to amass or contract.

Dr. Peter French of St Vincent's Hospital (Australia) and immediate past President of the Australia and New Zealand Society for Cell Biology has been exposing a variety of human and animal cell lines to cellular phone radiation. In one study involving exposures 3 times a day for 7 days (1999), Dr. French found that cellular phone radiation altered cell growth, shape, secretion

of histamine (the chemical involved in the allergic response) and gene transcription (necessary for cellular survival and division).

Long-time cellular phone users who talk more than an hour a day on those devices may be at greater risk to have high-frequency hearing loss. In 2007, Naresh Panda, from the Post Graduate Institute of Medical Education and Research (India), and colleagues presented data from a completed study of 150 people, ages 18 to 45, that found that those study subjects who used mobile phone for more than four years experienced greater hearing loss in high-frequency ranges in their right ear (the ear most held the phone to), than those who used the mobile phone for two years or less. One-to-two year users had a 16.48 decibel loss in the high-frequency range, while those who used the phones more than four years had a 24.54 decibel loss. Of note, the team observed that the hearing loss was more pronounced in those study subjects who experienced a warm sensation, fullness in the ears, or ringing in the ears as a result of mobile phone use.

Special Populations

Children

While some manufacturers target children for cell phone sales (see Chapter 1), scientific experts warn that cellular phone radiation penetrates the skulls and brains of kids more deeply than adults, and this radiation may cause tumors or otherwise affect a developing brain. Children may be more sensitive to microwaves than adults says an Australian report indicating they absorb microwaves at 3.3 times the rate of adults. In the young brain, RF radiation has been shown to cause changes in the convolution (folding) of brain tissue. As a result, University of California RF researcher Dr. Ross Adey has stated (1996) that "children categorically should not, be encouraged or allowed to use cell phones."

Dr. Kolodynski (1996) published a compelling study on the increased adverse health effect on children from RF exposure. In this Latvian study involving 966 school children, some conceived, born and raised in the area of the Skrunda Radio Location Station – a Russian early warning radar station, the researchers found significant differences in motor function, memory and attention between exposed children and those not exposed. Children living in front of the station had less developed memory and attention, their reaction time was slower and their physical endurance was decreased. The study authors attributed these deficits to the chronic electromagnetic radiation exposure.

In February 2000, Dr. Hyland reported to the European Union that pre-adolescent children can be expected to be potentially more vulnerable to cellular phone radiation than adults, for the following reasons:

- Absorption of microwaves of the frequency used in cellular phones is greatest in an object about the size of a child's head. Work by Dr. Gandhi and team from the University of Utah (1999) showed the greater penetration of the radiation into the brain in children occurs because they have thinner skulls.
- The still-developing nervous system and associated brain-wave activity in a child (and particularly one that is epileptic) are more vulnerable to excitement by microwave pulses – particularly GSM phone emissions, because those match the electrical activities of alpha and delta brainwaves. Indeed, both alpha and delta brainwaves constantly change up until the age of 12 years, meaning that the brains of children are particularly vulnerable to interference from GSM emissions.
- Cells in developing children multiply quickly, so DNA damage may be readily replicated and spread.

- A child's immune system is still developing, and in some ways less robust than in adults. Children are less able to cope with any adverse health effect provoked by chronic exposure to radiation.

In April 2000, the British Government's Independent Expert Group on Mobile Phones (IEGMP), led by Sir William Stewart (a famous British biochemist and president of the British Association for the Advancement of Science) and composed nearly entirely of biomedical specialists with hundreds of years of specialized scientific knowledge, reported on their examination of the possible health effects of mobile phones, base stations and transmitters. They found that while current evidence at the time did not suggest that cellular phone technologies put the health of the general population of the UK at risk, they cautioned that special consideration be given regarding the growing numbers of children using cellular phones. The committee warned: "If there are currently unrecognized adverse health effects from the use of mobile phones, children may be more vulnerable because of their developing nervous system, the greater absorption of energy in the tissues of the head ... and a longer lifetime of exposure. In line with our precautionary approach, we believe that the widespread use of mobile phones by children for non-essential calls should be discouraged. We also recommend that the mobile phone industry should refrain from promoting the use of mobile phones by children."

In early 2000, the question over cellular phone safety for children prompted Metrocall of Alexandria, Virginia (USA), the nation's third-largest pager company and a major seller of AT&T cellular phones, to issue an advisory for sales staff to encourage parents buying for a child or young adult to select a pager instead of a cellular phone, citing "potential health risks."

On December 8, 2000, the German Academy of Pediatrics issued an advisory statement recommending that parents restrict their children's use of cellular phones, calling for stricter exposure limits. "Unnecessary, frequent and extended use are to be strongly discouraged. Children only need mobile phones to communicate very infrequently, in exceptional situations" the Academy said. They advised that all mobile phone users should keep conversations as "brief as possible" but that additional precautions are appropriate for children in view of "special health risks" associated with their growing bodies.

In an Australian Senate inquiry held in the spring of 2001, SIRO Telecommunications and Industrial Physics chief Gerry Haddad warned that the new telecommunications exposure standards being drafted neglected to take a high enough level of protection, particularly in relation to children. Mr. Haddad said: "Restrict use of mobile phones to children for essential purposes ... A precautionary principle would seem to be a good idea."

In July 2001, Wolfram Koenig, head of German Radiation Protection Agency, warned in interview with a Berlin newspaper that "Parents should keep their children away from this technology [cellular phones] as much as possible."

In September 2001, Dr. Sianette Kwee from the University of Aarhus (Denmark) reported to the European Union that his studies "showed that there was a significant change in cell growth in these cells after being exposed to EMF fields from both power lines and from mobile phones. These biological effects were greatest in young and vigorously growing cells, but much less in old cells. These results tell us that microwave fields from mobile phones can be expected to affect children to a much higher degree than adults."

Following the release of Dr. Leszczynski's study (2002) implicating HSP27 in BBB permeability (see Mechanisms above) and indicating that human cells shrink when exposed to cellular phone radiation, the General Director of the World Health Organization, Gro Harlem Brundtland, issued a warning to parents to limit cellular phone use in children.

In June 2002, the Bangladesh government issued a ban on cellular phones for children under the age of 16, referencing the evidence from studies conducted around the world that suggest that cellular phone radiation may place children at increased risk of brain damage.

Investigators from Lund University (Sweden) reported (2003) on findings from their study of laboratory animals, of the age comparable to human teenagers, studying the potential of 2-hour daily use of cellular phones for nerve cell damage in the brain. The team warned that: "We cannot exclude that after some decades of often daily use, a whole generation of users may suffer negative effects, perhaps as early as in middle age."

Pregnant Women

Prenatal development may also be adversely affected by cellular phone radiation. Several studies involving laboratory animals give cause for concern.

Both Dr. Dutta (1989) and Dr. Magras (1997) found that female mice living around a base station (see section below) gave birth to smaller litters to the point where they became infertile.

Dr. Youbicier-Simo found (1998) that GSM phones operated near fertilized chicken eggs killed most of the embryos. In follow-up research, US scientists tested (1999) cellular phone-type radiation on more than 10,000 chicken embryos, from which numerous birth defects resulted.

Research by Dr. De Pomerai and colleagues (1999) on worm larvae found that overnight exposure to radiation at a frequency slightly less than digital cellular phone emissions caused an accelerated progression through the stages of larval development, resulting in larger size worms. In follow-up research (2002), Dr. De Pomerai found that cellular phone-type microwaves increased the number of worms that go on to produce eggs, making the worms more fertile, implicating a non-thermal effect of this type of radiation.

Elderly

Dr. Hyland warns that the elderly are vulnerable to cellular phone radiation for at least two reasons. In his February 2000 report to the European Union, Dr. Hyland explains that the immune systems of the elderly are not as robust as they used to be, and that some medications taken by the elderly may cause them to be at increased sensitivity to the radiation.

Base Stations

Base-stations (at which antenna, also known as masts or towers, that conduct cellular phone transmissions, are located) may pose health risks to those residing or working around them. Indeed, the installation of base stations for mobile telephone systems has been delayed or has met opposition from the public because of concerns that the RF emissions from these base stations might cause cancer in children. In the United States, 85% of the total number of base stations needed have yet to be constructed. Hesitation is rooted in an uncertainty as to whether a

significant increase in the numbers of these systems, and their interactions with other energy fields in our homes, cars, and work places, may cause increasingly significant health problems.

Researchers have reviewed data about residents living near the Skrunda Radio Location Station – a Russian early warning radar station – with great concern. Skrundra's radiation emissions were only 1/10th of the pulse rate of today's GSM masts yet the pulse frequency was quite close to that of the beta brainwave (see Brain Function above). In the *Science of the Total Environment*, a series of Skrunda researchers reported that:

- Children living with a 20 km (14 mile) radius of the radar station did not have as well developed neuromusculature, memory capabilities, or attention span, as children living outside the immediate area (Kolodynski 1996)
- Cows were found to have a six-fold increase in chromosome damage (Balode 1996)
- Pine trees within 4 km (2 1/2 miles) of the radar station displayed decreased annual growth (Balodis 1996)
- Plants within 2 km (1 1/2 miles) of the radar station displayed chromosome and reproductive damage (Magone 1996)

A study (1995) funded by the Bavarian State Government in Germany studied adverse health effects reported by farmers of dairy cattle that appeared only after a cellular phone mast was erected. Decreased yield from that herd of cattle and the display of odd behaviors (lining up so as to face in the direction away from the mast) occurred in when in vicinity of the mast. When the cattle were moved away from the mast, after a period of time the milk yield and the behavior of the cattle were restored to normal. According to Dr. Hyland (2000), other researchers have observed that cattle in pastures near masts have become emaciated, and were at increased risk for spontaneous abortions and still births.

In an expert opinion presented to the European Union by Dr. Hyland (2000), he points out that users of mobile phones and people resident in the immediate vicinity of base stations – as well as children attending schools with a mast on or near the property – have been experiencing radiation-related nose bleeds, muscular twitches, headaches, trouble sleeping, chronic fatigue, failure of short-term memory, learning difficulties, and anxiety. For many of the children, their headaches and nosebleeds disappeared once they were out of close proximity to the mast. Quite troubling is that Dr. Hyland also reported an increase in the frequency of seizures in epileptic children who are exposed to cellular phone radiation. In one case, an epileptic child was experiencing an average of 2 seizures a month. After the cellular phone mast was erected close to her home, she began having 8 seizures every day. Most dramatically, when the child was removed from proximity to the mast, or the mast was not functioning, her condition improved immediately and dramatically.

In that same report, Dr. Hyland also shared that mast emissions alter the immune system of domestic canine pets, which again is reversible upon removal from proximity to the mast. Additionally, declines in bird populations have been observed following the erection of masts.

Continuing in the report, Dr. Hyland warned that "it can reasonably be anticipated that the emissions from base stations are potentially more pernicious to health" than any other types of transmission equipment previously erected. While proceeding at a slow pace, there is no denying that the number of cellular masts is on the rise. More communities are looking for easy ways to increase their revenues, so leasing their land for this purpose is lucrative. For the same reason, owners of TV and radio towers are readily accommodating cellular phone transmitters. Intermediate antenna, designed to promote transmission between the large masts, can be cleverly

disguised as "street furniture" – lamp-posts and tree look-alikes – encouraging their placement inside shopping malls and near homes, increasing the proximity of a large number of people to radiation emitting equipment. Without a doubt, the concerns relating to the impact of cellular phone masts in human health will become increasingly more significant in the years to follow.

A study (2003) projecting the impact of electromagnetic radiation from base stations used for the third-generation (3G) networks for fast data transfer mobile phones found that a test group of humans exposed to the 3G base station signals experienced tingling sensations, headaches, and nausea. The study, conducted by three Dutch ministries, also found the radiation to be somewhat excitatory, boosting alertness and accelerating response times and memory performance.

Electronic Medical Devices

Digital cellular phones were found by Dr. Trigano (1999) to interfere with external pacemakers, which are temporarily used with some cardiac patients. In nine of the most common models of external pacemakers, Dr. Trigano observed that digital cellular phones in call mode caused either suppression or irregularity in the pacing. The interference persisted even when the phones were placed at a distance of 200 cm (57 in.) from the pacemaker.

Dr. David Hayes and colleagues from the Mayo Clinic (Minnesota USA) found (2001) that mobile phone caused interference in the operation of medical monitoring devices. The researchers detected interference serious enough to cause hospital equipment to fail, or cause difficulties in data recording or interpretation, in 41% of the 526 tests they conducted using 17 cellular phones. The most serious interference occurred when a cellular phone was held 1 to 2 inches from the most sensitive area of the equipment that monitors cardiac and respiratory functions. Ventilators shut down when cellular phones were held within 2 inches of the unit's communication port, and electrocardiograph tracings failed to display properly. As a result of their findings, Dr. Hayes recommended that cellular phone use in proximity to medical electronic devices in hospitals be restricted or banned "until there is reasonable proof of safety." Noting that the intensive care unit and operating rooms are at increased vulnerability, Dr. Hayes also recommended that cellular phones be banned in patient rooms and medical procedure areas as a precaution.

A Harvard University study found (2003) that a cellular phone signals interfered with eight of the 20 most common medical devices, including ventilators and defibrillators.

Occupational Exposure

Radiofrequency/microwave radiation is utilized in a variety of workplaces. Hospital and medical settings, as well as workers in the microelectronics, computer, and plastics industries, receive prolonged and increased exposure to RF radiation as a result of their jobs.

Dr. Nelson and team have conducted extensive studies on the occupational hazards of RF radiation. In one report (1997), they found that the thermal effects (see Mechanisms above) of RF exposure promoted the toxicity of some chemical agents. In pregnant rats, the researchers observed that exposure to combined RF radiation and solvents caused malformed fetuses. Alarmingly, Dr. Nelson also found that the greater the degree and duration of the RF exposure, the greater the extent of the toxicity of the chemical exposure.

Men and women who work on masts that transmit television, radio, and cellular phone signals are at obvious risk for high-dose exposure to RF and microwave emissions, given the close proximity

to these sources when working on the antenna. Dr. Shilling reported (1997) that three men who were exposed to high levels of cellular phone frequency radiation while working on a mast experienced immediate sensation of intense heating on their bodies, followed by pain, headache, numbness, malaise, diarrhea, and skin redness and swelling. After the immediate symptoms, the men experienced chronic headache involving the part of the head that was most exposed. In another study (2000), Dr. Shilling followed a group of six men who were exposed to high doses of RF radiation while working on masts in 1995 and 1996, each of whom experienced headache, numbness, diarrhea, malaise, and apathy. Four to five years after their exposures, four of the men who were suspected to have received the greatest exposures still reported their symptoms persisted without significant improvement.

Dr. Szmigielski and colleagues found (1998) that men who were exposed to RF radiation during a 12-hour day working shift experienced significant changes in the characteristics of their blood pressure and heart rate measurements.

In Britain, the IEGMP recommended (2000) that long-term follow-up of workers who are occupationally exposed to RF radiation could serve as an early warning system, alerting public officials to the potential for lower, limited dose RF exposure to affect the general public.

In 2007, a team of researchers from University of Bern (Switzerland) investigated a group of 20,141 Swiss railway employees, exposed to extremely low frequency magnetic fields, for a period of 30 years. Death rates for leukemia and brain tumor of highly exposed train drivers were compared to counterpart employees with less exposure. The team found evidence for exposure-dependent risk from extremely low frequency magnetic fields, for myeloid leukemia and Hodgkin's disease.

Chapter Closing Remarks

Millions of cellular phone users worldwide are now also exposed daily to radiofrequency and microwave radiation under prolonged and physically close conditions. As new data become available, our understanding of the role of cellular phone radiation emissions in human health will improve. However, the explosion of utilization of this technology in society creates a unique necessity for ongoing monitoring and interpretation of the scientific data. It is the responsibility of each cellular phone user to evaluate the extent of their exposure to cellular phone radiation and determine whether it places them at increased health risks.

Chapter 4 Minimizing Your Exposure to Cellular Phone Radiation

Cellular phones emit both radiofrequency and microwave radiation (Chapter 2). Numerous scientific studies (Chapter 3) in both lab animals and humans have identified an association between these emissions and an assortment of cellular and tissue changes, which may have significant implications on health and well-being.

Fortunately, there are simple ways in which cellular phone users can minimize their exposure to radiation. Selection of the type(s) of intervention that is best for you will primarily be based on two factors:

- The extent and frequency of cellular phone use, thus reflecting potential emissions absorption
- Lifestyle, reflecting the ease of use of the method of exposure minimization

This chapter begins by providing basic tips that every cellular phone user should consider implementing, as they are simple and easy to follow. We continue with a discussion on cellular phone accessories that purport to reduce the amount of radiation delivered from the devices to the human body.

Practical Prevention

Call Length and Frequency

A number of the scientific studies (Chapter 3) have showed a correlation between the length of calls and/or frequency of use, with biological changes. By keeping calls short and reducing the number of times a day you use a cellular phone, you greatly reduce the radiation to which you are exposed.



TIP Reserve cellular phone use for short, necessary conversations. Cellular phone "free minutes" may, in 5 to 20 years, may turn out not to be quite so absent of hitches. Whenever you have the choice, opt to use a corded phone instead of your cellular phone. Dr. Carlo has recommended (2000) that incoming mobile phone calls be kept as brief as possible and returned on a corded phone.

Distance

The concentration of radiation emissions is directly related to the power of the emitting device. The farther you can put yourself from the cellular phone handset, the less emissions you will receive. Radiation from all sources obeys the inverse square law. That is, the further you are from the source the less intense your exposure to the radiation. In fact, it drops off with the square of your distance from the source. For example: if you are twice as far from a fire you feel one-quarter of the radiant heat, but if you move four times as far away you only feel one-sixteenth of the heat. The similar exposure reduction holds true for distancing yourself from cellular phone emissions.



TIP Opt to use your cellular phone's "speakerphone" option, which permits a substantial distancing between the user and the handset during conversations.

Signal Path

The steel construction of vehicles and buildings creates an electrical shielding effect ("Faraday cage"). As a result, using a cellular phone inside an enclosed vehicle or building causes the phone to increase the power output it needs to establish a connection, receive signals, and transmit signals, all of which causes increased radiation emissions. A presentation by the House of Commons (United Kingdom) Science and Technology System reported (1999) that using a cellular phone inside an enclosed vehicle can cause radiation levels to rise by 10 times.

Cellular phone radiation may also be trapped in train carriages. A Japanese team has reported (2004) that passengers on packed trains could be exposed to high doses of electromagnetic fields, as a result of commuters all using their cellular phones at the same time. The exposure could be well above the maximum exposure level recommended by the International Committee for Non-Ionizing Radiation (ICNIRP). Commenting on his research, Tsuyoshi Hondou, from Tohoku University (Japan) reports that: "We have no regulation on the use of mobile phones in areas where many people are together. The problem could also arise on buses and elevators."



TIP If using the cellular phone inside a vehicle, open the window or door (if not in motion). This will improve the path for the cellular phone signals and possibly reduce the phone's need to increase its power level. Try to avoid using public transportation during peak times: delaying your travel by 30 minutes may significantly cut your 'second-hand' exposure to cellular phone electromagnetic radiation.

Phone Mode

The highest cellular phone emissions occur when the phone is establishing a connection with a base station. When using the phone in a mobile setting (driving in your car), the phone is constantly re-establishing its base station connection. The emissions in the mobile setting are further compounded by signal path issues (see above).



TIP When inside a vehicle, avoid keeping the cellular phone handset turned on unless you are expecting an incoming call, or making a call.

Carrying the Phone

Avoid keeping the cellular phones (when switched-on) adjacent to the body. In particular, do not keep it in on-mode in clothing pockets or clipped to the waist. The soft tissues of the body – namely heart, liver, kidneys, intestines, and reproductive organs – are very vulnerable to penetration by radiation, moreso than the brain (which is protected to a degree by the skull). According to Dr. Hyland's report to the Economic Union (2000), three sudden deaths occurred from colon cancer amongst members of a secret surveillance unit of the former Royal Ulster Constabulary, all of whom had worn radio or microwave transmitters in the lower part of their backs for extended periods of time.



TIP Women: carry your phone in a purse that is carried away from the body. Men: do not carry the phone in the on-mode in your chest, jacket, or pants pockets, unless you are expecting a call or making a call.

Fire Safety

In the early 2000s, a number of reports were filed that cellular phones triggered fires at gasoline pumps at gas stations. Today, gas station operators and cellular phone manufacturers both advise that customers turn off cellular phones when at the pump. This is in-part due to the fact that static electricity does pose a risk, responsible for starting 150 fires annually at gas stations across the United States. Static may be charged when drivers slide across their seats to exit the car, then touch the metal pump nozzle.



TIP When approaching and stopped at a gasoline station (for any reason), turn your cellular phone off.

Stormy Weather

Cellular phones can also act as lightning rods, pulling a bolt of lightning from the air, through the phone, and into the phone user. Worldwide, the numbers of deaths of cellular phone users due to lightning strikes has been on the rise. In 2006, a 15-year-old London girl talking on the phone in a park was struck by lightning. The girl suffered a heart attack (but was revived); however, her eardrum burst upon impact and her mental functions were impaired.



TIP In stormy weather, turn your cellular phone off.

Eyeglass Wearers

The House of Commons (United Kingdom) Science and Technology System report (1999) also found that cellular phone users who wear metal-rimmed glasses intensify their exposure to radiation emissions to the eye by 20% and to the head by 6.3%.



TIP Take glasses off when making or receiving cellular phone calls, or use the phone when you are wearing contact lenses.

Proximity to Base Stations

The number of "cells" (zones of service) (see Chapter 2) in the geographic area, in addition to the proximity of the cellular phone to a base station, factor into the power necessary for the phone to establish a connection and receive and transmit signals. The fewer the number of cells, and the farther apart the base stations, the greater the power (and radiation emission) necessary to maintain contact with the network.



TIP Many cellular phones can display the signal level at which they are operating when turned on. When receiving or making a call, take note of the reported signal level. If it is weak, keep the call short and continue it later on a corded phone or when you reach an area where the signal level is stronger.

Special Populations

As discussed in Chapter 3, children are at particularly pronounced risk of alterations to their cells and tissue as can be caused by radiation emissions. Additionally, certain segments of the population are, because of their health situation, at a potentially increased susceptibility to additional adverse effects that may be caused by cellular phone radiation.



TIP Pregnant women, the elderly, people on certain medications, epileptics, as well as others with pre-existing medical conditions, should discuss the risks of cellular phone use with their physicians. Children should not use cellular phones except for emergencies.

Accessories

Despite the establishment of standards of SAR ratings (see Chapter 2), which were implemented to provide a method of compliance by cellular phone manufacturers to maximum RF emissions set by governments, the public remains concerned about the possible health effects of radiation from cellular phones. As a result, an entire industry of manufacturers and retailers of RF protective devices has been spawned.

Radiation-reducing cellular phone accessories appeal to those consumers who do not wish to give up their frequent and lengthy use of the device. Responsible accessories manufacturers and retailers will openly share independent laboratory studies, validated by third-party testing reviewers, documenting that their devices reduce the amount of radiation delivered from the cellular phone to the user. This, however, should be the limit of their product claims. Most of these RF protective accessories have only been on the market for less than five years – and many of them for less than a year. To our knowledge, none of these accessory manufacturers have conducted controlled studies of humans to determine if and how their products alter the biological effects of cellular phone radiation. As a result, we consider it to be premature and irresponsible for any accessory manufacturer to state or imply that their product alters, in any way, the effect that cellular phone radiation has on the human organism.

Hands-Free Kits

Hands-free kits include a headset or earbud/microphone that connects by way of a cable into a special plug on cellular phones. They offer cellular phone users freedom of movement while using the phone, for example freeing up the hands for writing or typing. There is conflicting evidence on whether exposure to cellular phone radiation is reduced.

To use hands-free kits, many people tuck the phone handset into a chest or jacket pocket, or attach it to their belt. Positioning the phone at this location has possible risks to the soft tissue of the body (see *Carrying the Phone* above). Additionally, some cellular phones have been shown to require greater power to use hands-free mode, thus placing the soft tissue near the handset at greater risk.

In addition, wireless Bluetooth-type headsets also represent a risk, in regard to radiation exposure. Bluetooth phones operate in excess of 2 GHz. But even at lower frequencies than this, there is minimal advantage to attaching another transmitter to your ear, especially since there is strong evidence that electromagnetic effects on the brain are non-linear (see Chapter 2, *Cellphone Basics*). In short, low power does not necessarily mean safer equipment.

A laboratory evaluation commissioned by Britain's Cancer Association reported (2000) has raised concern over possible magnification of the radiation when using hands-free kits. Two of the most popular brands of hands-free kits were studied. The Cancer Association determined that the hands-free kit cable can create a standing wave that can propel the cellular phone signal wave through the cable and, by way of the earbud, deliver that signal directly into the ear. Additionally, the hands-free kit earbud channeled as much as 3 times the dose of radiation into the ear as opposed to using that same phone without the kit. Dr. Carlo has stated that this "coupling effect" can be remedied by using hands-free kits that incorporate ferrite filters in the cable. He suggested that, in selecting a hands-free kit, consumers choose the "filtered" rather than "non-filtered" version.

The air-tube type hands-free accessory uses a hollow "air-tube" to transmit sound from the cellphone speaker to the ear. The main advantage of using an air-tube headset is that neither the tube nor the earpiece uses metal conductors (wires), which thus virtually eliminates microwave radiation and does not channel it directly to the user's body.

Casings

Besides the antenna, the case of a mobile phone also emits microwaves, due to a lack of proper shielding in the case. Because of this, many mobile phones have detectable emissions out of the handset itself. The extent of this problem very much depends upon the type of phone used.

Finding a casing to fit your cellular phone may prove difficult, as every make and model of phone differs slightly in its design and casing manufacturers do not make one for every different phone. Assuming that you find a casing that fits, it may hamper the ability to use the phone, as some key and button functions may be difficult to carry out. Additionally, some studies show that phones in casings tend to lose signals, and have poor communication performance, range, and voice quality.

Antenna Add-Ons

Casings that envelope the antenna are available. While these do effectively reduce the radiation from the antenna, it may disrupt or weaken the communication performance. Additionally, because circuitry inside the cellular phone helps with cellular phone signal transmission, antenna casings cause the phone to work harder, thereby reducing battery life and possibly increasing the radiation emitted from the handset itself.

Diode accessories that are attached to the antenna may be more harmful than helpful. In tests of such products, the diode accessory has been found to increase the radiation emitted from the antenna, possibly by interfering with proper antenna function.

Shields

Shields are patches made from various types of material that, by self-adhesive, fit atop the earpiece of the phone. The goal of shields is to reduce the amount of radiation delivered to the user's head from the phone. By positioning the shield accessory in between the phone and the user, the purpose of shields is to absorb the emissions. It has been reported that Motorola has patented technology similar to these shields, leading to a frenzy of interest in these accessories.

Manufacturers of shield accessories acknowledge that a significant portion of radiation is emitted by cellular phone antennae. However, shield manufacturers submit that antenna radiation delivered to phone users is significantly reduced due to its distance from the user, the reach of the antenna emissions following the inverse square law (see Practical Precautions – Distance above). Additionally, shield manufacturers submit that antenna emissions are partially obscured by the battery, before they can reach the head. Some makes and models of cellular phones emit notable radiation emissions from points on the handset – not just the antenna. As a result, when users hold the handset to the head, the earpiece is in direct, close proximity to the brain.

Many shields are made of mesh consisting of carbon and lead. Shields made of this material from responsible manufacturers provide a fair amount of reduction – 90% or better – in cellular phone radiation delivered from the phone to the head.

Shields that are constructed from radar absorbing materials are also available. These shields are made of solid state materials and operate as passive circuit analog devices. No external power resource is required. Radar-absorbing material shields from responsible manufacturers are

effective at reducing cellular phone emissions delivered from the phone to the user's head to a greater extent than mesh shields.

Chapter Closing Remarks

We urge you not to succumb to any "scare tactics" that are utilized by many radiation-reducing accessory manufacturers and retailers to promote sales of their products. Your first and primary line of defense against cellular phone radiation should be to employ as many non-accessory interventions (see Practical Prevention) as possible. If, however, you determine that you may benefit from a cellular phone accessory, choose wisely:

- Ask the retailer to provide a copy of the test protocol and study results on emissions reduction. Be wary of any retailer that refuses to share this information with you.
- The Internet has provided anonymity to unscrupulous marketing companies. If you intend to purchase a radiation -reduction accessory from the web, prior to the sale make sure that you obtain contact information for the company (including its physical address) – in case of a problem with your product or the company's product claims.
- In the US, the Federal Trade Commission monitors all mediums of interstate advertising. In February 2002, the FTC charged two companies marketing shield accessories with making false and unsubstantiated claims. According to FTC, these defendants lacked a reasonable basis to substantiate their claims. This FTC action does not impune all shield manufacturers and retailers. Those who can provide third-party validated testing that supports statements relating to radiation reduction, and do not mislead the public by stating their products "prevent cancer" or other possible health effects, have not been challenged by FTC. As physicians keenly interested in promoting responsible preventive health interventions, we applaud FTC for their consumer protection activities relating to cellular phone radiation-reducing accessories demonstrated so far.

Chapter 5 You Make The Call

As our literature review (Chapters 3) indicates, the potential health risks associated with cellular phone radiation may include:

- cancer, namely brain cancers, leukemia, and lymphoma
- brain function, including memory, learning, and reaction time; also possibly involved in distraction
- alterations of brainwaves
- general malaise
- headache
- seizures
- changes in sleep pattern and quality
- immune system dysfunction
- fertility and reproductive issues
- changes in the central nervous system and cardiovascular system
- elevations in blood pressure
- hearing loss
- skin damage
- changes in red blood cells, possibly leading to kidney stones or heart disease

Research conducted by scientists recruited by commercial interests in the cellular phone industry and/or the trade organization that operates on its behalf (Cellular Telecommunications & Internet Association), has primarily investigated whether cellular phone radiation causes cancer. This is because the industry historically has, and presently maintains its position that, the biological effects of phone emissions (if there were any) on the human organism would be evident as "thermal" effects. As a result, industry-sponsored studies have been commissioned to assess whether cellular phone radiation adversely changes the genetic material inside cells, thereby possibly leading to cancer. As we have explained (see Chapter 3, Mechanisms of Damage), many non-industry scientists suspect that cellular phones may affect human health through "non-thermal" effects. These effects, suggest the independent researchers, are what may produce the constellation of non-cancer effects of cellular phone radiation – including headache, cognitive changes, sleep changes, immune and cardiovascular changes, fertility and reproductive concerns, and more. The cellular phone industry, has, as a whole, not yet recognized the potential for "non-thermal" effects of radiation from their devices, causing a deficit in scientific response by the cellular phone industry to the suggestions that associate cellular phones with various non-cancer biological changes.

As a result, when taken collectively, scientific studies to-date have been equivocal. In the lab setting, human volunteer studies, and surveys involving large populations, some researchers have found cellular phone emissions to stimulate responses, but other times there was no effect. This may be a result of variability from person to person of how susceptible they may be to cellular phone radiation emissions. Just like how a cold does not equally and completely affect all of the family members in a household, some researchers suggest that physical and biochemical differences from person to person influence how our bodies respond to cellular phone radiation.

Additionally, there has been some speculation that cumulative lifetime radiofrequency/microwave exposure may be identified in the future as the greatest determinant of our susceptibility to possible cellular phone radiation health effects. In addition to cellular phones and their base stations and other transmission equipment, today people are exposed to a wide and diverse range of radiofrequency/microwave emissions. Our environment is saturated with transmissions of

radio, television, paging devices, as well as cellular phones. Exposures of individuals to each of these sources of RF radiation may be well below established guidelines, but it is yet to be determined whether the collective, cumulative exposure over a lifetime translates into changes in our health.

Yet, the sheer numbers of current and future cellular phone users (Chapter 1) creates great cause for worry. Even if only a small percentage of cellular phone users are adversely affected, that could still equate to a public health issue of epidemic proportions. Adjusting for latency of disease states to the initial triggering exposure, it may be 2020 before a full-scale epidemic hits. Or it might not happen at all.

While we await conclusive scientific determination on the matter of possible health hazards from cellular – and cordless – phone use, individuals need to determine whether they should apply the "precautionary principle" to themselves now. There are simple ways to protect yourself from the full brunt of emissions from your cellular phone, and cellular phone users should consider implementing them if their exposure warrants. And, we should all heed the nearly universal warnings about cellular phone use in children.

We conclude this book by sharing a quote from Mr. Thomas John Watson, Sr. (1974-1956), American industrialist and founder of the International Business Machines Corporation (IBM): "Follow the path of the unsafe, independent thinker. And on issues that seem important to you, stand up and be counted at any cost."

Appendix A. Table of Cellular Phone Radiation Levels

The following data on SAR levels for popular cellular phones were obtained from the CNET website, at: <http://reviews.cnet.com/cell-phone-radiation-levels/>. Visit this webpage for the latest listings, as CNET will remove a phone from the list when it is discontinued by a manufacturer or a carrier, and subsequently update the rankings..

If your phone isn't listed below, and you purchased it since 1998, CNET explains that you can request the SAR information from the manufacturer or your carrier. You'll need the model number and FCC ID number, which is usually but not always listed in your owner's manual or under your phone's battery (you must pop the battery out).

20 HIGHEST-RADIATION CELLULAR PHONES (U.S.)		
RANKING	MANUFACTURER & MODEL	SAR LEVEL (Digital)
1	Motorola V195s	1.6
2	Motorola Zine ZN5	1.59
3	Kyocera Jax S1300	1.55
3a	Motorola VU204	1.55
4	RIM BlackBerry Curve 8330 (Sprint)	1.54
4a	RIM BlackBerry Curve 8330 (U.S. Cellular)	1.54
4b	RIM BlackBerry Curve 8330 (Verizon Wireless)	1.54
8	Nokia E71x	1.53
9	Pantech Matrix	1.52
10	LG Rumor 2	1.51
10a	RIM BlackBerry Bold	1.51
12	HTC SMT5800	1.49
13	Sony Ericsson W350a	1.48
14	Samsung Instinct	1.46
14a	Samsung Spex SCH-R210	1.46
16	Kyocera X-tc	1.45
16a	Motorola i576	1.45
16b	Motorola i776	1.45
16c	Motorola Adventure V750	1.45
16c	Samsung Highnote	1.45

CNET also maintains a list of the 20 lowest-radiation cellular phone models, at: http://reviews.cnet.com/4520-6602_7-5020356-1.html?.

Bibliography

- Carlo G and Jenrow R. "Scientific Progress - Wireless Phones and Brain Cancer: Current State of the Science," Medscape, June 31, 2000.
- Frumkin H, Jacobson A, Gansler T, Thun M. Environmental Carcinogens – Cellular Phones and Risk of Brain Tumors. *CA Cancer J Clin* 2001;51:137-141.
- Hyland GH. Memorandum (presentation to the European Union), February, 2000.
- Independent Expert Group on Mobile Phones. Mobile Phones and Health. National Radiological Protection Board (UK) 2000.
- "Report to Congressional Requesters: Telecommunications – Research and Regulatory Efforts on Mobile Phone Health Issues" (Report GAO-01-545), US Government Accounting Office, May 2001.

Foreword

- Bass G. "Is your cell phone killing you.?" *PC Computing Magazine*, Nov. 30, 1999.
- Burcum J. "A Medical Enigma - A Rise in Brain Tumors Sets Off Search For A Reason." *Minneapolis Star Tribune*, Jan. 6, 1999.
- "Cell phone-cancer link found by Tel Aviv University scientist," *EurekAlert Press Release*, Feb. 14, 2008.
- Lean, G. "Mobile phones 'more dangerous than smoking'," *The Independent*, Mar. 30, 2008.
- McGinity M. "Yacking Yourself To Death?" *zdnet.com*, April 10, 2000.
- Oakes C. "Cell Study: Hazards Are Real." *Wired Magazine*, June 21, 1999.
- Townsend M and Hanlon M. "New Mobile Phone Danger," *London Express*, April 4, 2000.
- Verschaeve L. "Can non ionizing radiation induce cancer?" *The Cancer Journal*, Vol. 8, No. 5.

Chapter 1

- 20/20 ABC TV. "Worried About Your Wireless?" Oct. 20, 1999. Unedited transcript.
- Allison L. "Democrats Deliver Senate Inquiry On Mobile Phones." *Australian Democrats Spokesperson on Telecommunications*, Dec. 9, 1999.
- Bass G. "Is your cell phone killing you.?" *PC Computing Magazine*, Nov. 30, 1999.
- Begich N and Roderick J. *Earth Rising - The Revolution: Toward a Thousand Years of Peace*, Earthpulse Press, January 2000.
- Carlo G. Letter to Mr. C. Michael Armstrong, Chairman and Chief Executive Officer, AT & T Corporation.
- "Cell Phone Subscribers in the U.S., 1985–2008," *Infoplease.com*, <http://www.infoplease.com/ipa/A0933563.html>; accessed 9 July 2009.
- Chidi GA. "Class action suit filed against cell phone makers," *PCWorld.com*, April 20, 2001.
- Cleary S, Li-Mingh L, Merchant R. "In vitro lymphocyte proliferation induced by radio-frequency electromagnetic radiation under isothermal conditions." *Bioelectromagnetics*. 1990;11:47-56.
- Cleary S, Liu L, Merchant R. "Glioma proliferation modulated in vitro by isothermal radiofrequency radiation exposure." *Radiation Research*. 1990;121:38-45.
- Consumer Update on Mobile Phones. Center for Devices and Radiological Health (CDRH), U.S. Food and Drug Administration; 1999..
- Cover-up claims over mobile phone danger, *Express Newspapers* 24 May, 1999.
- Federal Communications Commission. "Radiofrequency FAQs Page." Office of Engineering and Technology. June 1, 1998.
- Fist St. "Cell Phones And Cancer." *The Australian Newspaper*, May 5, 1997.
- Fleming et al. "Cover-up claims over mobile phone danger." *Express Newspapers*, May 24, 1999.

Gallagher, Ian et al. "Mobile Phones Cover-Up." The Express (UK), Oct. 16, 1999.

Gaudin S. "Cell phone patents raise questions," Network World, June 18, 2001, vol 18, no. 25.

Goldberg R. "The Cellular Phone Controversy: Real or Contrived?" EMF Health Report, Vol. 1, No. 1, 1993.

Hogan M, "Will your cell phone kill you?" PCWorld.com, April 2, 2002.

House of Commons, Great Britain. Third Report, The Science and Technology Committee. "Scientific Advisory System: Mobile Phones And Health. " Sept. 22, 1999.

Inskip PD, Linet M, Tarone R. et al. Cellular telephone use and brain tumors . N Engl Med, Vol. 344, pp. 79 -86, Feb. 2001.

International Commission on Non-Ionizing Radiation Protection. Health Issues Related to the use of hand-held Radiotelephones and Base Transmitters. June 1995.

Johannsen C, Boice JD, McLaughlin JK, Olsen JH. Cellular Telephones and Cancer--a Nationwide Cohort Study in Denmark . J Natl Cancer Inst, Vol. 93, No.3, pp. 203-207, Feb. 7, 2001.

Kate H. Phone safety fears for children The Mercury, October 27, 1999.

Keller J. "Are They Safe?" Wall Street Journal, Feb. 11, 1994.

"Leading Epidemiologists See Childhood Leukemia Risk at 4 mG," Microwave News, Vol. 20, No. 5, pp.1, 11-13, Sept/Oct 2000.

Maisch D, Rapley B. "Powerline Frequency Electromagnetic Fields and Human Health - Is it the time to end further research?," ACNEM Journal, Vol. 17, No.1 pp. 5-16, June 1998.

Maisch D. "Mobile Phone Use: its time to take precautions", Journal of the Australian College of Nutritional & Environmental Medicine, April 2001.

Maisch Don. "A Letter Bomb For The Mobile Phone Industry?" EMFacts Consultancy, Oct. 19, 1999.

Mega-Lawyer Peter Angelos Joins Mobile Phone-Cancer Fray. Microwave News, Vol. 20, No. 5, pp.1, Nov/Dec 2000.

Meyer A. Senior partner: Halsey Meyer Higgins, Solicitors, London. "Mobile Phones and Mobile Networks: Potential Litigation Or Law Suits."

"Mobile phone 'brain damage' lawsuit," Associated Newspapers Ltd, March 15, 1999.

Mobile Telephone Concerns Health Registry website, www.health-concerns.org.

Mobile warnings case rejected. BBC News. 10 November 1999.

Muscat JE, Malkin MG, et al. Handheld cellular telephone use and risk of brain cancer, JAMA, Vol. 284, pp. 3001-3004, 2000.

Neurologist claims cell phones caused his brain tumor, Consumeraffairs.com, August 4, 2000.

"Nominations from FDA's Center for Device and Radiological Health: Radio Frequency Radiation Emissions of Wireless Communication Devices (CDRH). Feb. 8, 2000.

Oakes Cs. "Cell Study: Hazards Are Real." Wired Magazine, June 21, 1999.

Park RL. Editorial comment, J Natl Cancer Inst, Vol. 93, No.3, pp. 166-167, Feb. 7, 2001.

Parker G, "Cell Phone-Tumor Lawsuit is Tossed," Associated Press, Sept. 30, 2002.

RCRWireless News, "Hardell brain-cancer study to be published, may affect Newman case," April 5, 2002.

Robinson T. "Why the cell phone radiation scare won't go away." Wireless NewsFactor, August 30, 2002.

Ross B. "Wireless Worries?" abcnews.com, Oct. 20, 1999.

Ryle S. "Insurers balk at risks of phones." The London Observer, April 11, 1999.

Sage C. Letter to the Clerk of the Transport and the Environment Committee, The Scottish Parliament.

Schwartz J. "Cell Phones May Have Cancer Link." Washington Post, May 22, 1999.

Scientific Advisory Group on Cellular Telephone Research. "Potential public health risks from wireless technology: Research agenda for the development of data for science-based

decisionmaking." Washington, DC: Scientific Advisory Group on Cellular Telephone Research; 1994.

Silva J. "Controversy follows WTR to the end." June 4, 1999.

Silva J. "Industry launches global effort to counter cancer claims." RCR News, Jan. 25, 1999.

Silva J. "Motorola Memo Raises Questions About WTR Research." RCR News, March 3, 1997.

Smith, Karen. "New Evidence Links Mobiles To Cancer." Wired, March 30, 2000.

Wen P. "Mixed signals." The Boston Globe. 4 October 1999; C1.

Whittelsey F. "Cell Phones and Kids: A Bad Call?" vote.com, 1999.

Willan P. "Cell-phone safety at issue in Italy." IDG News Service, May 20, 1999.

"Wireless phones and your health: a consumer self-protection guide for the purchase and safe use of wireless phones." Health Risk Management Group; October 1999.

World Health Organization. "Electromagnetic Fields And Public Health." Fact Sheet No. 193, revised June 2000.

"World's Biggest Probe into Mobile Phones And Cancer." Sunday Mirror, Oct. 24. 1999.

Wrolstad J, "US judge upholds cell phone safety suit," Wireless Newsfactor, January 19, 2001.

Chapter 2

Becker RO and Marino AA. Electromagnetism and Life, SUNY Press, Albany, 1982.

Burcum J. "A Medical Enigma - A Rise in Brain Tumors Sets Off Search For A Reason." Minneapolis Star Tribune, Jan. 6, 1999.

Cherry, N. Criticism of the Proposal to Adopt ICNIRP Guidelines for Cellsites in New Zealand & Australia: Radio Frequency & Microwave Radiation 100kHz - 300 GHz. pp: 109-112, April 2000.

Chiang et al. "Health Effects Of Environmental Electromagnetic Fields." Journal of Bioelectricity. 8(1), 127-131 (1989).

Consumidor. "Consumer Group Says China Cell Radiation Levels Unsafe." March 16, 2000.

Democrats in Parliament. Australian Senate Hansard for Feb. 12, 1997. Mobile Phones.

Dutta et al. "Radiofrequency Radiation-Induced Calcium Ion Efflux Enhancement From Human and Other Neuroblastoma Cells in Culture." Bioelectromagnetics, 10: 197-202 (1989).

Foster K and Moulder J, "Are mobile phones safe?," *IEEE Spectrum*, August 2000.

Frey, Allan H. "Headaches from Cellular Telephones: Are They Real and What Are the Implications?" Environmental Health Perspectives, March 1998.

Health Physics, 74(4), 494-522 (1998).

Hecht K, Balzer HU. Biological Effects of Electromagnetic Fields on Humans in the Frequency Range 0 to 3 GHz: Summary and results of a study of Russian medical literature from 1960 - 1996, Berlin 1997.

House of Commons, Great Britain. Third Report, The Science and Technology Committee. "Scientific Advisory System: Mobile Phones And Health. " Sept. 22, 1999.

Hyland GJ. Scientific Advisory System: Mobile Phones and Health, Vol.II, Appendix 15, pp.86-91, HM Government, 1999.

McDonough D. "The global cell phone radiation clash," Wireless NewsFactor, June 21, 2002.

McLauchlin JR. "A survey of possible health hazards from exposure to microwave radiation," Hughes Aircraft corp. Culver City, Ca. 1953.

Philips A, "Mobile Phone Adverse Health Concerns," www.powerwatch.org.

Popp FA et al. (Editors). Electromagnetic Bio-Information, Urban Schwarzenburg, 1989.

Presman AS. Electromagnetic Fields and Life, Plenum Press , New York, 1970.

Ridley, Kirstin. "British Scientists Demand Cell Phone Warnings." Reuters, Jan. 1, 1998.

"Rural mobile phone use 'riskier'," BBC News, May 16, 2005.

Silverman C, Am.J.Epi, 1973 and Proc IEEE V79, pp78-84 1980.

- Smith CW and Best S. *Electromagnetic Man*, J.M. Dent & Sons Ltd, London, 1989.
- Smith N. "Cellular industry condemns China plan to impose strictest radiation standards," May 24, 2002.
- Szmigielski, S. "Cancer morbidity in subjects occupationally exposed to high frequency (radio frequency and microwave) electromagnetic radiation." *Science of the Total Environment*, Vol.180, pp:9-17, 1996.
- The Science of the Total Environment* 180, Elsevier, 1996, pp 81-86.
- The World Factbook 2009; <https://www.cia.gov/library/publications/the-world-factbook/geos/XX.html>; accessed 9 July 2009.
- United Kingdom National Radiation Protection Board "Doll Report: EMFields & Cancer," Doc. NRPB V3, No1, 1992.
- US Federal Drug Administration, Cell Phone Facts: Consumer Information on Wireless Phones, at www.fda.gov/cellphones.
- US General Accounting Office, "Telecommunications: Research and Regulatory Efforts on Mobile Phone Health Issues: GAO-01-545," May 2001.
- Wilson, Robert. "What's Cooking?" *The Australian*, March 23, 1999.
- World Health Organization International EMF Project, at www.who.int/peh-emf/en.
- World Health Organization, "Electromagnetic Fields and Public Health: Extremely Low Frequency (ELF): Fact Sheet WHO/205," November 1998.

Chapter 3

- "3G phones can make brain hurt," CNN.com, October 1, 2003.
- Adey WR. "Cell And Molecular Biology Associated With Radiation Fields Of Mobile Telephones." Department of Biochemistry, University of California.
- Adey WR. "Cell And Molecular Biology Associated With Radiation Fields Of Mobile Telephones." Dept. of Biochemistry, University of California, Riverside.
- Along for the ride: Reducing driver distractions - Final report of the driver focus and technology program. National Conference of State Legislatures, March 2002.
- Altpeter ES et al. "Study of Health Effects of Shortwave Transmitter Station at Schwarzenburg," University of Berne, Inst. for Social & Preventative Medicine, August 1995.
- "Are cell phones safe? Questions remain," *Consumer Reports*, June 2004.
- "A Swedish study links mobile phones to brain damage: in rats, anyway," *Popular Science*, February 2004.
- Auvinen A, Hietanen M, Luukkonen R, Koskela RS. "Brain tumors and salivary gland cancers among cellular telephone users." *Epidemiology*. 2002 May;13(3):356-9.
- Balode Z. *Sci. Total Environment*, 180/1, pp. 81-85 (1996).
- Balodis V et al. *Sci. Total Environment*, 180/1, pp.57-64 (1996).
- Bastide M et al. *Bioelectromagnetics*, 1999
- Batista E. "No cells for Bangladesh kids." *Wired News*, June 5, 2002.
- Bawin et al. "Poss. mechanism of weak EMF coupling in brain tissue," *Bioelectrochem. Bio.*5:67-76 (1978).
- Bawin SW et al. *Ann. NY Acad. Sci.*, 247, 74-81 (1975).
- "Beware - Using A Mobile Can Ruin Your Sex Life." *Sunday Mirror*, April 16, 2000.
- "Biological responses indicative of genetic effects." In: Carlo GL, ed. *Wireless Phones and Health: Scientific Progress*. Kluwer Academic Publishers; 1998.
- Bjorkstern U. "Microwaves open up the Blood Brain Barrier." *Svenska Dagbladet (Sweden)*, Sept. 15, 1999.
- Blackman CF et al. *Radio Sci.*, 14, 93-98 (1979).

- Borbely AA, Huber R, Graf T, Fuchs B, Gallmann E, Achermann P. "Pulsed high-frequency electromagnetic field affects human sleep and sleep electroencephalogram." *Neurosci Lett* 275(3):207-210, 1999.
- Braune S et al. *The Lancet*, 351, 1857-1858 (1998).
- Burch JB, Reif JS, Pitrat CA, Keele TJ, Yost MG. "Cellular telephone use and excretion of a urinary melatonin metabolite." *Annual Review of Research on Biological Effects of Electric and Magnetic Fields from the Generation, delivery & Use of Electricity*, 1997, pp.110.
- Byus et al. "Alteration in protein kinase activity following exposure of cultured lymphocytes to modulated microwave fields." *Bioelectromagnetics* 5:34-51 (1984).
- Canada Health Agency. "Need for Cell Phone-Drug Reaction Data." *Microwave News*, Vol.19, No.2, pp: 10, March/April 1999.
- "Cancer scare for mobile phone users," *ITN Online* May 24, 1999.
- "Cellphone radiation affects cells in living humans," *NewScientist*, 23 February 2008.
- "Cell phone-cancer link found by Tel Aviv University scientist," *EurekAlert Press Release*, Feb. 14, 2008.
- "Cell phone signals excite brain, study finds," *PrisonPlanet.com*, June 26, 2006.
- "Cell phones may cause hearing loss," *WebMD Medical News*, Sept. 19, 2007.
- Chiang H. "Microwave and ELF electromagnetic field effects on intercellular communication," *Proceedings of the 20th Annual International Conference of the IEEE Engineering in Medicine and Biology Society* 20:2798-2801, 1998.
- Cleary et al. "Effects of RF power in mammalian cells," *Ann.N.Y.Acad.Sci.*649:166-175 (1992).
- Coghill R. *Electro and Magnetobiology*, 1999.
- Coghill, Roger. "Why I believe That All These Items Should Carry A Health Warning." *Daily Mail*, July 17, 1998.
- Daniells C., Duce I, Thomas D, Sewell P, Tattersall J, de Pomerai D. "Transgenic nematodes as biomonitors of microwave-induced stress." *Mutat-Res.* 1998 Mar 13. 399(1). P 55-64.
- Dasdag S, Ketani MA, Akdag Z, Ersay AR, Sari I, Demirtas OC, Celik MS. "Whole-body microwave exposure emitted by cellular phones and testicular function of rats," *Urol Res* 27(3):219-223, 1999.
- De Pomerai DI, Daniells C, Barker SL, Scott S, Duce IR, Thomas DW, Sewell PD, Tattersall JEH. "Effects of stress-inducing microwave radiation on life-cycle parameters in the nematode *Caenorhabditis elegans*." Presented at the Twentieth Annual Meeting of the Bioelectromagnetics Society, St. Pete Beach, FL, June 1999.
- Ding G, Xie X, Zhang L et al. "Changes of nitric oxide synthase in hippocampus and cerebellum of the rat following exposure to electromagnetic pulse." *Chin J Phys Med* 20:81-83, 1998.
- Donnellan M, McKenzie DR, French PW. "Effects of exposure to electromagnetic radiation at 835 MHz on growth, morphology and secretory characteristics of a mast cell analogue, RBL-2H3," *Cell Biol Int* 21:427-439, 1997.
- Dutta et al. "Radiofrequency Radiation-Induced Calcium Ion Efflux Enhancement From Human and Other Neuroblastoma Cells in Culture." *Bioelectromagnetics*, 10: 197-202 (1989).
- Dutta SK et al. *Bioelectromagnetics*, 5, 71-78 (1984)
- Dutta SK et al. *Biological Effects of Electropollution: Brain Tumours and Experimental Models*, 1986, pp.63-69.
- Electromagnetic Hazard & Therapy*, Vol.8, No1, 1997, pp1-5.
- Eulitz C, Ullsperger P, Freude G, Elbert T. "Mobile phones modulate response patterns of human brain activity," *Neuroreport* 9(14):3229-3232, 1998.
- "Fact Sheet N181 - Electromagnetic Fields And Public Health." *World Health Organization*, May 1998.
- "Fact Sheet on Brain Cancer," *American Cancer Society*, www.cancer.org.
- "Fact Sheet on Leukemia," *American Cancer Society*, www.cancer.org.
- "Fact Sheet on Lymphoma," *American Cancer Society*, www.cancer.org.

"FED: Pregnant Women Warned To Be Wary Of Using Mobile Phones." American Academy of Physicians General News, May 1, 1999.

Fist S. "Cell Phones And Cancer." The Australian Newspaper, May 5, 1997.

Fleming et al. "Cover-up claims over mobile phone danger." Express Newspapers, May 24, 1999.

French PW, Donnellan M, McKenzie DR. "Electromagnetic radiation at 835 MHz changes the morphology and inhibits proliferation of a human astrocytoma cell line." *Bioelectrochem Bioenerg* 43:13-18, 1997.

Freude G, Ullsperger P, Eggert S, Ruppe I. "Effects of microwaves emitted by cellular phones on human slow brain potentials," *Bioelectromagnetics* 19(6):384-387, 1998.

Freude G, Ullsperger P, Eggert S, Ruppe I. "Microwaves emitted by cellular telephones affect human slow brain potentials," *Eur J Appl Physiol* 81(1-2):18-27, 2000.

Freude Get et al. *Bioelectromagnetics*, 19, 384-387 (1998).

Frey AH. "Headaches From Cell Phones: Are They Real and What Are the Implications?" *Environmental Health Perspectives*, 106, 101-103 (1998).

Funch DP, Rothman KJ, Loughlin JE, Dreyer NA. "Utility of telephone company records for epidemiologic studies of cellular telephones." *Epidemiology*. 1996;7:299-302.

Garaj-Vrhovac V et al. *Mutation Research*, 281, 181-186 (1992).

German Academy of Pediatrics. "Keep Kids Away from Phones," *Microwave News*, Vol. 21, No. 1, pp:5, Jan/Feb 2001.

Ghandi O. Presentation given at Mobile telephones and health: an update on the latest research. Gothenburg, Sweden; September 16-17, 1999.

Graham-Rowe D. "Mobile phone emissions increase worm fertility." *New Scientist*, February 6, 2002.

Greenlee RT, Hill-Harmon MB, Murray T, Thun M. "Cancer statistics, 2001." *CA Cancer J Clin* 2001; 51:15-36.

Halsey Meyer Higgins, Solicitors, "Mobile Phones - Mobile Networks - Safety." Sept. 10, 1995.

Hardell et al. "Case-Control Study on Radiology Work, Medical X-ray Investigations, and Use of Cellular Telephones as Risk factors for Brain Tumors." *Medscape.com*, May 4, 2000.

Hardell L, Hallquist A, Hansson-Mild K, Carlberg M, Pohlson A, Lilja A. Cellular and cordless telephones and the reisk for brain tumours," *Eur J Cancer Prev* 2002;11:377-386.

Hardell L, Nasman A, Pahlson A, Hallquist A, Hansson Mild K. "Use of cellular telephones and the risk for brain tumours: A case-control study." *Int J Oncol* 15(1):113-116, 1999.

Hardell L, Reizenstein J, Johansson B, Gertzen H, Mild KH. "Angiosarcoma of the scalp and use of a cordless (portable) telephone," *Epidemiology* 10(6):785-786, 1999.

Harris S. "Now mobiles give you kidney damage," *Daily Mail*, December 13, 1999.

"Heavy mobile use 'damages sperm,'" *BBC News*, Oct. 24, 2006.

"Health bulletin," *Mens Health*, June 2003.

Hocking B. "Preliminary report: symptoms associated with mobile phone use." *Occup Med (London)*, Vol. 48, No. 6, pp: 357-360, 1998.

Holt J, Powerwatch Network Technical Supplement, May 1996.

Holt J. "BBC1 TV Watchdog Programme," June 3, 1996.

Houck JB, "Study: Human Cells Amplify Wireless Phone Radiation." *Wireless NewsFactor*, December 11, 2000.

Huber R, Graf T, et al. "Exposure to pulsed high-frequency electromagnetic field during waking affects human sleep EEG." *NeuroReport*, Vol. 11, No.15, pp: 3321-3325, Oct.2000.

Inskip PD, Tarone RE, Hatch EE, Wilcosky TC, Shapiro WR, Selker RG, Fine HA, Black PM, Loeffler JS, Linet MS. "Cellular-telephone use and brain tumors." *N Engl J Med*. 2001 Jan 11;344(2):79-86.

"Italian study raises concerns about mobile phones," *Yahoo News*, Oct. 23, 2002.

Johannsen C, Boice JD, Jr., McLaughlin JK, Olsen JH. "Cellular telephones and cancer D a nationwide cohort study in Denmark." *J Natl Cancer Inst* 2001;93:203-207.

- Jolly C, Morimoto RI. *Journal of the National Cancer Institute*, Vol. 92, pp: 1564-761, Oct. 2000.
- Kalnins T et al. *Sci. Total Environment*, 180/1, pp.51-56 (1996).
- Kantra S. "FDA, Its time to study cellphone radiation." *Popular Science* September 2002.
- Kearney S. "Kids phone usage fears", *Sunday Tasmanian*. March 18, 2001.
- Khudnitskii SS, Moshkarev EA, Fomenko TV. "On the evaluation of the influence of cellular phones on their users." *Med Tr Prom Ekol*, Vol.9, pp:20-24, 1999.
- Kolodynski AA, Kolodynska VV. "Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia." *The Science of the Total Environment*. Vol. 180, pp: 87-93, 1996.
- Krause CM, Sillanmaki L, Koivisto M, Haggqvist A, Saarela C, Revonsuo A, Laine M, Hamalainen H. Effects of electromagnetic field emitted by cellular phones on the EEG during a memory task. *Neuroreport* 2000 Mar 20;11(4):761-4.
- Lai H and Singh NP. "Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells." *Bioelectromagnetics*, Vol.16 pp: 207-210, 1995.
- Lai H and Singh NP. "DNA Single- and double-strand DNA breaks in rat brain cells after acute exposure to low-level radiofrequency electromagnetic radiation." *Int. J. Radiat. Biol.*, Vol. 69, pp: 513-521, 1996.
- Lai H and Singh NP. "Melatonin and a spin-trap compound blocked radiofrequency radiation-induced DNA strand breaks in rat brain cells." *Bioelectromagnetics*, Vol. 18, pp: 446-454, 1997.
- Lai H and Singh NP. *Int. J. Radiation Biol.*, 69, 13-521 (1996).
- Lai H et al. *Engineering in Medicine and Biology*, 6, 31-36 (1987).
- Lai H, Carino MA, and Singh NP. "Naltrexone blocked RFR-induced DNA double strand breaks in rat brain cells." *Wireless Networks Journal*, Vol. 3, pp: 471-476, 1997.
- Lai H, Horita A, Guy AW. "Microwave irradiation affects radial-arm maze performance in the rat." *Bioelectromagnetics*, 15:95-104, 1994.
- Lai, Henry. "Neurological Effects of Radiofrequency Electromagnetic Radiation Relating to Wireless Communication Technology." *Bioelectromagnetics Research Laboratory, Department of Engineering, University of Washington, Seattle, Washington*. Paper presented at the IBC-UK Conference: Mobile Phones - Is there a Health Risk? Sept. 16-17, 1997 in Brussels, Belgium.
- Lean, G. "Mobile phones 'more dangerous than smoking'," *The Independent*, Mar. 30, 2008.
- Lebedeva NN, Sulimov AV et al. "Cellular phone electromagnetic field effects on bioelectric activity of human brain." *Crit Rev Biomed Eng*, Vol. 28, No. 1-2, pp:323-337, 2000.
- Leszczynski D, Joenväärä S et al. "Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: Molecular mechanism for cancer- and blood-brain barrier-related effects." *Differentiation* 70:120-129, 2002.
- "Long term mobile phone use raises brain tumor risk: study," *Reuters via Yahoo News*, Mar. 31, 2006.
- Lyle DB et al. *Bioelectromagnetics*, 4, 281-292 (1983).
- MacArthur J. "The Cell Phone Chronicles." *brain.com*, April 25, 2000.
- Magone I. *Sci. Total Environment*, 180/1, pp.75-80 (1996).
- Magras IN, Xenos,TD. "RF radiation-induced changes in the prenatal development of mice," *Bioelectromagnetics* 18(6):455-461, 1997.
- Maisch D. "Setting radio frequency/Microwave (RF/MW) exposure guidelines to protect workers and the public: Russia and the West in major conflict." *Jan. 18, 2000*.
- Mann K and Roschke J. *Neuropsychobiology*, 33, 41-47 (1996).
- Mason PA, Escarciga R, Doyle JM, Romano WF, Berger RE, Donnellan JP. "Amino acid concentrations in hypothalamic and caudate nuclei during microwave-induced thermal stress: analysis by microdialysis," *Bioelectromagnetics* 18(3):277-283, 1997.

- Mcree DI. Proc. IEEE, 68, 84-91 (1980).
- Mobile Health Phone Watch. "Our 20-year study proves there is link between mobiles and cancer risk of deadly tumours significantly higher." March 26, 2000.
- "Mobile Phone Electromagnetic Fields Increase Resting Blood Pressure," Lancet, June 20, 1998.
- "Mobile phone radiation harms DNA, new study finds," Reuters News, Dec. 20, 2004.
- "Mobile phone may damage sperm," Reuters Health, June 24, 2004.
- "Mobile phones 'harm blood cells'," BBC News, April 6, 2004.
- "Mobile Phones Report Claims 'Strongest Link Yet' To Cancer," Reuters, March 27, 2000.
- Moran K. "Soviet Proof That Mobile Phones Do Cause Brain Damage." Daily Express, Nov. 10, 1999.
- Muscat J. "Cellular telephone use and risk of brain cancer." In: Carlo GL. Editor. Wireless phones and health II: State of the science. Kluwer Academic Publishers, 2000.
- Nageswari KS. Proc. Asia Pacific Microwave Conf. (Edited by R.S. Gupta), Vol. 1(B1.6), 59-61 (1996).
- National Highway Transportation Safety Administration. "An Investigation of the Safety Implications of Wireless Communications in Vehicles," November 1997.
- Nelson BK, Conover DL, Krieg EF Jr, Snyder DL, Edwards RM. "Interactions of radiofrequency radiation-induced hyperthermia and 2-methoxyethanol teratogenicity in rats," Bioelectromagnetics;18(5):349-359, 1997.
- Neurological Effects of Radiofrequency Electromagnetic Radiation. Bioelectromagnetics Research Laboratory, Dept. of Bioengineering, School of Medicine and College of Engineering, University of Washington, Seattle, Washington. Paper presented to the Workshop on possible biological and health effects of RF electromagnetic fields. Mobile Phones and Health, Symposium, Oct. 25-28, 1998, University of Vienna, Austria.
- Pershin et al. "Microwaves in immune response to VI-antigen," Electro. Magnetobiol. 13:203-209 (1996).
- Persson BRR, Salford LG, Brun A. "Blood-brain barrier permeability in rats exposed to electromagnetic fields used in wireless communication." Wireless Network, Vol.3, pp: 455-461, 1997.
- Phillips et al. "DNA damage in Molt-4 T-lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro." Bioelectrochemistry and Bioenergetics, Jan. 9, 1998.
- Preece AW et al. "Effect of a 915 MHz simulated mobile phone signal on cognitive function in man." Int J Radiat Biol, Vol. 75, No.4, pp: 447-456, 1999.
- Preston-Martin S, Mack WJ. "Neoplasms of the nervous system." In: Schottenfeld D and Fraumeni JF, eds. Cancer Epidemiology and Prevention. Oxford, 1996:1231-1281.
- Pryer, Nick. "Mobile Phones Can Affect Memory." Associated Newspapers Ltd., July 16, 1998.
- Questions and Answers for the National Cancer Institute Study of Brain Tumors and Use of Cellular Telephones, National Institutes of Health, December 21, 2000.
- Raloff J. "Researchers Probe Cell-Phone Effects." Science News, Feb. 12, 2000.
- Rats exposed to cell phone microwaves suffer long-term memory loss, according to new study by a University of Washington researcher. University of Washington Press Release, Nov. 30, 1999.
- Reiser HP et al. Eur. J. Med. Res., 1, 27-32 (1995).
- Repacholi et al. "Lymphomas in mice exposed to 900MHz pulsed EMFs," Rad. Res. 1997;147(5):631-640 (1997).
- Repacholi MH, Basten, A, Gebiski V, Noonan D, Finnie JH, Harris AW. Lymphomas in Eu-Pim1 Transgenic Mice Exposed to Pulsed 900 MHz Electromagnetic Fields. Radiation Research, Vol.147, pp.631-640, 1997.
- RF Radiation and Electromagnetic Field Safety. ARRL Handbook for Radio Amateurs, 1996.

Roosli M, Lortscher M, Efger M, Pfluger D, Schreier N, Emanuel L, Locher P, Spoerri A, Minder C. "Leukemia, brain tumors and exposure to extremely low frequency magnetic fields: Cohort study of Swiss railway employees." *Occup Environ Med*, 2007 May 24 [Epub ahead of print].

Rosenberg et al. "Cell-phone health risks need to be studied, FDA says." *Seattle Post-Intelligencer*. April 1, 2000.

Rothman KJ, Chou CK, Morgan R, et al. "Assessment of cellular telephone and other radio-frequency exposure for epidemiologic research," *Epidemiology*. 1996;7:291-298.

Rothman KJ, Loughlin JE, Funch DP, Dreyer NA. "Overall mortality of cellular telephone customers." *Epidemiology*. 1996;7:303-305.

Sajin G et al. *Proc. IEEE MTT-S Digest, TU4E-5*, 543-546 (1994).

Sajin G et al. *Proc. 25th European Microwave Conference*, pp.845-848 (1995).

Sajin G et al. *Proc. 27th European Microwave Conf. Vol. 1*, pp.596-599 (1997).

Salford G et al. *Microsc. Res. Tech.*, 27, 535-542 (1994).

Salford G et al. *Bioelectrochemistry & Bioenergetics*, 30, 293-301 (1993)

Savopol T et al. *Electro- and Magnetobiology*, 14, 99-105 (1995).

Schilling CJ. "Effects of acute exposure to ultrahigh radiofrequency radiation on three antenna engineers," *Occup Environ Med* 54(4):281-284, 1997.

Schilling CJ. "Effects of exposure to very high frequency radiofrequency radiation on six antenna engineers in two separate incidents." *Occup Med* 60:49-56, 2000.

Schwartz J. "Study: Cell Phone Use May Have Cancer Link." *Washington Post*, May 22, 1999, E01.

Shcheglov VS et al. *Electro- and Magnetobiology*, 16, 69-82 (1997)

Shirmacher A, Winters S, Fischer S et al. "Electromagnetic fields (1.8 GHz) increase the permeability to sucrose of the blood-brain barrier in vitro." *Bioelectromagnetics* Vol.21, No.5, pp:338-345, July 2000.

Singh NP and Lai H. *Proc. Asia Pacific Microwave Conf. (Edited by R.S. Gupta)*, Vol. 1(B1-4), pp.51-55 (1996)

Sobel et al. "Electromagnetic Field Exposure and Alzheimer's Disease." *Neurology*, Dec. 1996.

Stang A, Anastassiou G. et al. "The possible role of radio frequency radiation in the development of uveal melanoma." *Epidemiology*, Vol. 12, pp: 7-12, Jan. 2001.

Szmigielski S, Bortkiewicz A, Gadzicka E, Zmyslony M, Kubacki R. "Alteration of diurnal rhythms of blood pressure and heart rate to workers exposed to radiofrequency electromagnetic fields.: *Blood Press Monit* 3(6):323-330, 1998.

Takashima et al. "Models of long-range order in cerebral macromolecules: Effect of ELF and modulated VHF fields," *Radio Sci.* 14:141-145 (1979)

"Top German radiation expert warns on cellphones." *Reuters*, July 31, 2002.

Trigano AJ, Azoulay A, Rochdi M, Campillo. "A Electromagnetic interference of external pacemakers by walkie-talkies and digital cellular phones: experimental study." *Pacing Clin Electrophysiol* 22(4 Pt 1):588-593, 1999.

Uhlig R. "New studies link brain tumors to mobile phones." *Electronic Telegraph*, May 24, 1999.

UK Study: Mobile Phones Can make the Brain Work Faster. *Microwave News*. Vol.19, No.2, pp:1& 11, March/April, 1999.

Use of early mobile phones may increase brain tumour risk, *Reuters Medical News*, August 23, 2002.

"Using a mobile phone makes you age faster." *Daily Mail*. Oct. 18, 1999.

Veyret et al. "Antibody Responses of Mice Exposed to Low-Power Microwaves Under Combined, Pulse-and-Amplitude Modulation." *Bioelectromagnetics*, 12:47-56 (1991).

von Klitzing L. *Phys. Medica*, XI (2), 77-80 (1995).

von Klitzing L. "Low-Frequency pulsed electromagnetic fields influence EEG of man." *Physica medica*, April 28, 1995.

Wang BM and Lai H. "Acute exposure to pulsed 2450-MHz microwaves affects water maze learning in the rat." *Bioelectromagnetics*, 21:52-56, 2000.

Whittelsey F. "Cell Phones and Kids: A Bad Call?" vote.com, 1999.

Wrolstad J. "Controversy erupts over new cell phone-cancer study." *Wireless NewsFactor*, April 23, 2002.

Wrolstad J. "Driver distraction subject of new brain research." *Wireless NewsFactor*, August 12, 2002.

Wrolstad J. "Study: Cell Phones Interfere with Medical Devices." *Wireless NewsFactor*, January 9, 2001.

Youbicier-Simo BY et al. *Bioelectromagnetics*, 18(7), 514-523 (1997).

Youbicier-Simo et al., "Mortality of Chick Embryos Exposed to EMFs from Mobile Phones," *BEMS* 1998.

Chapter 4

"'Anti-Radiation' Trousers Fuel Mobile Phone Debate," Reuters, Sept. 12, 2002.

"Cell phone lightning strikes," *The Week*, July 21, 2006.

"Cell Phone On Your Belt Brings Radiation To Liver And Kidneys," *The Sunday Mirror*, July 10, 1999.

Company Memorandum, "MWT Test Comparisons," Millimeter Wave Technology Inc., November 6, 2001.

Company Memorandum, AMA Laboratories to MWT-Materials Inc., August 12, 2002.

Consumer Update on Mobile Phones. Center for Devices and Radiological Health (CDRH), U.S. Food and Drug Administration; 1999.

"Experts Debate Safety Of Earpieces For Cell Phone," *Jerusalem Post*, April 6, 2000.

Federal Drug Administration. "Consumer Update on Mobile Phones." Center for Devices and Radiological Health." Oct. 20, 1999.

Helin J. "How Dangerous Is Your Mobile Phone?" *Aftonbladet*, Feb. 8, 1997.

House of Commons, Great Britain. Third Report, The Science and Technology Committee. "Scientific Advisory System: Mobile Phones And Health." Sept. 22, 1999.

Ireland News Sunday Times, January 19th, 1997.

Maisch D. "Discussion Paper concerning the validity of the science, promotion and sales of EMR Protective Devices," *Emfacts Consultancy*. Nov. 21, 1999.

Marks P. "Give us a ring." *New Scientist*, November 11, 2000.

McDonough D. "Are useless cell phone shields bilking consumers," *Wireless NewsFactor* April 11, 2002.

McGinity M. "Yacking Yourself To Death?" *zdnnet.com*, April 10, 2000.

Personal communication, MWT Materials, August 23, 2002.

"Staying safe at the gas pump," *Parade Magazine*, Aug. 10, 2003.

Townsend M and Hanlon M. "New Mobile Phone Danger," *London Express*, April 4, 2000.

Wilson R. "What's Cooking?" *The Australian*, March 23, 1999.

Appendix A

"Cell phone radiation levels," CNET.com, <http://reviews.cnet.com/cell-phone-radiation-levels/>; accessed 10 July 2009.

ABOUT THE AUTHORS



Dr. Ronald Klatz, M.D., D.O., who coined the term "anti-aging medicine," is recognized as a leading authority in the new clinical science of anti-aging medicine. Since 1981, Dr. Klatz has been integral in the pioneering exploration of new therapies for the treatment and prevention of age-related degenerative diseases. He is the physician founder and President of the American Academy of Anti-Aging Medicine (A4M; www.worldhealth.net). In his capacity as A4M President, Dr. Klatz oversees AMA/ACCME-approved continuing medical education programs for more than 100,000 physicians, health practitioners, and scientists from over 105 countries worldwide.

As a world recognized authority on preventive medicine and advanced biotechnologies, Dr. Klatz is an innovator of new medical treatments, technologies, and therapeutics focused on forestalling the diseases of aging. Dr. Klatz is the inventor, developer, or administrator of 100-plus scientific patents. Held in high regard for his continuing medical education lectures on the demographics of aging and the impact of biomedical technologies on longevity, Dr. Klatz has published scientific articles appearing in *Resident and Staff Physician*, *British Journal of Sports Medicine*, *Medical Times/The Journal of Family Medicine*, *Osteopathic Annals*, and *American Medical Association News* (partial list).



Dr. Robert Goldman, M.D., Ph.D., D.O., FAASP, is physician co-founder and Chairman of the Board of the A4M and Chairman of the World Anti-Aging Academy of Medicine (WAAAM; www.waaam.net). Dr. Goldman serves as Chairman of the International Medical Commission overseeing sports medicine committees in over 184 nations. He also is President Emeritis of the National Academy of Sports Medicine (NASM; www.nasm.org).

Dr. Goldman has served as a Senior Fellow at the Lincoln Filene Center, Tufts University; as an Affiliate at the Philosophy of Education Research Center, Graduate School of Education, Harvard University, He is Clinical Consultant, Department of Obstetrics and Gynecology, Korea Medical University; and Professor, Department of Internal Medicine at the University of Central America Health Sciences, Department of Internal Medicine. Dr. Goldman holds the positions of Visiting Professor, Udayana University School of Medicine, Indonesia; Visiting Professor, Huazhong University of Science & Technology Tong Ji Medical School, China; Visiting Professor, The Wuhan Institute of Science & Technology, China; and Visiting Professor at Hainan Medical College, China.

ABOUT THE AMERICAN ACADEMY OF ANTI-AGING MEDICINE (A4M)



Among the fastest-growing medical specialties in the world, anti-aging medicine is an innovation in healthcare, blazing new advancements in advanced preventive medicine. Anti-aging medicine is founded on the application of advanced scientific and medical technologies for the early detection, prevention, treatment, and reversal of age-related dysfunction, disorders, and diseases. It is a healthcare model promoting innovative science and research to prolong the healthy lifespan in humans. As such, anti-aging medicine is based on solid scientific principles of responsible medical care that are consistent with those applied in other preventive health specialties. The goal of anti-aging medicine is not to merely prolong the total years of an individual's life, but to ensure that those years are enjoyed in a productive and vital fashion.

Mission

The American Academy of Anti-Aging Medicine, Inc. ("A4M") is a US federally registered 501(c)3 non-profit medical organization dedicated to the advancement of technology to detect, prevent, and treat aging related disease and to promote research into methods to retard and optimize the human aging process. A4M is also dedicated to educating physicians, scientists, and members of the public on biomedical sciences, breaking technologies, and anti-aging issues.

The A4M believes that the disabilities associated with normal aging are caused by physiological dysfunction which in many cases are ameliorable to medical treatment, such that the human lifespan can be increased, and the quality of one's life enhanced as one grows chronologically older. A4M seeks to disseminate information concerning innovative science and research as well as treatment modalities designed to prolong the human lifespan. Although A4M seeks to disseminate information on many types of medical treatments, it does not promote or endorse any specific treatment nor does it sell or endorse any commercial product.

Objectives & Core Activities

- Make available life-extending information about the multiple benefits of anti-aging therapeutics to practicing physicians and health practitioners
- Assist in developing therapeutic protocols and innovative diagnostic tools to aid physicians and health practitioners in the implementation of effective longevity treatment
- Act as an information center for valid and effective anti-aging medical protocols.
- Assist in obtaining and disseminating funding for scientifically sound and innovative research in anti-aging medicine
- Assist in the funding and promotion of critical anti-aging, clinically based research.
- Outreach, education, and advocacy for anti-aging medicine in the governmental and public arenas
- Provide continuing medical education and training for over 100,000 physicians, health practitioners, and scientists at dozens of scientific conferences taking place in the United States and in venues worldwide, in the anti-aging and regenerative medical sciences

Visit the Official Educational Website of the A4M
www.worldhealth.net