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## Téléphones portables, un danger pour la santé ?

### Conclusions du rapport Final WTR

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The immense popularity of the wireless phone and the continued worldwide growth of the wireless phone industry has created a unique challenge for government regulators, public health professionals, members of the wireless industry and all other persons who are concerned with the safety of wireless technologies. While scientific information currently available is unclear about safety, in the United States there are currently more than 80 million wireless phone subscribers, with thousands more people each day taking up the wireless phone. Worldwide, there are an estimated 400 million users.

As we approach the second decade of penetration of wireless phone into society in the United States, there are no federal measures regulating potential wireless phone health effects. Neither the Federal Communications Commission (FCC), responsible for the regulation of wireless technology, nor the Food and Drug Administration (FDA) responsible for requiring in appropriate circumstances, pre-market testing and post-market surveillance, has to date found consumer protection steps to be necessary. Currently, there are FCC guidelines for wireless phone emissions that were put into effect during the middle 1990's; however, these emission guidelines are not considered to be safety regulations. Prior to the processing of the current guidelines, wireless phones were expressly exempted from any guidelines whatsoever, the so-called low power exclusion.

Since early 1993, questions about cell phone safety have been raised in both scientific circles and the popular media. Hearings held by congressman Edward Markey (DMA), in 1993 and a decision by a Florida court in 1994 (the Reynard case) highlighted the dearth of scientific information relevant to wireless phone safety at the time. Indeed, the paucity of data upon which informed judgements about health risk could be made led to the sponsorship by the wireless industry of the unprecedented, independent, surveillance and research effort that has spawned the majority of the science that we now have to shed light on this important public health issue.

Science currently in hand worldwide is not definitive about health risks from wireless technology; however, legitimate questions about safety have arisen from the data. While some additional health and safety work is underway in various parts of the world, new information that could possibly shift the state of scientific understanding is not likely to surface for another five to six years. The scientific information now in

hand will be the basis for health protection for the foreseeable future. Options to reduce exposure to potential harmful radio frequency radiation (RFR) and thus reduce the risk of health problems are available, both through the efforts of wireless phone

manufacturers and providers of other radiation protection devices. However, the scientific

bases underlying these potentially protective devices are presently unclear. Because testing of these devices is underway, neither the government nor the industry has pushed the devices in the marketplace, and appropriately so.

The first questions about the potential for cellular phones to cause brain cancer were raised in 1993. The clinical observation by a Florida neurologist, Dr David Perlmutter, that his patient's brain tumor was located in an area where RFR from her cellular phone's antenna would be deposited, made international news after he aired his hypothesis, that use of the phone caused the tumor, on the Larry King Live television show. Biological bases for Perlmutter's hypothesis were derived from studies conducted by Dr Stephen Cleary of the Medical College of Virginia, showing a proliferation of tumor cells cultured in vitro following exposure to RFR.

At that time, most scientific believed that the low power pushing cellular phone signals was insufficient to cause heating of biological tissue, the only known mechanistic underpinning of RFR damage. Thus, the combined observations of Perlmutter and Cleary

were met with skepticism. Because Cleary was not able to quantify the degree of heating in his experimental system, scientists believed his findings were artifacts due to uncontrolled heating of tumor cells in his experimental system. Without a biological basis, the observation by Perlmutter of proximity of the tumor to the area exposed to RFR from the cell phone antenna was considered artifactual as well.

Nonetheless, these observations raised questions that led to and were to be addressed by the ambitious surveillance and research effort funded by the wireless industry, later known as the Wireless Technology Research (WTR) program.

In late 1994, Lai and Singh reported on their observation that rats exposed whole body to microwaves similar in intensity to those radiating from a cellular phone antenna appeared to experience single strand DNA breakage as a result of the exposure. The following year they published a similar report suggesting double strand DNA breaks in the same exposure scenario. Lai and Singh had adapted the traditionally in vitro single cell gel (SCG) assay to an in vivo situation. This adaptation had not been validated so interpretation of these findings with respect to scientific validity was difficult. In addition, the whole body microwave (2450 megahertz) exposure approach of the investigators was sufficiently different from actual human cell phone exposure results not interpretable with respect to human cell phone usage. Further, studies of the dosimetry of cell phone emission suggested that the antenna from a cellular phone would emit insufficient energy to break the base pair bonds holding DNA together, thus casting further doubt on the relevance of these findings to human cellular phone usage.

During the ensuing two years, spurred on in part by the shortcomings of these earlier studies, scientists pursuing biological effects focused on development of both in vitro and in vivo exposure systems that were capable of providing information directly relevant to humans using wireless phones. These very focused efforts included adaptations that provided the uniform fields of exposure and heating controls for in vitro experiments and head concentrated exposures for experiments using animals. With these new and directly relevant exposure systems now available, subsequent findings had to be looked at more seriously with respect to human health risk.

In 1997, Adey et al. were the first to report biological effects in rats exposed head first to cellular phone mediated RFR. While these data did not indicate a hazard from the RFR

exposure, indeed these data suggested a protective effect against tumors, this represented the first well controlled study showing biological effects from RFR exposure that were not heat induced.

Later in the same year, Repachioli and colleagues reported that genetically engineered mice exposed whole body to RFR exhibited an increase in lymphoma.

Repachioli's findings were met with skepticism because it was unclear what dose of RFR the mice in the experiment sustained and thus relevance to humans using wireless phones was unclear. In addition, the tumor excess he observed occurred near the end of the life

expectancy of the mice at around 18 months, and the transgenic model employed was traditionally used for only a six month.

Findings from the wireless industry funded WTR program began to emerge during the latter part of 1998 and the beginning of 1999. With the newly developed in vitro and in vivo exposure systems specifically designed for extrapolation to human wireless phone usage, and the first epidemiology studies looking at health risks among cellular phone users, the WTR research was expected to clarify the questions raised by previously published work.

The WTR program encompassed independent peer review coordinated through the Harvard School of Public Health, strict adherence to both Good Laboratory Practices (GLP) and Good Epidemiologic Practices (GEP), and the input of over one hundred scientists and physicians worldwide. The WTR program was designed to be of the highest scientific quality, and in its implementation, rigorously adhered to a peer reviewed research agenda that was 18 months in the making. Protocols for each study conducted under the WTR were peer reviewed prior to implementation, and progress in the field was regularly reported to and reviewed by the U.S. government's Interagency, National Cancer Institute, National Institute for Occupational Safety and Health, and the National Institute of Environmental Health Sciences.

All reports arising out of the WTR program were further peer reviewed, and a requirement for all investigators was that their findings also be submitted for publication in the peer scientific literature.

For decisions about health impact, the WTR program employed a public health paradigm, consistent with the regulatory framework for post-market surveillance for medical devices and pharmaceuticals. Within that framework, each of the more than fifty studies conducted with WTR support was judged in terms of whether or not the findings indicated a public health problem, i.e. a positive finding, that warranted public health intervention of some sort. Decisions about public health impact were made after rigorous peer review coordinated through the Harvard School of Public Health scientific review program designed specifically for the WTR effort. Under this framework, decisions about risk and intervention could be made with confidence prior to study findings appearing in the open scientific literature; the publication process can take months if not years. With thousands more people being exposed to wireless phone exposure every day, it was judged by the WTR that time expediency in applying the findings of this important research was of critical importance.

Further, this is the same paradigm that federal regulatory agency would use to intervene if this work were being pursued within a regulatory docket, i.e. decision making about public health impact after peer review but prior to publication. Thus, each of the studies reported here have been peer reviewed both at the protocol stage

and after the final report and conclusions were drawn. Each report is publicly available.

The batteries of WTR sponsored studies addressing genetic damage from wireless phone exposures were conducted simultaneously at two GLP facilities, Integrated Laboratory

System in Research Triangle Park, North Carolina and Stanford Research Institute in Palo Alto, California. Repetitions of the experiments were included in the peer reviewed protocols along with independent quality assurance audits.

In vitro assays of bacteria, mouse lymphoma cells and human lymphocytes, and in vivo studies of rats exposed head only to all types of wireless phone signals -cellular analog, cellular digital, and 1900 megahertz digital - has confirmed that RFR energy of the type and magnitude associated with wireless phones is insufficient to cause breakage of DNA.

However, a series of WTR sponsored studies addressing genetic damage to human blood cells through the assessment of micronucleus formation were unequivocally positive for all cellular and PCS phone technologies. The increase in the number of cells with mononuclei associated with RFR exposure suggests an impairment of the ability of human blood cells to repair broken DNA. Multinucleate cells can reproduce and lead to proliferation of damaged blood cells. Several repeats of these studies confirmed that the observed effects could not be explained by heating in the experimental system or any other artifact. The conclusion of the investigators was that under these experimental conditions the RFR from the wireless phone is genotoxic. The WTR sponsored epidemiology studies, conducted according to GEP, also raise questions about health risks associated with cellular phone usage. PCS and digital signaling in the cellular frequency bands were not covered in these studies because those technologies were not widespread use when the studies were conducted. While none of the WTR epidemiological studies taken alone is persuasive with respect to a definitive public health threat from cellular phone use, these data suggest that there could be a pattern of public health risk emerging.

Dreyer et al. Completed the largest cohort study to date of analog cellular phone users and found a significant increase in the risk of death from automobile accidents among cellular phone users, and an increase in the rate of brain cancer mortality in hand held phone users (near field exposure) as compared to car phone users with the antenna on the rear window (far field exposure). The rate of brain cancer death was more than three times greater in the hand held phone group as compared to the far field control group; however, the difference was not statistically significant.

Muscat et al. reported in a case-control analysis an increase in the risk of acoustic neuroma among people who reported using their cellular phone for more than six years. This finding is interesting for two reasons: first, the acoustic nerve is within the two to three inch penetration zone of the RFR from the wireless phone antenna; and second, those who used the phone for six years or more in this study handled phone in place during the late 1980's when there were no guidelines with respect to RFR emissions. Exposures sustained from these older phone types therefore could have been much higher than exposures from currently available phones. People with a history of using these phones represent a high exposure sentinel group very important for further study.

Another study by Muscat et al. Addressing primary brain cancer is also suggestive of a potential risk. This case-control study accrued newly diagnosed cases from five hospitals

across the United States and was designed to look at both duration and frequency of cellular phone usage. When all primary brain cancer cases and controls were included

in the analysis, there was no evidence of increased risk of primary brain cancer associated with cellular phone use history. However, the majority of the brain cancer included in the study were outside of the two to three inch exposure pattern generally accepted as the depth of RFR penetration from a wireless phone. A histopathological sub-type analysis, segregating neuro-epithelial tumors likely in range of the RFR exposure revealed a statistically significant increase in risk associated with cellular phone use. Further, those patients who reported using their phone on the right side of their head had a significant increase in tumors on that side of the head. This finding of laterality was consistent with the observations of Hardell (1999), who, in a case-control study conducted in Sweden, observed that tumors were more frequently found on the side of the head where the phone was used.

Taken together, the WTR research findings are not conclusive with respect to an increased risk of brain cancer or benign tumors associated with wireless phone usage. Indeed, these findings must be confirmed and could be chance occurrences.

Alternatively, these findings could be early indications of a serious public health threat. The science is in a gray area and serious and focused follow up is clearly necessary, both to identify the meaning of these findings and to provide consumers with means of protection.

Previously published WTR work identified that digital phones interfered with implanted cardiac pacemakers. The result of that work, made public through WTR symposia and published in the *New England Journal of Medicine*, providing guidance for changes in the design of pacemakers to shield against interference, and identified a distance threshold that has served consumers as an interim solution. Recommended follow up with respect to implanted cardiac defibrillators has not been completed, but remains an important priority.

Currently, the necessary consumer protection and scientific follow up derivative of the work completed to date by WTR and others is not in place. At this juncture, it is critical to recognize that a public health question has been raised by the existing science; therefore, public health professionals must be central to the next phase of follow up.

It is also noteworthy that the FDA, in its recommendation to the National Toxicology Program, has targeted animal studies as important. While the WTR does not disagree with the need for ongoing animal experiments, it should be noted that studies in experimental systems are complementary to the public health focused work recommended here, and does not take the place of it.

Specifically, the following public health follow up should be implemented.

1. A passive reporting system to capture health complaints among wireless phone users

needs to be established. Currently there is no mechanism in place to allow an assessment

of the presence or absence of clusters of disease among wireless phone users.

2. The analog phone user cohort studied by Dreyer et al. Included mortality follow up for

only one year, 1994. This study should be updated with analysis of mortality among the

cohort members for the years 1995 through 1999.

3. A similar cohort for digital phone users should be established and followed, with distinction between cellular and Personal Communication System (PCS) signaling included. Cellular phones transmit in the 800 to 900 megahertz range, whereas PCS phones transmit in the 1900 megahertz range.

4. Adult onset leukemia should be looked at as an outcome potentially related to RFR

exposure. The flat bones of the skull, which are important blood forming organs, are in range of exposure to RFR from a wireless phone's antenna. Further, the genotoxicity finding regarding the formation of micronuclei occurred in human blood.

5. Specific studies of children are warranted for all health outcomes relevant to the range of RFR exposures and the target tissues expected from wireless phone use among children.

Work completed by Dr Om Gandhi of the University of Utah suggest that children and young adults will experience an RFR exposure pattern that is distinguishable from adults

in its magnitude. Further, work completed by the WTR suggests that growing tissues and

cells undergoing mitoses could be at higher risk of the type of genetic damage that has been related to wireless phone RFR. These are characteristics of growing tissue in children

and young adults.

6. Studies of the impact of RFR exposure on pregnant woman specifically the developing

embryo and foetus are warranted based on the existing science. Work completed by the

WTR suggests that growing tissues and cells undergoing mitoses could be at higher risk of

the type of genetic damage that has been related to wireless phone RFR. These are characteristics of embryonic and fetal tissue. Newly released experimental work by Adey

suggests transplacental effects as well.

7. The appropriateness of the Specific Absorption Rate (SAR) as a measure indicative of

non-thermal and chronic health effects must be evaluated anew. Scientists, including those at the FDA, recognize that the distinctions among thermal and non-thermal effects

and acute and chronic effects, must be addressed in subsequent research. As a measure

of the rate or RFR passing through a tissue at a given time, the SAR does not have properties amenable to the evaluation of cumulative RFR exposures that could be critical

to both heating and chronic exposures.

8. Further studies of the effect of RFR on brain function should be conducted. The recent

work completed by Drs Preece, Mild, Oftedal and Sandstrom, in different laboratories,

raise important questions about subtle impact of RFR on brain function.

9. Further studies of wireless phone usage patterns among consumers are necessary. It remains unclear whether there are cumulative effects of usage, and intervention recommendations cannot be made informedly without a better understanding of the continuing evolution of wireless use characteristics.

The current lack of clarity in the science would be less a problem if there was not the current explosion in wireless technology usage across the globe. Recent advertising trends by the wireless industry targeting children, including wireless phones adorned with pictures of Disney characters such as Mickey or Minnie Mouse, are of special concern. Recent work by Gandhi at the University of Utah shows that penetration of RFR into the heads of children is greater than in adults. Growing mitotic cells in

children could be at higher risk for functional genetic damage such as that found in the WTR studies of exposure to RFR.

The first step in empowering consumers who are concerned to protect their health is to

communicate the current state of knowledge regarding these potential health impacts, as

uncertain as they are. Because there are interventions available to minimize exposures to RFR from the wireless phone antenna, consumers can then have choices with respect to minimizing their exposure. Many of the models of wireless phones currently available are equipped with headsets and hands free devices that allow for two way messaging similar to wireless phones, but without the concentrated RFR exposure from an antenna placed near the head. Pagers are preferable for young children and teenagers whose tissues are still growing.

The science is not clear enough to enable us to make informed judgements about how wireless phone usage patterns impact health. Studies completed to date do not allow us to distinguish, in terms of health risk, the differences among various patterns of usage. We do not know, for example, whether one ten minute phone call is better or worse than ten one minute phone call with respect to health impact. We know that the intensity of the RFR exposure is greatest during dialing and ringing, and, that the amount of RFR necessary to sustain a call lessens during the call. However, it is premature to speculate that lessening the length of calls, for example, lessens potential health impact. Similarly, it is premature to recommend that lessening the number of calls accrues any health benefit.

The state of our knowledge at this time with respect to meaningful public health intervention with regard to wireless phone usage is qualitative. Moving the antenna beyond the distance threshold of two to three inches away from the body is the only science based recommendation that can be supported by existing data.

As new data become available, our understanding of this complex problem will improve;

however, the explosion of this technology in society creates a unique necessity for ongoing interpretation of the science and communication of intervention options to those who are potentially affected and concerned. Consumers should be given the opportunity to know what potential risks they are likely to incur with the use of this technology, and have the opportunity to make informed judgements about the assumption of that risk.