

quency. For example, for GSM–900 MHz standard IC-NIRP safety limit will be calculated as $450 \mu\text{W}/\text{cm}^2$ [11].

It is important to note that ICNIRP recommendations have no legal validity, as it is only a recommendation. Each country has their own national legislation in the field of electromagnetic safety, and national limits are rather different in different countries. Some countries such as the USA and Germany conformed national EMR limits to ICNIRP recommendation. Other countries have much tougher national limits as compared with ICNIRP guidelines. For example, for GSM-900 MHz standard MW safety limits are: in Italy, Russia and China — $10 \mu\text{W}/\text{cm}^2$, in Switzerland — $4 \mu\text{W}/\text{cm}^2$, in Ukraine — $2.5 \mu\text{W}/\text{cm}^2$ [1]. As we can see, some countries, including Ukraine, have extremely strict national safety limits. Such national positions are explained first of all by long-term national research traditions in a field of electromagnetic biology, and on experience in studying the non-thermal biological effects of this kind of radiation. On the other hand, some countries like Switzerland follow a strict precautionary principle (Better protect than sorry).

RADAR RADIATION AND CANCER PROMOTION

Substantial military and occupational data indicate a significant effect of pulse microwaves on cancer development and other pathological conditions in human. Accordingly, a statistically significant increase in immature red blood cells among workers exposed to a radar was reported [15]. In addition, radar-exposed workers had significantly lower levels of leukocytes and thrombocytes than workers distant from MW sources.

Among Polish soldiers (128 thousand personnel subjects aged from 20 to 59 years), soldiers of 20–29 years old exposed to radar microwaves during 1970–1979 had cancer incidence rates 5.5 folds higher than non-exposed soldiers [16]. The greatest rise of cancer cases was detected in blood-forming organs and lymphatic tissues: by 13.9 folds for chronic myelocytic leukemia and 8.6 folds for myeloblastic leukemia. The level of mortality among all exposed personnel was significantly higher than in unexposed: for colorectal cancer (observed-expected ratio, OER 3.2; 95%), for cancer of esophagus and stomach (OER 3.2; 95%), cancer of blood-forming system and lymphatic tissues (OER 6.3; 95%) [17].

Almost two times more cases of cancer were indicated in the high-exposed American naval personnel served during the Korean War (1950–1954) as compared with the low-exposed subjects among 40 thousands of personnel [18]. Death rates for aviation electronic technicians, the group with the highest exposure rate, were significantly higher than those for the other personnel during the following years up to 1974 [15].

A very substantial increase in cancer incidence was also detected in commercial airline pilots. Thus, the standardized incidence ratio (SIR) for malignant melanoma cases was 10.2; 95.5% for pilots of com-

mercial airlines in Iceland [19]. Significantly increased risks of acute myeloid leukemia (SIR 5.1), skin cancer, excluding melanoma (SIR 3.0) and total cancer (SIR 1.2) were observed also among Danish male jet pilots [20]. These data have been explained as a result of excess cosmic ionizing radiation or even excessive sun radiation during a leisure time. However, analysis of brain cancers among US Air Force personnel has revealed that non-ionizing radiation and particularly MW had significant effect on cancer development (odds ratio, OR 1.38; 95%), whereas ionizing radiation had negative association with cancer cases (OR 0.58; 95%) [21]. To that, standardizing mortality ratio (SMR) for brain tumors was 2.1; 95% among German male cockpit crew members (6,017 people) [22]. Cancer risk was significantly raised (risk ratio 2.2; 95%) among cockpit crew members employed for 30 years as compared to those employed for less than 10 years. In addition, Non-Hodgkin's lymphoma (NHL) was also increased (SMR 4.2; 95%) among male cabin crew members (20,757 people). Importantly, any increase in cancers associated with ionizing (cosmic) radiation was not detected in this cohort study.

In another report, six incident cases of testicular cancer occurred within a cohort of 340 police officers between 1979 and 1991 in Seattle, Washington, observed/expected ratio was 6.9; $p < 0.001$ [23]. Occupational use of hand-held radar was the only shared risk factor among all six officers, and all had a routine habit of keeping the radar gun directly in close proximity to their testicles. Similarly, in Ontario, Canada risk assessment among police officers exposed to radar devices for speed measurement (1,596 females and 20,601 males) revealed an increased risk among men for testicular cancer (SIR 1.3) and for melanoma (SIR 1.45; 95%) [24].

In another study, eighty seven persons working with radars (and 150 matched control) were divided into risk groups according to frequencies of MW (200 KHz to 26 GHz) and power density ($8 \mu\text{W}/\text{cm}^2$ to $300 \mu\text{W}/\text{cm}^2$) [15]. Three specific radiation cataracts in persons working with extremely high MW exposure were identified. Lens changes were associated with level of exposure in different risk groups.

Other occupational studies revealed the highest risk ratio (2.6) for acute myelogenous leukemia in radio and radar operators among all occupational groups studied [25]. In addition, excessive risk for breast cancer was detected (SIR 1.5) among Norwegian female radio and telegraph operators (2,619 women) with potential exposure to radio frequency (405 kHz — 25 MHz) [26].

RADIATION FROM MOBILE COMMUNICATION SYSTEMS AND CANCER PROMOTION

Cell phones. A significant increase of risk of particular brain tumors in long-term (10 years or more) users of cell phones and cordless phones has been detected in series of epidemiological studies of Swedish oncologist Prof. L. Hardell with colleagues [27–33].

It is important that for a short-term use of cell phones similar effects were absent or less evident [4].

The risk of development of high-grade glioma has increased in more than 3 times (OR 3.1; 95 %) for bilateral users of cell phones and in more than 5 times (OR 5.4; 95%) for ipsilateral users after 10 years of using [34].

The risk of development of acoustic neuroma for bilateral users of cell phones was OR 2.9; 95% and OR 3.5; 95 % for ipsilateral users after 10 years of using [29].

Notably, the highest risk of brain tumors has been detected in the youngest users of cell phones (20–29-yr) among all analyzed age groups (20–80 years old), with OR 5.91; 95% for ipsilateral use of cell phones. The highest risk was associated with more than 5-year using period in the 20–29-yr age group for analog cell phones (OR 8.7; 95%) [28].

International multiyear Interphone project conducted under the management of the World Health Organization and substantially supported by industry, was an interview-based case-control study with 2708 glioma and 2409 meningioma cases and matched controls, conducted in 13 countries using a common protocol [35]. The results of study were rather controversial. For example, authors were forced to declare “a reduced odds ratio related to ever having been a regular mobile phone users was seen for glioma (OR 0.81; 95 %) and meningioma (OR 0.79; 95 %), possibly reflecting participation bias or other methodological limitations.” However, significantly increased risks of tumors development in “heavy” users of cell phones (with more than 1640 hours of using during less than four years) have been revealed in this study: for meningioma OR 4.8; 95 %, for glioma OR 3.77; 95% as compared with the matched controls [35]. One thousand and six hundred forty hours per four years means about one hour per day of a cell phone use. In this connection we can point to our data [36] that indicates amount of time which Ukrainian students (like students in other countries?) spend talking via cell phones every day. Our findings indicated that more than a half of them spend over one hour per day, and more than a quarter of them spend over two hours per day talking via cell phones every day.

Parotid gland, like a human brain, is another potential target for cell phone MW radiation during cell phone talks without hands-free devices. Thus, a study done by an Israeli team has indicated an association between a cell phone use and parotid gland tumors [37]. This study comprised 402 benign and 58 malignant cases of parotid gland tumors diagnosed in Israelis at age over 18 years in 2001–2003. The risk of parotid malignant tumors in intensive users of cell phones (for users with more than 5,479 hours of a use during less than five years) were OR 2.26; 95%. Recently new data have been published that totally a 4-fold increase of parotid malignant tumors in Israel during 1970–2006 took place, whereas other salivary glands tumors had been almost on a stable level

during that period of time [38]. Previously, a Finnish study has revealed the OR 5.0; 95% for salivary gland cancer among all Finland digital cell phone subscribers compared with control population after one-two years of a cell phone use [39].

The odds ratio for Non-Hodgkin's Lymphoma of T-cell, cutaneous and leukemia types has been found for analogue-cell-phone users as 3.4; 95%; for digital-phone users 6.1; 95 %; and for cordless-phone users 5.5; 95% by L. Hardell group [40]. An American study indicated OR 1.6; 95 % for NHL in users of cell phones with a period of use over eight years [41].

Uveal melanoma (in analysis of 118 cases with uveal melanoma and 475 controls in Germany) has been indicated to have odds ratio 4.2; 95% for people probable/certain exposed to cell phone radiation [42].

Testicular cancer (seminoma) risk had odds ratio 1.8; 95% for men keeping a cell phone during “stand by” in ipsilateral trousers pocket [43]. The results have been based on 542 cases of seminoma in Sweden.

Base transmitting stations. During the last decades more than one and half million base transmitting stations for mobile communication have been installed over the world. However, the World Health Organization suggested a priority to study effects mainly of cell phones, while discouraging studies on the effects of transmitting stations (with an exception of years 2003–2006 when WHO recommended studies of possible effects of radiation of transmitting stations as well) [44]. This is probably the main reason why only a few publications on this particular problem can be found to date [45–49].

The comparison of cancer cases among people living up to 400 m from base transmitting station and people living further than 400 m from station during 1994–2004 was carried out in Germany [48]. A total increase of cancer cases among people living nearby to transmitting station over the control population was 1.26 times during the first five-year period (1994–1998), and 3.11 times during the second five-year period (1999–2004) of operation of the station. Particularly, in the second period the increase of cancer cases was statistically significant both as compared with the population from more distant area and with the expected background incidence.

Population (n=622) living in the area nearby (up to 350 m) the cell phone base transmitting station (850 MHz, 1500 watt of full power) during one year of operation and matched individuals (n=1222) from other area have been compared in Israel [47]. There were 4.15 times more cases of cancer in transmitted station area than in the rest of a city. Relative cancer rates for females were 10.5 for close to station area, 0.6 for control area and 1 for the whole town. Cancer incidence of women in close to base station area was significantly higher ($p < 0.0001$) as compared with the control area and the whole city. Keeping in mind that very significant increase in a number of cancer cases took place during only one year period, the authors of the study suggested that MW could provoke latent

cases of cancer in inhabitants of the area nearby transmitting station.

French and Spanish researchers also revealed that inhabitants living near base station for mobile communication (up to 300 m) developed significantly higher rates of many subjective symptoms of health like headache, fatigue, sleep disorder, depression as compared with the matched control from distant area [49, 50].

RODENT MODEL OF CANCER PROMOTION BY MICROWAVES

A highly representative research has been carried out at the University of Washington, Seattle commissioned by US Air Force [51]. The experimental rats (100 animals) were exposed during 24 months at 21.5 hours per day to 2,450-MHz pulsed microwaves at 800 pps with a 10 μ s pulse width. The pulsed microwaves were square-wave modulated at 8 Hz. An average SAR was 0.4 W/kg for a 200-g rat. It was a model of long-term irradiation of Air Force pilots to pulsed microwaves of radar systems. Totally 155 indexes of metabolisms were checked out during the study. As a result, the most expressive effect of long-term MW irradiation of animals was a dramatic increase in a level of cancer cases. In total, 3.6 folds more cancer cases were detected in irradiated animals than in matched control. Lymphoma cases were diagnosed in the irradiated animals 4.5 times more often than in the control group. In addition, benign tumors of adrenal were detected seven folds more often in the irradiated animals than in the control.

In the next study under US Air Force contract, 200 female C3H/HeJ mice were exposed for 21 months (22 h/day, 7 days/week) to a horizontally polarized 435 MHz pulse-wave (1.0 ps pulse width, 1.0 kHz pulse rate) RF radiation environment with an incident power density of 1.0 mW/cm² (SAR 0.32 W/kg), while 200 mice were sham-exposed [52]. Although under the conditions of this study, an exposure of mice prone to mammary tumors did not affect the incidence of mammary tumors, when compared with the controls, some other tumor cases increased markedly. For example, bilateral cases of ovary epithelial stromal tumor raised by five folds; multiple cases of hepatocellular carcinoma, raised 3 folds, and adrenal gland tumor cases (total) raised 1.63 folds.

In the third published study of this series [53] the same prone-mammary tumor mice were irradiated during 20 months to continuous wave 2450 MHz MW radiation with SAR from 0.3 to 1 W/kg (20 h/day, 7 days/week). A hundred mice were exposed, while 100 mice were used as sham-exposed. As a result, the exposed mice had higher level of mammary tumors (1.27 folds), and higher total level of all types of tumor (1.38 folds) as compared with sham-exposed; the difference between groups was statistically insignificant. Meanwhile, multiple mammary tumor cases occurred in exposed mice twice more frequently than in sham exposed.

In other study mice with high incidence of spontaneous breast cancer and mice treated with 3,4-benzopyrene (BP) were irradiated to continuous wave 2,450 MHz microwaves in an anechoic chamber at 5 or 15 mW/cm² (2 hours daily, 6 sessions per week, 3 months) [54]. Irradiation with MW at either 5 or 15 mW/cm² resulted in acceleration of development of BP-induced skin cancer. Microwaves-exposed mice with high incidence of spontaneous breast cancer developed breast tumors earlier than control. Authors indicated that the promotion of cancer development and lowering of natural antineoplastic resistance was similar in mice exposed to MW at 5 mW/cm² and chronically stressed by confinement, but level of cancer cases in animals exposed to 15 mW/cm² was significantly higher as compared to chronically stressed by confinement control.

And in well-known study of M. Ripacholi *et al.* (1997) transgenic mice moderately predisposed to develop lymphoma spontaneously have been used for exposure to MW of 900 MHz, with pulse repetition frequency of 217 Hz, incident power densities of 2.6–13 W/m², and average SAR of 0.13–1.4 W/kg [55]. One group of mice (10¹ females) has been exposed for two 30-min periods per day during 18 months. Another group of mice (100 females) has been a sham-exposed control. Lymphoma risk was significantly higher, more than twice, in the exposed mice than in the matched control (OR 2.4; 95 %). In particular, follicular lymphoma was the major contributor to the increased tumor incidence.

MICROWAVES AND CELL METABOLISM

Free radical species, including reactive oxygen species (ROS), is an intrinsic feature of cell metabolism [56–58]. But disturbance of redox balance, uncontrolled activation of free radical processes, overproduction of ROS and/or suppression of antioxidant defense in cell often are the important signals of some hazardous changes in cell metabolism [59, 60]. That is why data indicated oxidative effect of some factor is extremely important in risk-assessment research.

A significant increase of ROS and nitrogen oxide generation in cells under non-thermal intensities of MW has been detected both *in vivo* [61–67] and *in vitro* [68–72]. Possibilities of mitochondrial and membrane NADH oxidase dependent ways of ROS generation in exposed cells have been suggested [71, 72]. Accordingly, it was found that the first step in MW (875 MHz, 0.07 mW/cm²) interaction with model cells (Rat1 and HeLa) was mediated in the plasma membrane by NADH oxidase, which can rapidly (during the minutes) generate ROS [72]. ROS directly stimulate matrix metalloproteinases and allow them to cleave and release heparin-binding epidermal growth factor (EGF). This secreted factor activates the EGF receptor, which in turn activates the extracellular-signal-regulated kinase (ERK) cascade and thereby induces transcription and other cellular pathways. On the other hand, on the model of purified human

spermatozoa exposed to MW (1.8 GHz, SAR from 0.4 W/kg to 27.5 W/kg) a significant overproduction of ROS in mitochondria was detected, along with a significant reduction in motility and vitality of spermatozoa [71]. All observed effects were significantly correlated with SAR levels, suggesting that significant effects of MW exposure occurred under non-thermal levels of MW.

Therefore, MW can induce cellular oxidative stress, which in turn can cause cancer stimulation [57, 59]. To that, it is known nowadays that in addition to damage via oxidative stress, ROS in cells can play a role of a secondary messenger for certain intracellular signaling cascades which can induce oncogenic transformation [60].

DNA damage in cells exposed to low-intensity microwaves both *in vivo* and *in vitro* was demonstrated during the last years in more than 50 independent studies [73]. The most often method used for detection of DNA damage after the MW exposure was alkaline Comet Assay. A statistically significant increase of both single strand and/or double strand breaks of DNA has been detected in humans [74, 75], animal models [76–79] and cell cultures [76, 80–83] exposed to low intensity microwaves.

Recently, an oxygen damage of DNA in human spermatozoa through formation of 8-hydroxy-2-deoxyguanosine (8-OH-dG) under non-thermal microwaves irradiation *in vitro* has been demonstrated [71].

Consequently, as DNA mutation is a critical step in carcinogenesis and increased level of 8-OH-dG takes place in many tumors [60], the possibility of MW to initiate oxidative damage of DNA is extremely dangerous signal for risk-assessment studies.

Ornithine decarboxylase (ODC) significantly changes its activity under conditions of non-thermal microwave exposure [84–88]. It was one of the first markers of carcinogenesis revealed to be activated under the low intensity microwaves exposure. ODC is involved in processes of cell growth and differentiation, and its activity is raised in tumor cells. Although overexpression of ODC is not sufficient for transformation of normal cells into tumorigenic ones, an increased activity of the enzyme was shown to promote the development of tumors from pre-tumor cells [89].

DISCUSSION AND CONCLUSIONS

In this review we presented evidences for carcinogenic effects of low intensity microwaves. Both epidemiological and experimental data led us to a conclusion that at least under certain conditions the exposure to long term low intensity MW can lead to tumorigenesis. Supporting evidences come from statistically significant epidemiological data based either on long-term analysis, e.g., on mortality of US Navy personnel in 20 years after expose during the Korean War [15], or on relatively short, one year exposure, e.g., by base transmitting station for mobile communication in Israel [47]. In the latter case we fully agree with the authors that MW exposure most likely results in acceleration

of pre-existed cancer development. It is of note here that the same conclusion was drawn in epidemiological research on fast increase cancer incidence among adult population in Colorado exposed to extremely low frequency radiation [90].

The main shortcoming of the most epidemiological data, both in military studies and in mobile communication risk assessment, is a lack of a strict dose measurement of exposure. We strongly suggest that in the forthcoming epidemiological studies the correct measurement of intensity and dosage of exposure should be obligatory. The example of a large-scale epidemiological research employing personal MW dosimeters can be found in recent studies in Germany [91–94]. On the other hand, we also realize that the levels of the MW exposure in contemporary epidemiological studies, at least in those which deal with mobile communication systems, were within the official “safety limits” set by appropriate national standards and ICNIRP recommendations. Therefore, taking into account the reviewed data, we conclude that the relatively long-term (e.g., 10 years) exposure to microwaves emitted from mobile communication devices operating within “safety limits” set by current regulating bodies can be considered as a potential factor for promotion of cancer growth. Indeed, in the most studies on rodents the intensity of MW exposure was appropriately measured, and in majority of them the MW intensity was below ICNIRP safety limits. Nevertheless, majority of these studies to a greater or lesser extent demonstrated obvious carcinogenic effects after long term exposure (up to 24 months). This further emphasizes that at least under certain conditions the exposure to both pulsed and continuous MW with intensities below the current official “safety limits” can indeed promote cancer development.

In addition, experimental evidences of involvement of typical markers of carcinogenesis like overproduction of reactive oxygen species or formation of 8-OH-dG under conditions of MW exposure further indicate potential danger of this type of radiation for human health. It is important to emphasize here that experimental data, especially obtained in studies *in vitro* often reveal significant biological effects even after short-term (e.g., only a few minutes) [72] and/or extremely weak intensity of exposure to MW (by several orders of magnitude lower than in ICNIRP recommendations) [95]. Taking these data into account we strongly suggest that currently used “thermal” assessment of potential hazards of MW exposure is far from being appropriate and safe.

Taken together, we state here that nowadays there is enough convincing data to appropriately assert that the long-term exposure to low intensity electromagnetic microwaves can indeed promote cancer development. To that, the official recommendations by ICNIRP and safety limits set by many national regulatory bodies for technical devices emitting microwave radiation, first of all for mobile communication systems, must be re-assessed according to the recent alarming

data; and additional studies for unprejudiced risk assessment must be carried out. At present, we strongly suggest for a wide implementation of precautionary principle for everyday microwave exposure that implies maximum restriction of excessive exposure.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGMENTS

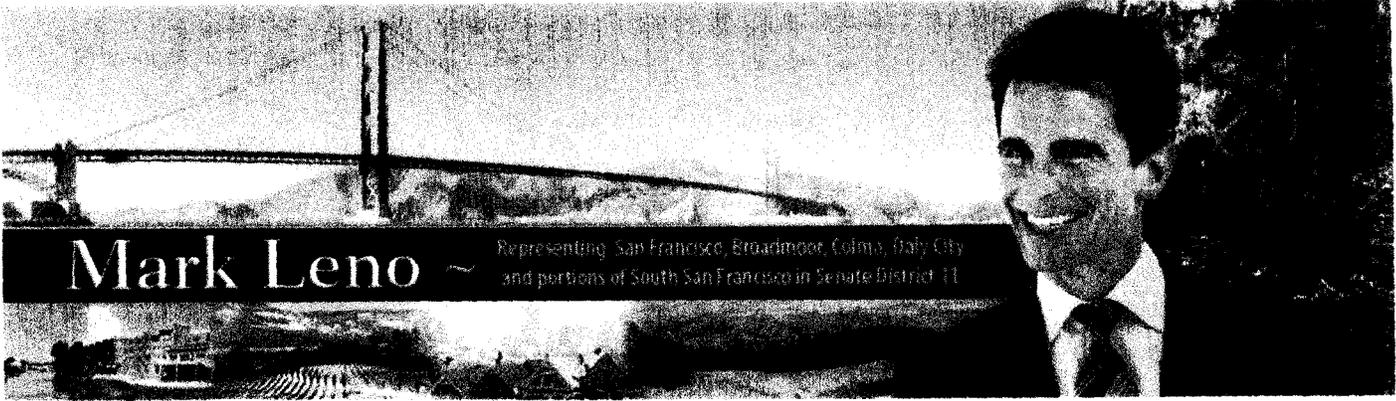
This study was supported by National Academy of Sciences of Ukraine (Grant No 2.2.5.349); and received a financial contribution from the European Community within the Seventh Framework Programme (FP/2007–2013) under Grant Agreement No. 229603; and was also co-financed by the South Moravian Region via SoMoPro programme.

REFERENCES

1. Hardell L, Sage C. Biological effects from electromagnetic field exposure and public exposure standards. *Biomed Pharmacother* 2008; 62: 104–9.
2. Breckenkamp J, Berg G, Blettner M. Biological effects on human health due to radiofrequency/microwave exposure: a synopsis of cohort studies. *Radiat Environ Biophys* 2003; 42: 141–54.
3. Ahlbom A, Green A, Kheifets L, *et al.* Epidemiology of health effects of radiofrequency exposure. *Environ Health Perspect* 2004; 112: 1741–54.
4. Morgan LL. Estimating the risk of brain tumors from cellphone use: Published case-control studies. *Pathophysiology* 2009; 16: 137–47.
5. Khurana VG, Teo C, Kundi M, *et al.* Cell phones and brain tumors: a review including the long-term epidemiologic data. *Surg Neurol* 2009; 72: 205–15.
6. Hardell L, Carlberg M, Hansson Mild K. Epidemiological evidence for an association between use of wireless phones and tumor diseases. *Pathophysiology* 2009; 16: 113–22.
7. Kundi M. The controversy about a possible relationship between mobile phone use and cancer. *Environ Health Perspect* 2009; 117: 316–24.
8. Leszczynski D, Xu Z. Mobile phone radiation health risk controversy: the reliability and sufficiency of science behind the safety standards. *Health Res Policy Syst* 2010; 8: 2.
9. Yakymenko I, Sidorik E. Risks of carcinogenesis from electromagnetic radiation of mobile telephony devices. *Exp Oncol* 2010; 32: 54–60.
10. Yakymenko I, Sidorik E, Tsybulin O. Metabolic changes in living cells under electromagnetic radiation of mobile communication systems. *Ukr Biokhim Zh* 2011; 83: 5–13.
11. ICNIRP. Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Phys* 1998; 74: 494–522.
12. Gandhi O, Lazzi G, Furse C. Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz. *Microwave Theory and Techniques* 1996; 44: 1884–97.
13. de Salles AA, Bulla G, Rodriguez CE. Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head. *Electromagn Biol Med* 2006; 25: 349–60.
14. Christ A, Gosselin MC, Christopoulou M, *et al.* Age-dependent tissue-specific exposure of cell phone users. *Phys Med Biol* 2010; 55: 1767–83.
15. Goldsmith JR. Epidemiological evidence relevant to radar (microwave) effects. *Environ Health Perspect* 1997; 105: 1579–87.
16. Szmigielski S. Polish epidemiological study links RF/MW exposures to cancer. *Microwave news* 1985; 5: 1–2.
17. Szmigielski S. Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. *Sci Total Environ* 1996; 180: 9–17.
18. Robinette CD, Silverman C, Jablon S. Effects upon health of occupational exposure to microwave radiation (radar). *Am J Epidemiol* 1980; 112: 39–53.
19. Rafnsson V, Hrafnkelsson J, Tulinius H. Incidence of cancer among commercial airline pilots. *Occup Environ Med* 2000; 57: 175–9.
20. Gundestrup M, Storm HH. Radiation-induced acute myeloid leukaemia and other cancers in commercial jet cockpit crew: a population-based cohort study. *Lancet* 1999; 354: 2029–31.
21. Grayson JK. Radiation exposure, socioeconomic status, and brain tumor risk in the US Air Force: a nested case-control study. *Am J Epidemiol* 1996; 143: 480–6.
22. Zeeb H, Hammer GP, Langner I, *et al.* Cancer mortality among German aircrew: second follow-up. *Radiat Environ Biophys* 2010; 49: 187–94.
23. Davis RL, Mostofi FK. Cluster of testicular cancer in police officers exposed to hand-held radar. *Am J Ind Med* 1993; 24: 231–3.
24. Finkelstein MM. Cancer incidence among Ontario police officers. *Am J Ind Med* 1998; 34: 157–62.
25. Savitz DA, Calle EE. Leukemia and occupational exposure to electromagnetic fields: review of epidemiologic surveys. *J Occup Med* 1987; 29: 47–51.
26. Tynes T, Hannevik M, Andersen A, *et al.* Incidence of breast cancer in Norwegian female radio and telegraph operators. *Cancer Causes Control* 1996; 7: 197–204.
27. Hardell L, Mild KH, Carlberg M. Case-control study on the use of cellular and cordless phones and the risk for malignant brain tumours. *Int J Radiat Biol* 2002; 78: 931–6.
28. Hardell L, Mild KH, Carlberg M, *et al.* Cellular and cordless telephone use and the association with brain tumors in different age groups. *Arch Environ Health* 2004; 59: 132–7.
29. Hardell L, Mild KH, Carlberg M, *et al.* Tumour risk associated with use of cellular telephones or cordless desktop telephones. *World J Surg Oncol* 2006; 4: 74.
30. Hardell L, Hansson Mild K. Mobile phone use and risk of acoustic neuroma: results of the interphone case-control study in five North European countries. *Br J Cancer* 2006; 94: 1348–9; author reply 52–3.
31. Hardell L, Carlberg M, Soderqvist F, *et al.* Long-term use of cellular phones and brain tumours: increased risk associated with use for > or =10 years. *Occup Environ Med* 2007; 64: 626–32.
32. Hardell L, Carlberg M, Hansson Mild K. Case-control study on cellular and cordless telephones and the risk for acoustic neuroma or meningioma in patients diagnosed 2000–2003. *Neuroepidemiology* 2005; 25: 120–8.
33. Hardell L, Carlberg M. Mobile phones, cordless phones and the risk for brain tumours. *Int J Oncol* 2009; 35: 5–17.
34. Hardell L, Carlberg M, Mild KH. Case-control study of the association between the use of cellular and cordless telephones and malignant brain tumors diagnosed during 2000–2003. *Environ Res* 2006; 100: 232–41.
35. Cardis E, Deltour I, Vrijheid M, *et al.* Brain tumour risk in relation to mobile telephone use: results of the INTER-

- PHONE international case-control study. *Int J Epidemiol* 2010; **39**: 675–94.
36. Yakymenko I, Sidorik E, Tsybulin O, *et al.* Potential risks of microwaves from mobile phones for youth health. *Environment & Health* 2011; **56**: 48–51.
 37. Sadetzki S, Chetrit A, Jarus-Hakak A, *et al.* Cellular phone use and risk of benign and malignant parotid gland tumors — a nationwide case-control study. *Am J Epidemiol* 2008; **167**: 457–67.
 38. Czerninski R, Zini A, Sgan-Cohen HD. Risk of parotid malignant tumors in Israel (1970–2006). *Epidemiology* 2011; **22**: 130–1.
 39. Auvinen A, Hietanen M, Luukkonen R, *et al.* Brain tumors and salivary gland cancers among cellular telephone users. *Epidemiology* 2002; **13**: 356–9.
 40. Hardell L, Eriksson M, Carlberg M, *et al.* Use of cellular or cordless telephones and the risk for non-Hodgkin's lymphoma. *Int Arch Occup Environ Health* 2005; **78**: 625–32.
 41. Linet MS, Taggart T, Severson RK, *et al.* Cellular telephones and non-Hodgkin lymphoma. *Int J Cancer* 2006; **119**: 2382–8.
 42. Stang A, Anastassiou G, Ahrens W, *et al.* The possible role of radiofrequency radiation in the development of uveal melanoma. *Epidemiology* 2001; **12**: 7–12.
 43. Hardell L, Carlberg M, Ohlson CG, *et al.* Use of cellular and cordless telephones and risk of testicular cancer. *Int J Androl* 2007; **30**: 115–22.
 44. Kundi M, Hutter HP. Mobile phone base stations—Effects on wellbeing and health. *Pathophysiology* 2009; **16**: 123–35.
 45. Abdel-Rassoul G, El-Fateh OA, Salem MA, *et al.* Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology* 2007; **28**: 434–40.
 46. Hutter HP, Moshhammer H, Wallner P, *et al.* Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med* 2006; **63**: 307–13.
 47. Wolf R, Wolf D. Increased incidence of cancer near a cell-phone transmitted station. In: Columbus F, editor. *Trends in cancer prevention*: Nova Science Publishers, Inc, 2007: 1–8.
 48. Eger H, Hagen K, Lucas B, *et al.* Einfluss der räumlichen Nähe von Mobilfunkseideanlagen auf die Krebsinzidenz. *Umwelt-Medizin-Gesellschaft* 2004; **17**: 273–356.
 49. Santini R, Santini P, Danze JM, *et al.* Study of the health of people living in the vicinity of mobile phone base stations: 1. Influences of distance and sex. *Pathol Biol* 2002; **50**: 369–73.
 50. Navarro E, Segura J, Portoles M, *et al.* The Microwave Syndrome: A Preliminary Study in Spain *Electromagn Biol Med* 2003; **22**: 161–9.
 51. Chou CK, Guy AW, Kunz LL, *et al.* Long-term, low-level microwave irradiation of rats. *Bioelectromagnetics* 1992; **13**: 469–96.
 52. Toler JC, Shelton WW, Frei MR, *et al.* Long-term, low-level exposure of mice prone to mammary tumors to 435 MHz radiofrequency radiation. *Radiat Res* 1997; **148**: 227–34.
 53. Frei MR, Jauchem JR, Dusch SJ, *et al.* Chronic, low-level (1.0 W/kg) exposure of mice prone to mammary cancer to 2450 MHz microwaves. *Radiat Res* 1998; **150**: 568–76.
 54. Szmigielski S, Szudzinski A, Pietraszek A, *et al.* Accelerated development of spontaneous and benzopyrene-induced skin cancer in mice exposed to 2450-MHz microwave radiation. *Bioelectromagnetics* 1982; **3**: 179–91.
 55. Repacholi MH, Basten A, GebSKI V, *et al.* Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHz electromagnetic fields. *Radiat Res* 1997; **147**: 631–40.
 56. Kamata H, Hirata H. Redox regulation of cellular signalling. *Cell Signal* 1999; **11**: 1–14.
 57. Halliwell B, Whiteman M. Measuring reactive species and oxidative damage in vivo and in cell culture: how should you do it and what do the results mean? *Br J Pharmacol* 2004; **142**: 231–55.
 58. Nemoto S, Takeda K, Yu ZX, *et al.* Role for mitochondrial oxidants as regulators of cellular metabolism. *Mol Cell Biol* 2000; **20**: 7311–8.
 59. Valko M, Leibfritz D, Moncol J, *et al.* Free radicals and antioxidants in normal physiological functions and human disease. *Int J Biochem Cell Biol* 2007; **39**: 44–84.
 60. Valko M, Rhodes CJ, Moncol J, *et al.* Free radicals, metals and antioxidants in oxidative stress-induced cancer. *Chem Biol Interact* 2006; **160**: 1–40.
 61. Ferreira AR, Bonatto F, de Bittencourt Pasquali MA, *et al.* Oxidative stress effects on the central nervous system of rats after acute exposure to ultra high frequency electromagnetic fields. *Bioelectromagnetics* 2006; **27**: 487–93.
 62. Grigoriev YG, Grigoriev OA, Ivanov AA, *et al.* Confirmation studies of Soviet research on immunological effects of microwaves: Russian immunology results. *Bioelectromagnetics* 2010; **31**: 589–602.
 63. Irmak MK, Fadillioglu E, Gulec M, *et al.* Effects of electromagnetic radiation from a cellular telephone on the oxidant and antioxidant levels in rabbits. *Cell Biochem Funct* 2002; **20**: 279–83.
 64. Ozgur E, Guler G, Seyhan N. Mobile phone radiation-induced free radical damage in the liver is inhibited by the antioxidants N-acetyl cysteine and epigallocatechin-gallate. *Int J Radiat Biol* 2010; **86**: 935–45.
 65. Ozguner F, Altinbas A, Ozaydin M, *et al.* Mobile phone-induced myocardial oxidative stress: protection by a novel antioxidant agent caffeic acid phenethyl ester. *Toxicol Ind Health* 2005; **21**: 223–30.
 66. Ozguner F, Oktem F, Ayata A, *et al.* A novel antioxidant agent caffeic acid phenethyl ester prevents long-term mobile phone exposure-induced renal impairment in rat. Prognostic value of malondialdehyde, N-acetyl-beta-D-glucosaminidase and nitric oxide determination. *Mol Cell Biochem* 2005; **277**: 73–80.
 67. Sokolovic D, Djindjic B, Nikolic J, *et al.* Melatonin reduces oxidative stress induced by chronic exposure of microwave radiation from mobile phones in rat brain. *J Radiat Res (Tokyo)* 2008; **49**: 579–86.
 68. Agarwal A, Desai NR, Makker K, *et al.* Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: an in vitro pilot study. *Fertil Steril* 2009; **92**: 1318–25.
 69. Luukkonen J, Hakulinen P, Maki-Paakkanen J, *et al.* Enhancement of chemically induced reactive oxygen species production and DNA damage in human SH-SY5Y neuroblastoma cells by 872 MHz radiofrequency radiation. *Mutat Res* 2009; **662**: 54–8.
 70. Zmyslony M, Politanski P, Rajkowska E, *et al.* Acute exposure to 930 MHz CW electromagnetic radiation in vitro affects reactive oxygen species level in rat lymphocytes treated by iron ions. *Bioelectromagnetics* 2004; **25**: 324–8.
 71. De Iuliis GN, Newey RJ, King BV, *et al.* Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS One* 2009; **4**: e6446.
 72. Friedman J, Kraus S, Hauptman Y, *et al.* Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies. *Biochem J* 2007; **405**: 559–68.

73. Ruediger HW. Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology* 2009; **16**: 89–102.
74. Gandhi G, Anita. Genetic damage in mobile phone users: some preliminary findings. *Indian J. Hum. Genet.* 2005; **11**: 99–104.
75. Yadav AS, Sharma MK. Increased frequency of micronucleated exfoliated cells among humans exposed in vivo to mobile telephone radiations. *Mutat Res* 2008; **650**: 175–80.
76. Lai H, Singh NP. Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics* 1995; **16**: 207–10.
77. Lai H, Singh NP. Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. *Int J Radiat Biol* 1996; **69**: 513–21.
78. Ferreira AR, Knakievicz T, Pasquali MA, *et al.* Ultra high frequency-electromagnetic field irradiation during pregnancy leads to an increase in erythrocytes micronuclei incidence in rat offspring. *Life Sci* 2006; **80**: 43–50.
79. Kesari KK, Behari J, Kumar S. Mutagenic response of 2.45 GHz radiation exposure on rat brain. *Int J Radiat Biol* 2010; **86**: 334–43.
80. Diem E, Schwarz C, Adlkofer F, *et al.* Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutat Res* 2005; **583**: 178–83.
81. Paulraj R, Behari J. Single strand DNA breaks in rat brain cells exposed to microwave radiation. *Mutat Res* 2006; **596**: 76–80.
82. Wu W, Yao K, Wang KJ, *et al.* Blocking 1800 MHz mobile phone radiation-induced reactive oxygen species production and DNA damage in lens epithelial cells by noise magnetic fields. *Zhejiang Da Xue Xue Bao Yi Xue Ban* 2008; **37**: 34–8.
83. Schwarz C, Kratochvil E, Pilger A, *et al.* Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes. *Int Arch Occup Environ Health* 2008; **81**: 755–67.
84. Paulraj R, Behari J, Rao AR. Effect of amplitude modulated RF radiation on calcium ion efflux and ODC activity in chronically exposed rat brain. *Indian J Biochem Biophys* 1999; **36**: 337–40.
85. Byus CV, Kartun K, Pieper S, *et al.* Increased ornithine decarboxylase activity in cultured cells exposed to low energy modulated microwave fields and phorbol ester tumor promoters. *Cancer Res* 1988; **48**: 4222–6.
86. Litovitz TA, Krause D, Penafiel M, *et al.* The role of coherence time in the effect of microwaves on ornithine decarboxylase activity. *Bioelectromagnetics* 1993; **14**: 395–403.
87. Litovitz TA, Penafiel LM, Farrel JM, *et al.* Bioeffects induced by exposure to microwaves are mitigated by superposition of ELF noise. *Bioelectromagnetics* 1997; **18**: 422–30.
88. Hoyto A, Juutilainen J, Naarala J. Ornithine decarboxylase activity is affected in primary astrocytes but not in secondary cell lines exposed to 872 MHz RF radiation. *Int J Radiat Biol* 2007; **83**: 367–74.
89. Clifford A, Morgan D, Yuspa SH, *et al.* Role of ornithine decarboxylase in epidermal tumorigenesis. *Cancer Res* 1995; **55**: 1680–6.
90. Wertheimer N, Leeper E. Adult cancer related to electrical wires near the home. *Int J Epidemiol* 1982; **11**: 345–55.
91. Roosli M, Frei P, Bolte J, *et al.* Conduct of a personal radiofrequency electromagnetic field measurement study: proposed study protocol. *Environ Health* 2010; **9**: 23.
92. Heinrich S, Thomas S, Heumann C, *et al.* Association between exposure to radiofrequency electromagnetic fields assessed by dosimetry and acute symptoms in children and adolescents: a population based cross-sectional study. *Environ Health* 2010; **9**: 75.
93. Milde-Busch A, von Kries R, Thomas S, *et al.* The association between use of electronic media and prevalence of headache in adolescents: results from a population-based cross-sectional study. *BMC Neurol* 2010; **10**: 12.
94. Thomas S, Heinrich S, Kuhnlein A, *et al.* The association between socioeconomic status and exposure to mobile telecommunication networks in children and adolescents. *Bioelectromagnetics* 2010; **31**: 20–7.
95. De Pomerai D, Daniells C, David H, *et al.* Non-thermal heat-shock response to microwaves. *Nature* 2000; **405**: 417–8.



HOME LATEST NEWS BIOGRAPHY LEGISLATION COMMITTEES PHOTO GALLERIES VIDEOS RESOURCES CONTACT ME

Senator Mark Leno Introduces Bill Requiring Disclosure Of Cell Phone Radiation Levels to Consumers

February 18, 2010

SACRAMENTO - Senator Mark Leno today introduced legislation designed to give consumers more information about how much radiation their cell phones emit. The bill, sponsored by the Environmental Working Group (EWG), requires that cell phone retailers label phones with the level of radiation they emit, measured by the specific absorption rate or SAR. That label would be prominently displayed next to the phone's purchase price.

"As the use of cell phones has increased exponentially across the globe, so have concerns about the safety of cell phone radiation," said Senator Leno (D-San Francisco). "While more research still needs to be done on the risks of long-term cell phone use for both adults and children, consumers have a right to know how much radiation their cell phones emit."

Recent research has raised concerns about the safety of exposure to wireless emissions from cell phones. Scientists around the world have associated prolonged cell phone use with health problems, including behavioral problems in young children and increased risk for brain cancer, salivary gland tumors, migraines and vertigo in adults. These studies also show that children's brains absorb twice as much cell phone radiation as adults. As a result, six countries, including the United Kingdom and Germany, have issued warnings about cell phone use.

"A number of health agencies around the world advise people to reduce exposures to cell phone radiation, driven by recent studies raising questions about the safety of this radiation, particularly for children," said Renee Sharp, director of EWG's California office. "That's why it's essential for consumers to have radiation output information before they purchase phones for themselves and their families." EWG today released its latest guide to cell phone radiation levels, focusing on the newest smart phones on the market. To view the report, visit www.ewg.org.

San Francisco Mayor Gavin Newsom has introduced similar cell phone legislation at the local level, which requires retailers to post a phone's radiation level along with its price and other features.

Senator Leno's bill will be eligible to be heard in policy committees in the Senate as early as mid-March.

By Lynn Wescroft



Contact my office



Sign up for my e-news letters



Located in



Constituent services



Request a meeting



Find your representative



Request a meeting online

Search

Testimony of Olga V. Naidenko, Ph.D.
Senior Scientist
Environmental Working Group
Before the
Subcommittee on Labor, Health and Human Services, and Education, and Related
Agencies
Committee on Appropriations
United States Senate

Hearing on The Health Effects of Cell Phone Use
Monday, September 14, 2009
Dirksen Senate Office Building, Room 138, 2 p.m.

Mr. Chairman and distinguished Members of the Subcommittee: My name is Olga Naidenko, and I am a Senior Scientist at Environmental Working Group (EWG), a nonprofit research and advocacy organization based in Washington, DC; Ames, Iowa; and Oakland, California. I thank the members of the subcommittee for holding this important hearing and for the opportunity to testify.

Last week, EWG released the results of a 10-month investigation of more than 200 peer-reviewed studies, government advisories, and industry documents on the safety of cell phone radiation. We found that the studies amassed during the first two decades of cell phone use produced conflicting results and few definitive conclusions on cell phone safety. But the latest research, in which scientists are for the first time able to study people who have used cell phones for many years, suggests the potential for serious safety issues.

Studies published over the past several years find significantly higher risks for brain and salivary gland tumors among people using cell phones for 10 years or longer. The state of the science is provocative and troubling, and more research is essential. We at Environmental Working Group are still using our cell phones, but we also believe that until scientists know much more about cell phone radiation, it's smart for consumers to buy phones with the lowest emissions.

As of December 2008, U.S. wireless subscribers numbered 270.3 million -- 87 percent of Americans -- a 30 percent jump in three years (CTIA 2009). Some 60 percent of the global population -- four billion people -- subscribe to wireless services (ITU 2008). As the market for new devices has grown, so has the urgency that cell phone safety be well understood, and that cell phone radiation standards be sufficient to protect public health.

In this testimony we highlight five key areas of concern:

- Consumers have a right to know the level of radiation their phones emit;
- Latest science points to potential risks to children's health;
- Federal standards for cell phone radiation need to be modernized;
- What consumers can do to reduce exposures to cell phone radiation;
- EWG's recommendations to the government, industry, and the public.

1. Consumers have a right to know the level of radiation their phones emit

EWG advocates that cell phone companies label their products' radiation output so that consumers can make informed choices at the point of sale, and that the government require this disclosure. Currently, most people are given no information at all about radiation emissions when they purchase a phone.

To fill this information void, EWG's research team created a user-friendly, interactive online guide to cell phone emissions, covering over 1,200 phones currently on the market. Consumers can use this free online database to make informed decisions about which cell phones to buy. The EWG guide uses easy-to-read graphics to illustrate each phone's radiofrequency emissions, enabling consumers to make quick comparisons of radiation output of various wireless devices.

In the 64 hours following the publication of our science review and cell phone radiation database, 442,000 people accessed these materials on our website, collectively viewing 1.4 million online pages. During those same 3 days our findings were reported in 100 news articles and in national and local broadcast news, including the *New York Times*, *NBC Nightly News*, *WebMD*, and *USA Today*. This powerful response from the public and from news media outlets reflects consumers' keen interest in the issue of cell phone safety. Clearly, people are eager to know if cell phones are safe and how they can protect themselves and their families from potential adverse effects of excessive exposure to cell phone radiation.

2. The latest science points to potential risks to children's health

Prior to 2003, studies of cancer risk and cell phone use produced conflicting results. The Food and Drug Administration (FDA) told consumers that scientists had found no harmful health effects from exposure to cell phone emissions (FDA 2003). But FDA's assurances were based on studies of people who had used cell phones for just 3 years, on average (FDA 2003), not long enough to develop cancer. At that time, studies had not addressed the risks of longer-term cell phone radiation exposures. The research gap is closing. Recent studies find significantly higher risks for brain and salivary gland tumors among people using cell phones for 10 years or longer. The state of the science is provocative and troubling, especially for the health of children. Among recent findings are the following:

- A joint study by researchers in Denmark, Finland, Norway, Sweden and the United Kingdom found that people who had used cell phones for more than 10 years had a significantly increased risk of developing glioma, a usually malignant brain tumor, on the side of the head they had favored for cell phone conversations (International Agency for Research on Cancer (IARC) 2008; Lahkola 2007).
- French and German scientists reported an increased risk of glioma for long-term cell phone users (Hours 2007; Schuz 2006). Analysis of all published cell phone-brain tumor studies found that people who had used a cell phone for 10 or more years, the overall risk for developing a glioma on the cell phone side of the head increased by 90 percent (Hardell 2009; Kundi 2009).
- Cell phone use for 10 years and longer has been also associated with significantly increased risk of acoustic neuroma, a type of benign brain tumor, on the primary side of cell phone use (International Agency for Research on Cancer (IARC) 2008; Lonn 2004; Schoemaker 2005). An extensive review of published studies of acoustic neuroma found that long-term cell phone users had a 60 percent greater risk of being diagnosed with the disease (Hardell 2009; Kundi 2009).
- A study from Israel reported an association between frequent and prolonged mobile phone use and parotid (salivary) gland tumors (Sadetzki 2008). Scientists analyzing data from Sweden and Denmark combined found that people who had used cell phones for at least 10 years ran an increased risk of benign parotid gland tumors (International Agency for Research on Cancer (IARC) 2008; Lonn 2006).

The National Research Council (NRC) has observed that "with the rapid advances in technologies and communications utilizing [radiation in the range of cell phone frequencies], children are increasingly exposed... at earlier ages (starting at age 6 or before)" (NRC 2008). Research by France Telecom scientists showed that under standard conditions of use, twice as much cell phone radiation would penetrate a child's thinner, softer skull than an adult's (Wiert 2008). Children will be exposed to cell phone radiation for more years and therefore in greater total amounts than the current generation of adults (NRC 2008).

Children are likely to be more susceptible than adults to effects from cell phone radiation, since the brain of a child is still developing and its nervous tissues absorb a greater portion of incoming radiation compared to that of an adult (Conil 2008; de Salles 2006; Gandhi 1996; Kang 2002; Martinez-Burdalo 2004; Wang 2003; Wiert 2008). Much more research is essential. However, in response to the information already available over the potential health risks of cell phone emissions, government agencies in Germany, Switzerland, Israel, United Kingdom, France, and Finland and the European Parliament have recommended actions to help consumers reduce exposures to cell phone radiation, especially for young children. Among warnings issued by government agencies are the following:

□ **United Kingdom Department of Health:** "UK Chief Medical Officers strongly advise that where children and young people do use mobile phones, they should be encouraged to: use mobile phones for essential purposes only; keep all calls short - talking for long periods prolongs exposure and should be discouraged." (UK Department of Health 2005).

□ **Canada - City of Toronto Department of Public Health:** "Today's children have started to use cell phones at a younger age, therefore their lifetime exposure to cell phone RFs will likely be greater. As a result, the chances that a child could develop harmful health effects from using a cell phone for a long time may be greater... Toronto Public Health is recommending that children, especially pre-adolescent children, use landlines whenever possible, keeping the use of cell phones for essential purposes only, limiting the length of cell phone calls and using headsets or hands-free options, whenever possible." (Toronto Public Health 2008a, b).

□ **Finland - Finnish Radiation and Nuclear Safety Authority:** "It would be good to restrict children's use of mobile phones." "Precaution is recommended for children as all of the effects are not known... Parents are recommended to guide their children to use a handsfree that minimises the exposure of head significantly. When using a hands-free it is recommended to keep the mobile phone at least a few centimetres away from the body." (STUK (Finnish Radiation and Nuclear Safety Authority) 2009).

In contrast, the two U.S. federal agencies that regulate cell phones, the FDA and the Federal Communications Commission (FCC), have all but ignored evidence that long term cell phone use may be risky.

3. Federal standards for cell phone radiation need to be modernized

The FCC set cell phone radiation standards 17 years ago, when few people used cell phones. These standards fail to provide an adequate margin of safety for cell phone radiation exposure and do not account for risks to children. The FCC standards closely follow the 1992 recommendations of the Institute of Electrical and Electronics Engineers (IEEE) (FCC 1997). The FCC adopted IEEE's proposal to allow 20 times more radiation to the head than the average amount allowed for the whole body, even though the brain may well be one of the most sensitive parts of human body with respect to radiofrequency radiation and should have more protection. EWG's conclusion: current U.S. cell phone radiation standards are outdated and may not be sufficiently protective. EWG urges the FDA and the FCC to upgrade its standards to take account of the newest scientific evidence and also increasing cell phone use by children.

4. What consumers can do to reduce exposures to cell phone radiation

EWG recommends a number of simple actions consumers can take to reduce exposures to cell phone radiation. We recommend these simple precautionary measures until the science on cell phone risks is settled, and until the federal government modernizes current radiation limits to reflect the latest research.

- Use a low-radiation phone.** Consumers can find radiation emissions for their current phone on EWG's database (www.ewg.org/cellphone-radiation), in their user's manual, or by contacting the manufacturer. EWG's database lists alternate, low-radiation phones, allowing people to consider purchasing a phone that emits the lowest radiation possible and still meets their needs.

- Use a headset or speakers.** Headsets emit much less radiation than phones. Experts are split on whether wireless or wired is safer. Some wireless headsets emit continuous, low-level radiation, so EWG advises removing the headset from the ear between calls. Using a phone in speaker mode also reduces radiation to the head.

- Listen more, talk less.** Cell phones emit radiation to transmit voice or text messages, but not to receive messages. Listening more and talking less reduces exposures.

- Hold phone away from the body.** Holding the phone away from the torso when talking (while using the headset or speaker) reduces radiation exposures. EWG advises against holding the phone against the ear, in a pocket, or on the belt where soft body tissues absorb radiation.

- Choose texting over talking.** Phones use less power (less radiation) to send text than voice. And unlike speaking with the phone at the ear, texting keeps radiation away from the head.

- Stay off the phone if the signal is poor.** Fewer signal bars on the phone means that it emits more radiation to get the signal to the tower. EWG recommends that people make and take calls when the phone has a strong signal.

- Limit children's phone use.** Young children's brains absorb twice the cell phone radiation as an adult's. EWG joins health agencies in at least six countries in recommending limits for children's phone use, such as for emergency situations only.

- Skip the "radiation shield."** Radiation shields such as antenna caps or keypad covers reduce the connection quality and force the phone to transmit at a higher power with higher radiation.

5. Recommendations

The government should invest in additional research on the health effects of cell phone radiation, with special emphasis on children and teens.

The government should require industry to make cell phone radiation level information available at the point of sale, so consumers can make informed decisions about the phones they buy.

Given the troubling questions raised by the research thus far, the cell phone industry should not wait for government action, but instead, offer consumers phones that operate with the least possible radiation, and should offer radiation information at the point of sale.

In the meanwhile, cell phone users can protect themselves and their families by buying low radiation phones. Cell phone users can also reduce radiation exposures by using their phone in speaker mode or with a headset.

In conclusion, EWG strongly believes that the government should support additional research into this important health question, and that the public has the right to know what levels of radiation they may be exposed to, what may be the potential risks, and what precautionary measures they can take to protect themselves and their families from any adverse health effects of cell phone radiation.

Thank you for your time. I welcome the opportunity to answer any questions you may have.

EXHIBIT A

REFERENCES

Conil E, Hadjem A, Lacroux F, Wong MF, Wiart J. 2008. Variability analysis of SAR from 20 MHz to 2.4 GHz for different adult and child models using finite-difference time-domain. *Phys Med Biol* 53(6): 1511-25.

CTIA. 2009. *Wireless Quick Facts. Year End Figures*. Available: http://www.ctia.org/media/industry_info/index.cfm/AID/10323 [accessed September 2 2009]. de Salles AA, Bulla G, Rodriguez CE. 2006. Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head. *Electromagn Biol Med* 25(4): 349-60. FCC. 1997. Federal Communications Commission Office of Engineering & Technology. *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields. OET Bulletin 65 Edition 97-01* Available: <http://www.fcc.gov/oet/rfsafety/> [accessed December 10 2008].

FDA. 2003. *Cell Phone Facts. Consumer Information on Wireless Phones. Questions & Answers*. Available: <http://web.archive.org/web/20031205121949/www.fda.gov/cellphones/qa.html> [accessed June 10 2009].

Gandhi OP, Lazzi G, Furse CM. 1996. Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz. *IEEE Transactions on Microwave Theory and Techniques* 44(10): 1884 - 97.

Hardell L, Carlberg M, Hansson Mild K. 2009. Epidemiological evidence for an association between use of wireless phones and tumor diseases. *Pathophysiology* 116(2-3): 113-22.

Hours M, Bernard M, Montestrucq L, Arslan M, Bergeret A, Deltour I, et al. 2007. [Cell Phones and Risk of brain and acoustic nerve tumours: the French INTERPHONE case-control study]. *Rev Epidemiol Sante Publique* 55(5): 321-32.

International Agency for Research on Cancer (IARC). 2008. *INTERPHONE study results latest update - 8 October 2008*. Available: <http://www.iarc.fr/en/research-groups/RAD/current-topics.php> [accessed June 8, 2009].

ITU. 2008. International Telecommunication Union Press Release. *Worldwide mobile cellular subscribers to reach 4 billion mark late 2008*. Available: http://www.itu.int/newsroom/press_releases/2008/29.html [accessed March 19 2009].

Kang G, Gandhi OP. 2002. SARs for pocket-mounted mobile telephones at 835 and 1900 MHz. *Phys Med Biol* 47(23): 4301-13.

Kundi M. 2009. The Controversy about a Possible Relationship between Mobile Phone Use and Cancer. *Environ Health Perspec* 117(3): 316-24.

Lahkola A, Auvinen A, Raitanen J, Schoemaker MJ, Christensen HC, Feychting M, et al. 2007. Mobile phone use and risk of glioma in 5 North European countries. *Int J Cancer* 120(8): 1769-75.

Lonn S, Ahlbom A, Christensen HC, Johansen C, Schuz J, Edstrom S, et al. 2006. Mobile phone use and risk of parotid gland tumor. *Am J Epidemiol* 164(7): 637-43.

Lonn S, Ahlbom A, Hall P, Feychting M. 2004. Mobile phone use and the risk of acoustic neuroma. *Epidemiology* 15(6): 653-9.

Martinez-Burdalo M, Martin A, Anguiano M, Villar R. 2004. Comparison of FDTD-calculated specific absorption rate in adults and children when using a mobile phone at 900 and 1800 MHz. *Phys Med Biol* 49(2): 345-54.

NRC. 2008. National Research Council. Identification of Research Needs Relating to Potential Biological or Adverse Health Effects of Wireless Communication. Available: http://www.nap.edu/catalog.php?record_id=12036 [accessed December 10 2008].

Sadetzki S, Chetrit A, Jarus-Hakak A, Cardis E, Deutch Y, Duvdevani S, et al. 2008. Cellular phone use and risk of benign and malignant parotid gland tumors—a nationwide case-control study. *Am J Epidemiol* 167(4): 457-67.

Schoemaker MJ, Swerdlow AJ, Ahlbom A, Auvinen A, Blaasaas KG, Cardis E, et al. 2005. Mobile phone use and risk of acoustic neuroma: results of the Interphone case-control study in five North European countries. *Br J Cancer* 93(7): 842-8.

Schuz J, Bohler E, Berg G, Schlehofer B, Hettinger I, Schlaefer K, et al. 2006. Cellular phones, cordless phones, and the risks of glioma and meningioma (Interphone Study Group, Germany). *Am J Epidemiol* 163(6): 512-20.

STUK (Finnish Radiation and Nuclear Safety Authority). 2009. Statement of Finnish Radiation and Nuclear Safety Authority (STUK) concerning mobile phones and health on 7th January 2009. Available: http://www.stuk.fi/sateilytieto/sateilyn_terveysvaikutukset/matkapuhelin_terveysvaikutus/en_GB/stukin_matkapuhelinkannanotto/ [accessed March 20 2009].

Toronto Public Health. 2008a. Cell Phone Use by Children and Youth. Board of Health report (May 2008). Available: <http://www.toronto.ca/health/hphe/radiation/radiofrequency.htm> [accessed March 29 2009].

Toronto Public Health. 2008b. Fact Sheet - Children and Safe Cell Phone Use (July 2008). Available: <http://www.toronto.ca/health/hphe/radiation/radiofrequency.htm> [accessed March 29 2009].

UK Department of Health. 2005. Mobile Phones and Health. Available: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4006938 [accessed March 29 2009].

Wang J, Fujiwara O. 2003. Comparison and Evaluation of Electromagnetic Absorption Characteristics in Realistic Human Head Models of Adult and Children for 900-MHz Mobile Telephones IEEE Transactions on Microwave Theory and Techniques 51(3): 966-70.

Wiat J, Hadjem A, Wong MF, Bloch I. 2008. Analysis of RF exposure in the head tissues of children and adults. Phys Med Biol 53(13): 3681-95.

Media Presence on Cell Phone Safety Concerns:

All major media outlets from print to broadcasting have reported on the topic of cell phone radiation spanning the last decade. This is true both in the U.S. and overseas. The following list includes a few titles of media articles, stories and broadcasts which have covered this topic. A simple Google search should take the reader to these stories:

- KTVU San Francisco, John Fowler special Broadcast report: "Keeping Cell Phone in Bra May Lead to Breast Cancer," Nov. 16, 2012. Emmy Award received on June 15, 2013.
- Telegraph, U.K. "Are We Ignoring the Dangers of Cell Phones." May 30, 2013.
- Huffington Post. "Circadas and Cell Phones: Welcome the the 21st Century." April 30, 2013.
- Mail Online. "Cell Phone Radiation Does Harm Your Baby and May Cause Hyperactivity, Study Says." Nov. 11, 2012.
- Microwave News. "Spike in Aggressive Brain Cancer in Denmark." Nov. 8, 2012.
- San Francisco Chronicle. "Keep that cell phone out of your bra." Oct. 23, 2010.
- Haatetz. "Knesset backs bill requiring cell phones to bear health hazard warning." March 1, 2012.
- New York Times. "Are Cells the New Cigarettes?" June 26, 2010.
- New York Times. "Should You Be Snuggling with Your Cellphone?" Nov. 13, 2010.
- GQ. "Warning: Your Cell Phone May be Hazardous to Your Health." February 2010.
- CNN. "Gupta: Cell Phones, Brain Tumors and a Wired Earpiece." Dr. Sanjay Gupta, Chief Medical Correspondent. May 20, 2011.
- CNN. "W.H.O: Cell phone use can increase possible cancer risk." May 31, 2011.
- CNET. "Are Cell Phones Safe? Researchers Still Uncertain." Sept. 13, 2009.
- CNET. "Cell Phone Radiation: Harmless or Health Risk." May 31, 2011.
- CNET. "Cell Phone Radiation: A Self-Defense Guide." June 6, 2012.
- Reuters. "Italy Court Ruling Links Mobile Phone Use to Tumor." Oct. 19, 2012.
- U.K. documentary. "Resonance: Beings of Frequency." 2012.

What do the Firefighters Know that We Don't?

Posted by GreenSwanStaff at July 10th, 2013



Back in 2004, the International Association of Fire Fighters issued their formal position forbidding the installation of cellular towers on fire stations. Citing numerous sources and scientific studies, the IAFF stated that this position would remain in effect "until a study with the highest scientific merit and integrity on health effects of exposure to low-intensity RF/MW radiation is conducted and it is proven that such sitings are not hazardous to the health of our members." They went on to state that "acknowledged experts in the field of RF/MW radiation research have shown that RF/MW transmission of the type used in digital cellular antennas and phones can have critical effects on cell cultures, animals, and people in laboratories and have also found epidemiological evidence (studies of communities, not in the laboratory) of serious health effects at "non-thermal levels," where the intensity of RF/MW radiation was too low to cause heating."

Perhaps the firefighters were talking to the right scientists. Recent studies in India and Brazil are now showing spikes in cancer rates to humans living in close proximity to cellular towers or base stations. As disturbing as this new research might appear, adverse effects to humans residing in proximity to cell towers have been present for at least 10 years. Back in 2004, researchers in Israel examined the medical records of people living within 350 meters of a cellular mast who showed a fourfold increased incidence of cancer compared with the general population and a tenfold increase specifically among women compared to the population residing further away from the mast.

As more and more cell towers receive permitting for installation, we should perhaps ask our local planning departments to pause and look at the epidemiological studies which have been highlighting increased pathology associated with this technology. One piece of data seems to hold true: Cell towers need to be positioned at safer distances than they are now.

Category: Cellphones and Health Consequences Post Tagged with cell phone towers, Fire Fighters, hazards, RF / MW radiation, RF radiation,

serious health effects, transnission

← Previous Post

Leave a Review

You must be logged in to post a comment.

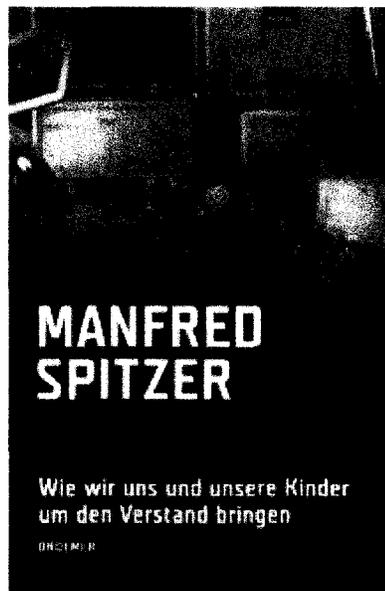
F
S

S
R
Et

You are here: [Home](#) » [Cellphones and Health Consequences](#) » “Digital Dementia”

“Digital Dementia”

Posted by [GreenSwanStaff](#) at July 3rd, 2013



Digital Dementia

An article published last month in the U.K. brought to light recent reports from South Korean doctors of a surge in early onset “digital dementia” afflicting young people who have come to rely heavily on electronic devices. In some alarming cases, children are no longer able to remember everyday details such as their phone numbers.

This deterioration of cognitive abilities had traditionally been observed in people who had suffered from a head injury or psychiatric conditions. Today more than 67 percent of South Koreans are using smartphones. According to The Ministry of Science, 64 percent of teenagers use smartphones with an average of 7 hours of day of usage.

Because smart and digital technology only supports development of the left side cognitive functions of the brain, the right side, which is the center connected to our concentration, languishes and remains underdeveloped. The right side of the brain is crucial to our health and wellbeing as its weakening will affect attention and memory span.

According to Dr. Manfred Spitzer, a German neuroscientist who in 2012 wrote a book titled, “Digital Dementia,” the negative effects of digital overuse on the developing brain are irreversible and he has called for a total ban on digital media in German classrooms to ward off potential cognitive loss and digital addiction among children.

Dr. Spitzer states that there have been no independent studies “that unequivocally establish that

F
SS
I
Ei

computers and screens in the classroom makes learning more effective.” On the contrary, Spitzer explains how digitalizing classrooms has a negative effect on learning and limits the brain’s ability to adjust to new challenges, in effect petrifying the neuroplastic capacity of the brain. This is especially true for the youngest of children. Not only will learning be stunted in the long run, but the reliance on technological education will result in dependency: “In reality, using digital media in kindergarten or primary school is actually a way of getting children addicted.”

Lastly, Dr. Spitzer states that the multi-tasking which now comes with modern smart and electronic media inhibits concentration and right-side brain development. In short, the Internet and its associative devices will make us dumb. These negative effects will be especially true for children and teenagers whose brains are still developing and as such, have the most at stake.

★ **Category: Cellphones and Health Consequences** 📌 **Post Tagged with cognitive abilities, digital dementia, digital media, Manfred Spitzer**

← Previous Post

Next Post →

Leave a Review

You must be [logged in](#) to post a comment.

Corporate Headquarters

Green Swan, Incorporated
Novato, CA 94945
[Contact Us](#)

Quick Support

[Too Close](#)
[Too Close Parental](#)
[Pocket Alert](#)
[Cell Spacer](#)
[Too Close Free](#)

Translation

 [Edit Translation](#)
Translations provided by Google.

Follow Us!



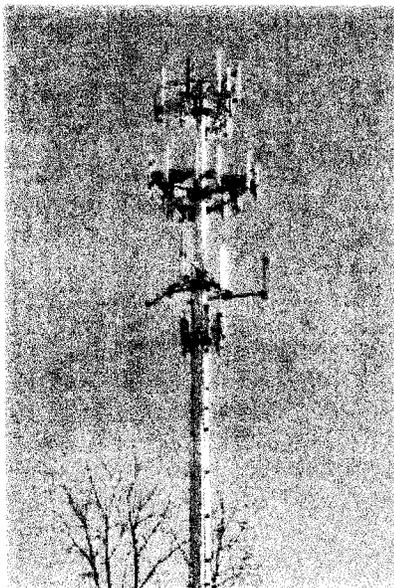
Legal

[Terms of Use](#)
[Privacy Policy](#)
[Disclaimer](#)

You are here: [Home](#) » [Cellphones and Health Consequences](#) » When it comes to Your Fabulous Smartphone, You M Sources of Non-ionizing Radiation!

When it comes to Your Fabulous Smartphone, You May Not Know it but it Emits at Least 12 Sources of Non-ionizing Radiation!

Posted by [GreenSwanStaff](#) at June 26th, 2013



Most folks think they just need to be worried about cellular radiation when it comes to smartphone technology. Thanks to the ingeniousness of our emerging technologies, these remarkable phones can now do much more than make a phone call. Ironically, it's now getting less and less intuitive to find the telephone function with each newly acquired device.

It's important for us to realize that maintaining an adequate safe distance from your phone is getting even more critical as the phones, with increasing sophistication and capacities, have embedded in them numerous non-ionizing radio transmitters, all which perform specific functions.

Most of us know that we have GPS tracking and we can zero in on Wi-Fi signals at will. Blue Tooth enabled functions also come with our standard smartphones now. Additionally, NFC (Near Field Communication) enabled business cards, merchandise, credit cards, and barcodes, all emit radio frequency signals. Other low frequency emitting sources include the cell phone battery, motherboard, touch sensor, and the heated components of the hardware itself.

F
S

S
I

EI

To make matters even more complicated, each 4G smartphone now emits radiofrequency radiation on 3 and soon to be 4 radio bands or PCS (Personal Communication Systems). Furthermore, as early as fall 2013, AWS (Advanced Wireless System) bands will be available to our cell phones and other data enabled devices.

Keep in mind that your network usage affects your local cellular site. The CDMA (Code Division Multiplexing Access) cellular tower will decrease its geographical "footprint" as you occupy that tower with usage. Your phone is now forced to connect to the tower furthest from you. This is referred to as "cell breathing" - when the phone then has to use more energy to reach the tower which is less occupied yet still available within the geographical footprint. In short, the phone now itself emits maximum available power at its disposal to complete your phone call.

These are powerful devices which will adversely affect your health if not used with caution. Enjoy your phone calls, but keep your distance!

 **Category: Cellphones and Health Consequences, Message from Green Swan**

 **Post Tagged with CDMA, cellular tower, Code Division Multiplexing Access, non-ionizing radio transmitters, Wi-Fi exposure**

[← Previous Post](#)

[Leave a Review](#)

You must be [logged in](#) to post a comment.

Corporate Headquarters

Green Swan, Incorporated
Novato, CA 94945
[Contact Us](#)

Quick Support

[Too Close](#)
[Too Close Parental](#)
[Pocket Alert](#)
[Cell Spacer](#)
[Too Close Free](#)

Translation



[Edit Translation](#)

Translations provided by Google.

Follow Us!



Legal

[Terms of Use](#)
[Privacy Policy](#)
[Disclaimer](#)

You are here: [Home](#) » [Cellphones and Health Consequences](#) » [It's Time to Slow Down and Re-Evaluate High Speed](#)

It's Time to Slow Down and Re-Evaluate High Speed Wireless.

Posted by [GreenSwanStaff](#) at June 21st, 2013



Early in June, we saw a bevy of articles extolling President Obama's pitch for a five year plan of the installation of \$18 billion in high speed wireless networks throughout the United States including into 99% of the country's schools.

First outlined in the President's State of the Union address, this ambitious plan is designed to keep America competitive and at the cutting edge, ready and poised to compete globally.

While meritorious in its objectives, numerous scientific studies suggest that wireless connectivity is harmful to living tissue. This should be a red flag particularly to any planned installation that involves the participation of children. Numerous countries, such as France, the U.K., Israel, and Russia, have put the brakes on Wi-Fi in schools and libraries and cell phone use for children. Their logic is simple: Many studies show alarming effects due to non-ionizing radiation exposure and as such, the jury is "still out" as to safety and long term consequences.

Perhaps the European Community's Mobi-Kids study will help shed light on the effects of non-ionizing radiation on children's health. This ambitious 5 year project, involving several countries partnering with their European counterparts, seeks to study wireless communication devices and their effect on certain increasing childhood pathologies, specifically brain cancer and brain tumors. Expected results are due by 2016.

As we await the results of the European research, where might we find data today to help us evaluate the wisdom of the quest to install Wi-Fi in 99% of U.S. schools? Dr. Martha Herbert, PhD, MD, a board certified neurologist at the Harvard Medical School, has shed important light on the topic of Wi-Fi and the dangers it poses to children's health. In her February 8, 2013 letter to the Los Angeles Unified School District titled "Wireless vs. Wired Classrooms," Dr. Herbert carefully outlines some of the science which should make us all reconsider the wisdom of wireless networks. Specifically, Dr. Herbert states:

F
S

S

I

Ei

“There are thousands of papers that have accumulated over decades - and are now accumulating at an accelerating pace, as our ability to measure impacts become more sensitive - that document adverse health and neurological impacts of EMF/RFR [Electromagnetic Frequencies / Radiofrequency Radiation]. Children are more vulnerable than adults, and children with chronic illnesses and/or neurodevelopmental disabilities are even more vulnerable... Current technologies were designed and promulgated without taking account of biological impacts other than thermal impacts. We now know that there are a large array of impacts that have nothing to do with the heating of tissue. The claim from Wi-Fi proponents that the only concern is thermal impacts is now definitely outdated scientifically... EMF/RFR from Wi-Fi and cell towers can exert disorganizing effect on the ability to learn and remember, and can also be destabilizing to immune and metabolic function. This will make it harder for children to learn, particularly those who are already having problems in the first place.”

So before we rush out and spend \$18 billion on nation-wide Wi-Fi installation, let's hope that the decision making folks in Washington will take a moment to speak with Dr. Herbert and her colleagues. It seems that slowing down, re-evaluating and perhaps re-considering the merits of further Wi-Fi installations at this time would be prudent.

✦ **Category: Cellphones and Health Consequences**

← Previous Post

Next Post →

Leave a Review

You must be [logged in](#) to post a comment.

Corporate Headquarters

Green Swan, Incorporated
Novato, CA 94945
[Contact Us](#)

Quick Support

[Too Close](#)
[Too Close Parental](#)
[Pocket Alert](#)
[Cell Spacer](#)
[Too Close Free](#)

Translation



[Edit Translation](#)

Translations provided by Google.

Follow Us!



Legal

[Terms of Use](#)
[Privacy Policy](#)
[Disclaimer](#)