

# BUSINESS BIAS AS USUAL: THE CASE OF ELECTROMAGNETIC POLLUTION

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**ABBREVIATIONS:** CI, confidence index; EC, European Commission; EEA, European Environment Commission; ELF, extremely low frequencies; EM, electromagnetic; EMF, electromagnetic fields; EP, European Parliament; EU, European Union; IARC, International Agency for Research on Cancer; ICNIRP, International Commission for Non-Ionizing Radiation Protection; MMF, Mobile Manufacturers Forum; MP, mobile phone;  $\mu$ T, microTesla; OR, odds ratio; RF, radiofrequencies; SCENIHR, Scientific Committee on Emerging and Newly Identified Health Risk (EC); s.s. statistically significant; V/m, volts/meter; WHO, World Health Organization

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## 1. INTRODUCTION. PROTECTING HUMAN HEALTH OR PROTECTING BUSINESS; HOW TO IDENTIFY THE *BUSINESS BIAS*

About 50 years ago, Lorenzo Tomatis anticipated – with bitterness, but at the same time the clarity and optimism that distinguish the competent researcher – that "the world of research consists of a few dozen people who really matter, a small group of trusted workers, a significant number of uninformed and a cohort of unscrupulous profiteers, true violators ...."(1). Identifying violators and profiteers whose goal is to promote career and business rather than perform honest research is not an easy task; it is much simpler, instead, to carry out good research and identify any studies that are faulty or biased. This is, of course, a researcher's main goal.

Indeed, for many years best practice in both environmental and occupational epidemiology (2) has been well established. But at the same time the correct use of these methods is not routinely applied, a failure regrettably borne out by numerous studies on exposed workers (in oil refineries, petrochemicals, etc.) or military personnel (exposed to depleted uranium etc.), or people living in polluted areas (from industrial plants, etc.). Moreover, the findings of studies carried out with the benefit of corporate funding often show that a population exposed to some occupational or environmental risk factor, or to particular pharmacological treatments, is healthier than the control population (of course, only until truly independent studies are carried out – these often uncovering very different results). With the aim of highlighting and correcting this common failure, a more recent article pointed out 15 errors and bias, so enabling epidemiologists to steer clear of the most serious diagnostic error possible, i.e., reporting a sick population as healthy (3).

This serious underestimation of the epidemiological risk of disease can be produced in good or bad faith. The latter - termed *business bias* in occupational and environmental epidemiology - can be understood as a intentional study bias, specifically set up to prioritise both economic and career-related ambitions over scientific research, whose natural vocation should be improvement of human health. In later studies, other authors have clearly shown examples of how what is considered *health-oriented research* could in fact turn into *business* or *funds-oriented research* (4). Today, there are now 25 points in place of the earlier 15 points, and it is increasingly clear that the business bias issue has become a new risk factor for the health of populations (5). Inconsistencies, contradictions and omissions can easily be identified by carefully reading all the sections of a scientific article. Furthermore, there is a clearly noticeable, tell-tale inconsistency in the contrast between the calmness of the conclusion of a study (the part that is always read) and the alarm evident in other sections (those often disregarded: materials, methods and results).

## 2. CONFLICTS OF INTERESTS AND LIMITS OF EXPOSURE TO NON-IONIZING ELECTROMAGNETIC FIELDS (EMF)

Discussion on the need to minimize exposure to EMF (frequency range: 0-300 GHz) has for over half a century been split between two irreconcilable positions. On the one hand a "conservative" stance, rooted in the definition of exposure limits fixed since the mid-50s on the basis of the assumption that the only effects of EMF dangerous to the human health are the acute effects, resulting from the passage of electric current or overheating: stimulation of muscles and eripheral nerves, shocks, burns, heating of surface tissues. Simple avoidance of these effects would ensure the safeness of exposure to EMF<sup>1</sup>. This position

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<sup>1</sup> Documents published since 1953 by the American Conference of Government and Industrial Hygienists (ACGIH), and by the Conferences of American Military Bodies held since 1957 by the Air Research and Development Command, USA. The ACGIH is neither a public body nor a government organization, but an industry-based private association of hygienists, despite the misleading name (F. Casson: "La Fabbrica dei Veleni" p.42; Sperling & Kupfer eds., Cles, Trento, Italy 2007). The ACGIH's role in underlining the inadequate exposure limits for protecting human health – totally ignoring experimental and epidemiological evidence – has been widely reported. The ACGIH has very close ties with private industry and, of the over 600 threshold values set by the ACGIH, at least 100 are based exclusively on the opinion of industry experts, without any experimental support (D. Davis: "La Storia Segreta del Cancro" p.357; Codice ed., Turin, Italy 2008). As regards the interests of the American military bodies in the development of RF, we can note the report by the National Academy of Sciences - National Research Council ("An Assessment of Non-Lethal Weapons Science and Technology" by the Naval Studies Board, Division of Engineering and Physical Sciences – National Academy Press 2002: 2-13). In this report, the section on "Directed-Energy Non Lethal Weapons" states that: "The first RF non-lethal weapons are based on a biophysical susceptibility known empirically for decades. The heating action of RF signals is well understood and can be the basis for several additional directed-energy weapons. Leap-ahead non-lethal weapons technologies will probably be based on more subtle human-RF interactions in which the signal information within the RF exposure causes an effect other than simply heating: for example, stun, seizure, startle and decreased spontaneous activity". This admission by the Naval Studies Board confirms that: "1) some of these non-thermal effects can be weaponized with bioeffects that are incontrovertibly adverse to health; 2) there has been knowledge for decades about the susceptibility of human beings to non-thermal levels of RF exposure; 3) the concept that RF interacts with humans based on the RF information content (signal information) rather than heating, so it can occur at subtle energy levels, not at high levels associated with tissue heating is well established; 4) a dedicated scientific research effort is promising enough for continued federal funding" (Bioinitiative Report: "A Rationale for a Biologically Based Public Exposure Standard for Electromagnetic Fields: ELF and RF", 2007: Section 4: "Evidence for Inadequacy of the Standards": 11-12; [www.bioinitiative.org/](http://www.bioinitiative.org/)). The magazine "Nexus" (no. 69, August-September 2007: "EM Arms and Human Rights"; [www.nexusitalia.com](http://www.nexusitalia.com)) shows that the American military-industrial-intelligence complex has an arsenal of EM arms for use in today's battlefields and against the citizen as a means of social control, in contravention of the convention on human rights. During the 50s and 60s the CIA began seeking methods for influencing cognition, emotions and human behavior. This research included the wireless use of EM energy defined as "informatic war" and "non-lethal arms". New technological capabilities have been developed under projects financed through slush funding over recent decades: these technologies bring about the ability to influence the human emotions, disturb thought and inflict severe pain through the manipulation of EM fields. The EM spectrum has provided a range of new weapons that have already been adopted in both private and military arenas, for example millimeter waves, pulsed energy projectiles (PEPs) and other high-power EM arms. PEPs represent a type of weapon used to paralyze a victim with pain: the expansion of the plasma acts on the nerve cells and the long-term effects are still quite unknown. The Direct Acoustic Device "Voice-to-Skull" is a non-lethal EM weapon that produce highly disturbing noises within the cranium. This technology has been tested by businesses including McDonald's and Wal-Mart to direct advertising messages into the consumer's head. The power of

was agreed on at the end of the 90s by a group of scientists which was self-constituted under the International Commission for Non-Ionizing Radiation Protection (ICNIRP). Working with so-called “ghosts” (dummies reproducing the human shape and biochemical constitution of human tissue), this group identified the EMF values at which a significant thermal effect is registered, and introduced reductions of 10 and 50 times for workers and the general population, respectively<sup>2</sup>. The ICNIRP set a single exposure limit to protect from acute and thermal effects: for the general population, this limit is 100 microTesla ( $\mu\text{T}$ ) for magnetic fields (MF) produced by the EMF at low frequencies (0-100 KHz), in particular at 50-60 Hz (ELF, extremely low frequencies: power lines), and of 27-61 Volts/meter (V/m) - depending on the frequency - for electric fields produced by the EMF at high-very high frequencies (100 kHz - 300 GHz: RF, radiofrequencies: radio/TV and mobile telephony emissions). For workers, the “safe limits” are 500  $\mu\text{T}$  for ELF/EMF and 137 V/m for RF/EMF<sup>3</sup>, respectively. For the ICNIRP, the acute effects with thermal origin are the only EMF effects harmful to the human health that have specifically been determined, while other effects – in particular long-term effects and biological effects of non-thermal origin – are inadequately documented or give contradictory results, for which reason they have been excluded from consideration when setting exposure limits. The position and limits defined by the ICNIRP have been accepted by the principal organizations overseeing health care, including the WHO, as well as by many national scientific committees and the European Commission (EC)<sup>4</sup>.

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the US Defense Department (UDD) is hard to believe: in May 2006 the Air Force provided a total of US\$ 24 million in contracts for “Research and Development” (R&D) on EMF to Northrop Grumman, Voss Scientific, Lockheed Martin, ElectroMagnetic Applications, and other private companies. Already in 1996 the UDD had recognized a key element in wars of the future in R&D on EM radiation. The development of non-lethal weapons has also been taken up by the universities, with millions of dollars being set aside for grants and research doctorates: the Pennsylvania State University hosts the Institute for Non-Lethal Defense Technologies, the New Jersey University of Medicine and Dentistry hosts the Institute for Stress and Motivated Behavior, the University of New Hampshire hosts the Center for Non-Lethal Technological Innovation, while many military schools fund courses on the technology of non-lethal weapons.

<sup>2</sup> ICNIRP Statement: Health Physics, 1996; 70:587-93. Overview of research papers limited to the biological and health effects of RF/EMF with negative results, funded mainly by managers or operators of the technologies concerned. The few papers showing positive results cited – of the many found in the literature - were labeled as “inadequate number of repetitions”, “not significant”, or “carried out under conditions of sizable thermal increase”, even though these criticisms were quite invalid.

<sup>3</sup> ICNIRP Guidelines: Health Physics, 1998; 74: 494-522. Overview regarding all EMF frequencies (0-300 GHz), carried out using the same criteria as above. At the time, the ICNIRP members with conflicts of interests included: M. Repacholi, president until 1996; M. Grandolfo, vice-president until 1996; M. Hietanen, vice-president from 1996; R. Matthes, scientific secretary; R. Saunders, P. Vecchia and E. Vogel, “external experts”. At a later date, P. Vecchia became president of ICNIRP, M. Hietanen became vice-president, and M. Repacholi became emeritus president.

<sup>4</sup> ICNIRP: in 1974, the self-appointed working group of the International Radiation Protection Association (IRPA) set up a sub-group on Non-Ionizing Radiation (NIR). At the Paris conference of 1977 IRPA and NIR then formed the International Non-Ionizing Radiation Committee (INIRC). In the

On the other hand, a large part of the scientific community – especially where there is no constraint from funding by manufacturers or managers/operators of the technologies concerned – maintains a “cautionary” position based on application of the Precautionary Principle and the necessity to minimize EMF exposures. This position is justified by both epidemiological and experimental data. The former data – documented after exposure of human subjects to EMF so weak as to be able to exclude any significant heating – show immediate and long-term health effects including tumors and cancers, while the latter data reveal biological effects on *in vitro* systems, animals and human volunteers, indicating molecular, cellular and functional mechanisms supporting a biological plausibility (see box 1). The

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following years, IRPA, INIRC and WHO collaborated on developing the guideline criteria for protection of human health from EMF. Finally, at the Montreal conference of 1982, IRPA and INIRC formed ICNIRP. Since 1996 (see footnote 2), this body has adopted the proposal – already drawn up earlier by the WHO and IRPA – of considering only the acute effects of a thermal nature when defining the limit values of exposure to EMF, and since that date these values have remained unchanged in all subsequent revisions made by ICNIRP (1998, see footnote 3; 2004: “Epidemiology of health effects of radiofrequency exposure”, *Env. Med.* 112 (17): 1741-1754, 2007, see footnote 8). The particular attention given to ICNIRP by authoritative international bodies results from the close ties this body has established with the WHO (M. Repacholi was for many years President then Emeritus President of ICNIRP and, at the same time, head of the WHO’s EMF Project, see the following note on the WHO) and with the EC.

EUROPEAN COMMISSION: despite the unanimous view expressed by the EP on the basis of a report from one of its scientific committees, in conflict with adoption of the guidelines and limits proposed by ICNIRP, the EC on 12.07.99 adopted recommendation 519/EC, which accepted in full the ICNIRP/WHO proposals. The following years saw an ever-increasing strengthening of the links between ICNIRP, WHO and the EC (through SCENIHR, the EC’s scientific commission on EMF), expanding to increasing numbers of national commissions (see note below and footnotes 14 and 15), and also tighter relationships even with operators of the technologies using EMF, in particular MMF (see footnote 16). A well documented criticism of the conflicts of interests compromising the initiatives of the “ICNIRP-WHO-EC consortium” - listing cases where the founding principles of these bodies are flouted – was published by Don Maisch (“Conflict of interest and bias in health advisory committee: a case study of the WHO’s EMF task group”: *JACNEM*, 21(1): 15-17, 2006). Anyway ICNIRP remains a private and fully autonomous body, and as sanctions cannot be applied to this association – as was recognized by the UN Secretary-General when responding to one of the many cases brought by associations, private citizens, and groups of scientists, since intervening to alter the static positions of ICNIRP was not possible precisely because of its body’s private nature. Instead, there are the cautionary positions held by other “independent” committees, medical associations and even the EEA and EP, to protect human health from the short-term biological effects and the long-term effects (certainly not thermal in nature) of EMF – these positions are highly critical of the “monopoly” formed by ICNIRP, WHO, the EC and their countless “ramifications” (see footnote 5 and Sections 2.3, 3 and 6).

WHO: the reader is referred to the “fact sheets” published since 1998, regarding the “EMF Project” launched by the WHO and co-funded by electricity network operators and mobile telephony companies. Leading the project until 2006 was M. Repacholi, also emeritus president of the ICNIRP, member of various national scientific committees and consultant to various electricity and mobile telephony companies, as he himself has admitted to the Australian Senate and in a number of interviews. In 2006 E. van Deventer took over the position. See: A. Valberg, E. van Deventer and M. Repacholi: *Environ Health Perspect* 2007; 115:416-24, review funded by the National Institute of Environmental Health Sciences and by the WHO, despite Valberg having a senior role in a private energy company for whom Repacholi himself often acted as consultant (Gradient Corporation USA).

NATIONAL SCIENTIFIC COMMITTEES: the reader is referred to the reports of the Royal Society of Canada (“Recent Advances in Research on Radiofrequency Fields and Health 2001-2003”: *J. Toxicol Environ. Health.* 2001, Part B, Vol. 4-4), the Independent Expert Group on Mobile Phones (IEGMP: “Mobile Phones and Health” 1999-2001: [www.nrpb.org.uk](http://www.nrpb.org.uk)) , the “Zmirou Report” (“Zmirou

cautionary limits suggested for the population are lower by about two orders of magnitude than those set by the ICNIRP: 0.1-0.2  $\mu\text{T}$  (rather than 100) for ELF/EMF and 0.5-0.6 V/m (rather than 27-61) for RF/EMF<sup>5</sup>.

### 3. RESIDENTIAL AND OCCUPATIONAL EXPOSURES TO ELF/EMF

**3.1. Childhood leukemias, tumors in adults, neurodegenerative disorders and acute diseases.** IARC's monograph no. 80/2002 on this topic (6) is based on dozens of increasingly sophisticated studies, plus two "pooled analyses". The first of these two (7) includes nine carefully conducted studies and shows a statistically significant (s.s.) doubling of the risk of contracting childhood leukemia through exposure at home to power lines, in the presence of MF equal to or greater than 0.4  $\mu\text{T}$ , relative to those exposed to less than 0.1  $\mu\text{T}$  (OR=2.00; 95%CI=1.24-3.13)<sup>6</sup>. The second pooled analysis (8) covers 15 studies and shows a statistically

Report to the French Health General Directorate" 2001: [www.sante.gouv.fr/index.htm](http://www.sante.gouv.fr/index.htm)), the reports of the UK National Radiological Protection Board NRPB: Vol.15 No.3 ("Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields, 0-300 GHz", 2004), and the most recent reports (Swedish Radiation Protection Authority 2006; SCENIHR/EC 2007; Health Council of the Netherlands 2007; Mobile Telecommunications and Health Research Programme 2007). All set out almost only the negative data, while the few positive results quoted, among the many that exist, are considered "inadequate" or "inadequate number of repetitions" or sometimes are even partially processed to make them show appear "not significant". Furthermore, many of the members of these committees have clear conflicts of interests even though they declare that the funding received from the companies with interests in the area concerned does not represent any conflict of interests.

<sup>5</sup> From 1997, positions of caution have been presented at conferences putting forward the need to minimize exposure, with drastic reduction in the limits adopted by ICNIRP/WHO/EC: for example, Rockville ("Physical Characteristics and Possible Biological Effects of Microwaves Applied in Wireless Communication" 1997); Vienna ("Possible Biological and Health Effects of Electromagnetic Fields"1998); Salzburg ("International Conference on Cell Tower Siting" 2000: [www.land-sbg.gu.at/celltower](http://www.land-sbg.gu.at/celltower)); Stockholm ("Workshop on Electrosensitivity" 2001: [www.Feb.se/NEWS/Program10927.pdf](http://www.Feb.se/NEWS/Program10927.pdf)). In addition, the "STOA Report" by G. Hyland ("The Physiological and Environmental Effects of Non-Ionizing Electromagnetic Radiation"; Working Document for the STOA Panel, European Parliament/EU Directorate General for Research, 2001: [www.europarl.eu.int/stoa/publi/pdf/00-07-03eu.pdp](http://www.europarl.eu.int/stoa/publi/pdf/00-07-03eu.pdp)); the "independent" International Commission for the Electro-Magnetic Safety (ICEMS) funded in Venice 2002; the influential "BioInitiative Report" 2007 (see footnote 1), noted by bodies including the EEA and the EP; and the extremely cautionary position of the Russian National Committee on Non-Ionizing Radiation Protection 2008 (rcnirp@mail.ru). Many strongly "cautionary" appeals have also been published by doctors from various countries: Freiburg 2002; Helsinki 2005; Brussels 2007, Holland 2009. In particular there is the well-known "Appeal from the Viennese Doctors" 2007, with an attached "vademecum" for voluntarily limiting the risk from EMF exposure, plus a review of initiatives of various European governments (France, Austria, Germany, Great Britain, Spain, Luxembourg) for minimizing the dissemination of new wireless technologies (wifi, wimax) and for reducing exposure limits to RF.

<sup>6</sup> OR ("odds ratio"): relationship between the number of sick (cases) in exposed and non-exposed subjects. The OR is calculated on the basis of the ratio: exposed cases/non-exposed cases x controls (non-sick subjects) non-exposed/exposed controls. 95% CI (confidence interval): probability interval at 95% of OR. When OR is above 1 and 95%CI does not include 1 (i.e. the whole 95%CI interval lies above 1) means that in the exposed there is a s.s. increase at 95% probability of falling ill. In the specific case, the values indicate that there is 95% probability that the risk of falling ill from leukemia (OR) in children who lived exposed to 0.4  $\mu\text{T}$  lies between 1.3 and 3.1 relative to that (OR=1) of children who live exposed to below 0.1  $\mu\text{T}$ , and that the most probable increase in risk is a doubling (OR=2.0).

significant increase in the same type of risk for exposures above 0.3  $\mu\text{T}$  (OR=1.7; 95% CI=1.2-2.3). According to IARC, the association between childhood leukemia and high levels of magnetic fields is not likely to be due to chance, but it could be affected by distortions. In particular, a distortion of the selection could explain part of the association. However, it is highly unlikely that the distortion due to unknown confounding factors can explain the entire effect observed. In addition, if the relationship observed was a result of a causal link, the risk associated with the exposure might be higher than that reported. In fact, a number of studies have shown s.s. increases in risk of childhood leukemia exceeding those cited above, and even at MF values lower than 0.3-0.4  $\mu\text{T}$  (Table 1). The fraction of the infant population exposed at home to leukemogenic MF levels (0.3-0.4  $\mu\text{T}$ ) could range between 1 and 4%, but these MF levels represent just one average of values produced during the year by the voltage arising from power lines and today it is still not known whether average or maximum values of MF should be correlated with the incidence of childhood leukemias. Consequently, in view of the fact (see Table 1) that increase in risk often far exceeds a simple doubling (up to 5-6 times) and is found even at low MF levels (up to 0.1  $\mu\text{T}$ ) – and noting that much higher MF peaks are common (3-5  $\mu\text{T}$ , and in some cases over 10  $\mu\text{T}$ ) – this fraction could be very much higher. Furthermore, it is possible that children living close to power lines and who are exposed to MF of intensities of the order of those mentioned above are subject to an increase risk of contracting other types of cancer. Finally, a number of studies indicate that children exposed in the home to MF produced by power lines suffer from restricted growth and shorter lifespan, and have raised risk of developing some form of cancer in adult life (9).

Various authors have also noted s.s. increases in various types of tumor in adults with residential and occupational exposure (Table 2). Much common office equipment (computers, photocopiers, fax machines, video-display units) causes simultaneous exposure to ELF/EMF and RF/EMF, and evaluation of the contribution from these various EM sources shows the need to minimize exposure to this equipment, to avoid harmful effects to the health from using them (10).

**Table 1. Childhood leukemias in residential exposures to ELF/EMF**

Authors	reference	year	OR	95% CI	$\chi^2$
Wertheimer N. and Leeper E.	Am. J. Epidemiol. 109: 273-284	1979	3.0	1.1-8.1	> 0.30
Savitz D.A. et al.	Am. J. Epidemiol. 128: 21-38	1988	3.8	1.2-11.7	> 0.30
London S.J. et al.	Am. J. Epidemiol. 134: 923-937	1991	2.2	1.1-4.3	> 0.15

Olsen J.H. et al.	Brit. Med. J. 307: 891-895	1993	5.6	1.6-19.0	> 0.40
Feychting M. and Ahlbom A.	Am. J. Epidemiol. 138: 467-481	1993	3.8	1.4-9.3	> 0.30
Coghill R.W. et al.	Eur. J. Cancer Prev. 5: 153-158	1996	4.7	1.2-27.8	> 0.20
Michaelis J. et al.	Epidemiology 9: 92-94	1997	3.8	1.2-11.9	> 0.20
Linnet M.S. et al.	New Engl. J. Med. 337: 1-7	1997	3.3	1.2-9.4	> 0.40
Li C.Y. et al.	J. Occup. Environ. Med. 40: 144-147	1998	2.7	1.1-5.6	< 100 m
UKKCS <sup>2</sup>	Lancet 354: 1925-1931	1999	2.4	1.2-5.1	> 0.1-0.2
Green L.M. et al.	Cancer Causes Control 10: 233-243	1999	4.5	1.3-15.9	> 0.14
Green L.M. et al.	Int. J. Cancer 82: 161-170	1999	3.5	1.1-10.5	> 0.15
Bianchi N. et al.	Tumori 86: 195-198	2000	3.5	1.1-9.7	> 0.10
Schuz J. et al.	Int. J. Cancer 91: 728-735	2001	3.2	1.3-7.8	> 0.20
Schuz J. et al.	Int. J. Cancer 91: 728-735	2001	5.5	1.2-27.0	> 0.40
Draper G. et al.	Br. J. Med. 330: 1290-1293	2005	1.7	1.1-2.5	< 200 m
Draper G. et al.	Br. J. Med. 330: 1290-1293	2005	1.2	1.02-1.5	200-600 m
Kabuto M. et al.	Int. J. Cancer, 119: 643-650	2006	4.7	1.2-19.0	> 0.40

<sup>1</sup> For exposures in  $\mu T$  or for distance in m from the power lines; <sup>2</sup> UK Childhood Cancer Study Investigators

**Table 2. Tumors in adults in occupational and residential exposures to ELF/EMF**  
(Most of the data refer to exposures with MF values of 1-5  $\mu T$ )

Authors	reference	condition, sex	tumors	OR (95%CI)
Floderus B. et al.	Cancer Caus. Cont. 5:189-94, '94	railway workers ♂	leukemia, brain tumors	4.3 (1.6-11.8)
"	"	train drivers ♂	breast tumors	4.9 (1.6-15.7)
Tynes T. et al.	Cancer Caus. Cont. 7:197-204, '96	electricity network workers ♂	breast tumors	1.5 (1.1-2.0)
Coogan P.F. et al.	Epidemiol. 7:459-64, '96	electricity workers ♀	breast tumors	1.8 (1.1-3.1)
Milham S.	Am. J. Ind. Med. 30:702-4, '96	environmental exposure ♂, ♀	leukemia and other tumors	3.9 (1.6-8.0)
Rodvall Y. et al.	Eur. J. Epidemiol. 14:563-9, '98	electricity workers ♂	gliomas	1.9 (0.8-5.0)
Pollan M. et al.	Am. J. Publ. Health 89:875-81, '99	electronic programmers ♀	breast tumors	1.8 (1.2-2.7)
"	"	telegraph line operators ♀	"	1.5 (1.1-2.0)
"	"	telephone line operators ♀	"	1.3 (1.1-1.5)
"	"	various ELF occupations ♀	"	from 1.3 to 1.7
(s.s.)				
Villeneuve P.J. et al.	Occup. Envir. Med. 57:249-57, '00	electricity workers ♂	non-Hodgkin lymphoma	3.6 (1.3-9.8)
van Wijngaarden E.	Occup. Env. Med. 57:258-63, '01	electricity workers ♂	brain tumors	1.7 (1.0-3.0)
Bethwaite P. et al.	Cancer Causes Contr. 12:683-9, '01	electrical welders ♂	leukemia	2.8 (1.2-6.8)
Villeneuve P.J. et al.	J. Epidemiol. 31:210-7, '02	electrical welders > 0.6 $\mu T$ ♂	glioblastomas	5.4 (1.2-24.8)
Hakansson N. et al.	Occup. Environ. Med. 59:481-6, '02	electrical welders ♀	renal tumors, leukemia	1.4 (1.0-2.0)
"	"	" ♀	gliomas	3.0 (1.1-8.6)
Tynes T. et al.	Occup. Envir. Med. 60:343-7, '03	residents exp. to > 0.2 $\mu T$ ♂, ♀	skin melanomas	1.9 (1.2-2.8)
Charles L.E. et al.	Am. J. Epidemiol. 157:683-91, '03	electricity workers ♂	prostate tumors	1.6 (1.1-2.4)
Weiderpass E. et al.	J.Occup.Envir.Med. 45:305-15, '03	electricity workers ♀	gastrointestinal tumors	1.5 (1.1-2.0)
"	"	" ♀	pancreatic tumors	1.8 (1.2-2.8)
Fazzo L. et al.	Epidemiol. & Prev. 29:243-52, '05	residential ELF exposure ♂, ♀	peritoneal tum., digest. syst.	2.2 (1.2-4.3)
"	"	" ♂, ♀	leukemia	4.5 (1.1-17.9)
Lowenthal R.M. et al.	Intern. Med. J. 37:614-19, '07	residential ELF exposure ♂, ♀	lymphomas and myelomas	3.2 (1.3-8.3)
Fazzo L. et al.	Int.J.Occ.Env.Health 15:133-42, '09	residential ELF exposure ♂, ♀	pancreatic tumors, leukemia	8.2 (3.1-21.8)

**N.B. Negative data are given in over 50 articles published since 1998, all funded by the major electricity companies (National Grid Corporation UK, Electric Power Research Institute USA, and other electricity companies), or by private bodies with interest in the development of technologies that use ELF/EMF.**

**In adults, occupational or residential exposure to ELF/EMF may also raise incidence of spontaneous abortion (11) and cause alterations of electrical brain activity and of the muscular, cardiocirculatory, hormonal and immune systems, of the cutaneous tissue, as well as neurological disturbances (of the attention, memory, visual-motor coordination, and of mental health: depression, and risk of suicide). Furthermore, epidemiological data indicate an increase in risk, in certain**

cases s.s., of neurodegenerative diseases (12): lateral amyotrophic sclerosis (13), Parkinson's disease (14), and Alzheimer's disease (15), in subjects with occupational exposure to ELF/EMF. The increase in risk is found at magnetic field levels comparable with those present in some residential situations (0.2-5.0  $\mu$ T).

Finally, a number of types of tumor, pre-neoplastic effects and synergistic interactions with chemical and physical carcinogens have been observed in rodents irradiated with ELF/EMF in the laboratory, at MF levels corresponding in man – bearing in mind the different conditions of exposure and lifetime - to 0.3  $\mu$ T in residential exposure to power lines (16).

A number of mechanisms of biological action have also been identified that could explain the induction of short- and long-term effects of the ELF/EMF, possibly in association with predisposition through genetic factors: (17, Box 1)

**Box 1. Non-thermal biological effects of EMF supporting the plausibility of a possible carcinogenic action of these radiations.**

- 
- 1) alteration of the synthesis of the hormone melatonin, involved in the deactivation of peroxide radicals, which produce DNA damage triggering carcinogenesis;
  - 2) stimulation of Fenton's reaction, with consequent increase in damage due to free radicals on biological macromolecules;
  - 3) modification of the permeability of the cell membrane and consequent alteration of the flow of biologically important ions, in particular calcium;
  - 4) modification of the brain's electrical activity and of the permeability of the hemato-encephalic membrane, with consequent damage to the cerebral neurons and alteration of the functioning of the cerebral neuroreceptors and neurotransmitters;
  - 5) alteration of the functioning of the immune system;
  - 6) inhibition of apoptosis (programmed cell death);
  - 7) expression of heat shock proteins;
  - 8) genetic and epigenetic effects;
  - 9) synergistic interactions with other carcinogens (ionizing radiation, polycyclic aromatic hydrocarbons, benzene derivatives).
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**3.2 Criticism of the positions held by IARC, ICNIRP, EC and WHO.** The IARC monograph (6) concludes stating that: a) there is limited evidence in man of carcinogenicity of ELF/EMF in reference to childhood leukemia; b) there is insufficient evidence of other forms of cancer in man and, in general, in experimental animals. For these reasons, ELF/EMF are considered “possible carcinogenic agents for man” (Group 2B). In view of the above epidemiological and experimental data - most already available in 2001 - the conclusions of IARC cannot be justified except in the light of the new IARC “trends” (18) described by L. Tomatis, founder and scientific director of IARC (1969-1993), and by J. Huff, editor of IARC monographs (1977-1979)<sup>7</sup>.

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<sup>7</sup> IARC is an International Scientific Organization which operates under the sponsorship of WHO. Tomatis and Huff alert that from 1994 IARC has witnessed a complete overhaul of the criteria for evaluating carcinogenicity, with a wholesale devaluation of the criteria underpinning

The classification of ELF/EMF (Group 2B) determined by the IARC working group in 2001 is still upheld today by WHO/EC/ICNIRP and other national organizations<sup>8</sup>.

**3.3. The innovative position of the Italian civil magistracy.** The limits put forward by the international agencies and even those set by law should not be the only points of reference in the controversy on the possible damage to human health deriving from exposure to ELF/EMF: this was established by Sentence 9893/2000 of the Italian Supreme Court (*Corte di Cassazione*), which established that the regular judge had full power, including for determination of the danger to health on the basis of scientific knowledge acquired at the time of the ruling. This is a principle that has frequently been emphasized in the sentences of various Court cases: Milan 43678/2003; Potenza 195/2003; Modena 1430/2004; Como 1490/2005; Venice 441/2008; Criminal Court (*Cassazione Penale*) 33285/2008. These hearings established that: 1) the constitutional right to health is understood in the broadest sense, including the right to live in an environment that is healthy and that should also be protected preventively, that is, where there is the presence of merely a danger of falling ill or contracting a disease. This protection, to be effective, cannot in fact be subordinate to a state of illness or disease arising; 2) the harm, in the form of risk, should be prevented and compensated for, even if it is not known who will be struck, nor when, but it is instead known that when it does strike it will be too late, in the sense that a harmful event that could have been avoided has instead

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identification of carcinogenic factors: 1) the criteria for evaluating the carcinogenicity of an agent, based on study of the mechanisms of action (biological effects, in particular genotoxic) are no longer applied; 2) the evidence of carcinogenicity deriving from animal experimentation is undervalued; 3) possible confounding factors of the scientific criteria aimed at primary prevention of carcinogens in the workplace or at home are highlighted out of all proportion; 4) consequently, epidemiological data are hardly ever conclusive; 5) there is a higher percentage (from less than 10% in the 70s to over 30% in the 90s) of experts predisposed to favour the industrial interests, who are being invited by IARC onto the working groups. It follows that, according to Tomatis and Huff, the IARC monographs have lost the authority and independence they original had. This criticism can easily be leveled at the ELF/EMF monograph: in fact, IARC working group involved in the preparation of the ELF/EMF monograph (6) included M. Repacholi, President of ICNIRP and coordinator of the WHO's EMF Project, funded by electricity network and mobile cellphone companies; L. Kheifets, employee of Electric Power Research Institute (EPRI), private body which enjoys all USA electricity company research funding; J. Juutilainen, R.D. Saunders and B. Veyret, members of various national committees, but with conflicts of interests; and also representatives of major electricity companies: J. Swanson (National Grid Company, UK); W. H. Bailey (Exponent, USA); V. del Pizzo (CA EMF Program, USA).

<sup>8</sup> A very important example, in view of the authority of the source, is report no. 238 of June 2007 (Environmental Health Criteria 238: Extremely Low Frequency Fields), sponsored by the WHO, ICNIRP and the World Labor Organization. The report, signed by the new head of WHO's EMF Project E. van Deventer, was actually put together in October 2005 by a working group whose members included scientists with conflicts of interests (M. Repacholi, L. Kheifets, A. Ahlbom, C. Johansen, J. Juutilainen, R. Matthes, E. Van Rongen, P. Vecchia). Furthermore, it was prepared, – in clear conflict with WHO and ICNIRP principles, in the presence and with the contribution of “observers” from electricity companies of the US APRI, UK (National Grid Transco), Canada (Hydro-Québec), France (EDF Gaz), Japan (Japan NUS Co.) and Brazil (Electric Energy Research Center). The report notes that there is no justification whatsoever for application of the Precautionary Principle to ELF/EMF: there is a lack of clear evidence of either long-term effects (even childhood leukemias) or acute non-thermal effects. Consequently, a single limit is applied of 100  $\mu$ T to give protection from “clearly documented” effects, i.e. only short-term biological thermal effects!

arisen; 3) observation of the limits set by the regulations in force does not make exposures to ELF/EMF in themselves legal and compatible with the protection of the right to health. Instead, account should be taken of the constitutional relevance of the right to health (Art. 32 of the Constitution) and of the consequent level of protection, necessarily prevailing over freedom of enterprise provided for by Article 41 of the Constitution Article stating that: "Private economic endeavor is free but may not be carried out in conflict with social utility or in any way that compromises safety, freedom or human dignity" and that: "The law determines the programs and appropriate controls in such a way that public and private activity can be directed towards and coordinated for social ends"; 4) the scale of values set out by the Constitution should also include the Precautionary Principle, as provided for by Article 174 of the EU Treaty, which should be considered part of the national regulations; 5) in cases of doubt as to level of risk, the Precautionary Principle requires the adoption of the most conservative arrangement consistent with minimizing risk, where necessary opting for "zero risk"; 6) where a number of epidemiological studies have shown a significant increase in risk, the emissions should be considered dangerous, even though the mechanisms of action are still not known. Here in fact the causality link can only be determined in terms of probability<sup>9</sup>.

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<sup>9</sup> It being beyond the scope of this chapter to give an overview of the workings of the magistracy of other countries, comparison has been limited to the very contrasting positions of the Italian magistracy and that of the USA: reference is made to the paper by Prof. E. Al Mureden ("*I danni da uso del cellulare tra tutela previdenziale e limiti della responsabilità del produttore*" in *Responsabilità Civile e Previdenza*, no. 6: 1392-1423, Giuffrè Ed. 2010). In the USA, it is an absolutely unbroken rule that any manufacturer not observing the norms is responsible, while manufacturer who do observe them is never responsible. For this reason, there can never be compensation for damage arising despite full observance of the norm – including exposure limits set by law. Health protection is assured in the USA through the judgment of administrative agencies, who have been conferred powers to draw up rules and regulations. In fact, the Food and Drugs Administration (FDA) has the role both of assessing risk, costs and benefits associated with the commercialization of use of goods and technologies (risk management), including those using and emitting EMF (risk assessment), and also of drawing up the regulations designed to protect the user's health. The "technical regulations" approved by the FDA at once are the absolute reference point for justifying any sanctions imposed by the FDA itself, and also give legal backing to the decisions whereby the civil judge demands the employer or insurance body to pay compensation commensurate with the level of resulting invalidity and, when appropriate, also punitive damages. However, even considering the problem of compensation, reference must necessarily be made to the prescriptions of the FDA, since otherwise application of the norms regarding civil liability would prove misguided. Concerning atmospheric pollution too, American law for the environment has almost always chosen to grant wide discretionary powers to the Environmental Protection Agency (EPA) for setting pollution safety levels (according to the translation of an article by D.P. Selmi published in "*Rivista Giuridica Ambiente*" 1999: 787-792). The EPA is required to set the national standards of environment quality at levels "appropriate for protecting public health" - the wording here is vague, which in practice means that the EPA has broad discretionary powers in setting air quality control levels. However, a decision of the American Appeal Court has pointed out two areas to clarify: 1) what criteria should EPA adhere to in setting air quality control levels; 2) and (of greater resonance) what are the best ways of monitoring the EPA's discretionary powers. In the case brought by the American Trucking Association Inc. *versus* United States EPA (1999 Westlaw 300618), the Court maintained that the EPA did not base its decisions on any clearly set out principles when considering the principles in terms of criteria used for setting quality levels, and that there should be clear guidelines for monitoring the EPA's powers. According to the Court, a well-founded reasoning must be provided either by the statute drawn up by Congress, or by the EPA itself. Since the statute is set out in general terms ("appropriate for protecting public health"), the Court's view is

#### **4. MOBILE PHONES AND HEAD TUMORS: A REPRESENTATIVE CASE**

The worldwide spread of the use of mobile phones (MPs: analog and digital cellulares, and cordless) has heightened concerns about possible adverse effects, especially head tumors. According to the International Telecommunications Union, the number of cellphone subscriptions has reached 5 billion (mid 2010), with over half of all users thought to be children and young adults. There are no data for cordless users, but a figure of 2 billion is a reasonable assumption. Given these figures, even an established modest increase (20-30%) in tumor risk for MP users would result in significant social and health costs and individual suffering, while higher risks could give rise to a health crisis of dramatic proportions. While most technologies carry risks, these should be assessed accurately and responsibly.

Whether or not there is a relationship between MP use and head tumor risk is still a matter of debate. On the one hand there are, researchers who recognize the validity of positive results – such as those by L. Hardell (19) who has documented a s.s. increase (100%) of head tumors (brain gliomas and acoustic nerve neuromas) in people exposed to MPs for a long overall total time (more than 10 years) - and who are requesting application of the Precautionary Principle, especially for children who face decades of exposure. On the other hand there are researchers who form their own conclusions, largely reassuring, on the basis of the results of the Interphone project, which involved research groups from 13 countries (20). It is therefore vital to understand the weight of the conflict between Hardell's positive results and those from other studies considered reassuring in their failure to find any increased risk of head tumors in MP users. Progress requires a critical analysis of the methodological elements necessary for an impartial evaluation of contradictory results (Box 2).

**BOX 2. Main methodological elements that should be considered to ensure the reliability of epidemiological studies on the relationship between MP use and increased risk of head tumors.**

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- a) the compatibility of latency and/or exposure time since first use of MPs with the progression time of the examined tumors;
  - b) the inclusion among the exposed of all users of MPs, cordless included;

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that the EPA is best positioned to give this reasoning. This decision deserves close examination, because it spotlights an important aspect of environmental law, i.e., how wide does the law allow the discretionary powers of public agencies such as the EPA to be? In fact, American law has for a long time (since 1930) accepted the principle that Congress can authorise the public agencies - through a rather generalised legislation – to take responsibility for specific issues.

The Italian legal system - as clearly seen from the cases noted above – takes the extreme opposite position: once an activity has been classified as “dangerous”, there is a tendency for the absolutory proof to be considered as never obtained, and the employer or body responsible for monitoring of harmful technologies can only try to demonstrate that all suitable means of preventing the harm have been adopted. Instead, the performer of the dangerous activity has to attempt to undermine “upstream” the categorization as dangerous, or else demonstrate that the case in question is coincidental - this is because once a technology is included among those labeled as harmful, the responsibility for it becomes an automatic consequence of demonstration of the harm caused (see also, footnote 12, in the reference to the sentence regarding the damage (tumor) caused by radiation emitted by MPs).

- c) the laterality of the head tumor localization relative to the habitual laterality of MP use;
- d) the percentage of actually exposed subjects, based on the frequency and duration of the MP use;
- e) the number of subjects selected (cases and controls), and the percentage of their participation in the study;
- f) the distribution of the relative risk values (OR) above and under 1, and the probability that such distribution might be casual;
- g) the full and correct selection and citation of data included in the meta-analyses.

The pooled analyses of epidemiological case-control studies by Hardell (19) produced positive results indicating a cause-effect relationship: exposures for or latencies from at least 10 years to MPs increase by up to 100% the risk of tumor on the same side of the head preferred for phone use (ipsilateral tumors) – which is the only side significantly irradiated – with statistical significance for brain gliomas and acoustic neuromas. On the contrary, studies published under the Interphone project produced “negative” results (20) and are characterized by a substantial underestimation of the risk of tumor. The data published a year ago by Interphone (20) included the risk of malignant (gliomas) and benign (meningiomas) brain tumors in people using only cellphones (not cordless), and have been widely publicized as reassuring by the authors as well as by the organizations that promoted and funded the study (IARC and EU 70%, the cellphone companies 30%), by the main agencies responsible for protecting human health, and by more than 100 newspapers which have made headlines around the world. This despite the article (20) being accompanied by a “commentary” (21) with a very telling title: “Call me on my mobile phone...or better not? — a look at the Interphone study results”. This commentary pointed out some major defects of the Interphone protocol and results that would have substantially “diluted” risk estimates. In this context, we consider even more important the editorial by E. Cardis - former coordinator of the Interphone project - and S. Sadetzki. This latter headed the Israeli Interphone team and his own studies - showing large increases in parotid tumor risk in regular and long-time cellphone users (22) – were presented in September 2009 to the US Senate (23). This editorial (24) has a rather eloquent title: " Indications of possible brain-tumour risk in mobile-phone studies: should we be concerned?". Furthermore, the highly risk-assertive response of the two editorial authors was not based on new experimental data, but instead on a critical review of the results of the Interphone final study (20), to which they themselves contributed. It seems to us that such a stance represents a milestone in the quest for truth<sup>10</sup>.

<sup>10</sup> The editorial of Cardis and Sadetzki (24) leaves little doubt about the relevance of their criticisms, which we comment on as follows. Within the 17 Interphone studies: 1) less than 5% of total cases had completed at least 10 years of latency or continued cellphone use, which means that over 95% had a totally inadequate exposure time: since in most of the tumors examined the latency is high (10-30 years), this is a factor giving rise to “dilution” of risk. The percentage of cases or controls exposed for at least 10 years in the Interphone (20) is 0% in four studies, less than 5% in four studies, less than 10% in five studies, not even given in one study; – Hardell documents 18% of cases with exposure to MPs of at least 10 years; 2) the failure to identify the ipsilateral tumors, arising on the side of the head habitually used for calls, mainly in the temporal lobe which is exposed to 97-99% of the radiation emitted during phone use, with consequent further "dilution" of risk due to the detection of tumors on the whole brain mass, for the most part not exposed to radiation: only 2% of total cases of ipsilateral tumors were actually exposed for at least 10 years; – Hardell reports 16% of his total cases with

Additional factors contributing to “dilution” of risk estimates, not reported by Cardis and Sadetzki in their editorial [24], are pointed out in our recent review (25)<sup>11</sup>.

Cardis and Sadetzki did not limit themselves to criticism, but reported that the Interphone data obtained using the essential factors for identifying a carcinogenic effect due to cellphone exposure - significant time use, continuity of use or latency of at least 10 years, and ipsilateral tumor detection – showed a s.s. rise of up to 100% glioma risk in five studies – and the same is observed for acoustic neuromas (two studies) and parotid gland tumours (one study). As they stated: *“The overall balance of the above-mentioned arguments suggests the existence of a possible association”* between cellphone use and increase in brain tumor risk<sup>12</sup>.

ipsilateral tumors, some of which involved exposure for an overall total time or latency of 15 years; 3) the Interphone protocol defines “exposed” subjects as having used a cellphone “at least once a week for at least six months” (which means almost never!). Therefore, even if a risk exists, it is “diluted” because of the dominance, in the sample examined, of subjects exposed too little or not at all: the average daily use of cellphones in subjects considered “exposed” by Interphone is just 2-5 minutes a day, often for less than 5 years. These data obviously are barely significant relative to today’s intensive use of cellphones, especially by those who use them for work purposes; – in Hardell’s studies, MP use is reported to be over 1000 hours for 194 cases, and over 2000 hours for 85 cases, so that the average daily use of MPs ranges from over 16 to just over 32 minutes per day for at least 10 years; 4) in the Interphone studies, participation in the epidemiological study of cases or controls is low: less than 50% in three studies, less than 60% in 5 studies, less than 70% in five studies; – in Hardell’s studies, participation is always very high (85-90%) for both cases and controls; 5) the reduced participation in the study by the non-mobile users initially selected – in particular controls who are not affected by tumors, naturally less interested in the aims of the research than regular users, especially cases affected by tumors – represents a further factor of “dilution” of risk estimates. This “selection bias” is recognized by the Interphone authors themselves, but in their view it does not cause reduction in risk estimated by more than 10%, which is true for the overall Interphone data, but in some studies this bias alone can result in a more significant reduction in risk assessment; more than 15% in two studies, more than 25% in three studies, and even more than 30% in two studies; – in Hardell’s studies the percentage participation is basically equivalent for the exposed and non-exposed cases and controls.

<sup>11</sup> 1) The Interphone protocol considers cordless phone users as not exposed, while it is documented that the radiation emitted by cordless can even exceed the intensity of a cell phone, so much so that Hardell records significant increases in the risk of meningiomas and acoustic nerve neuromas also in people using only cordless; 2) the Interphone study fails to consider other types of malignant and benign head tumor, except gliomas, meningiomas, neuromas and parotid gland tumors; – in Hardell’s studies, increased risks in MP users also involve other types of head tumor, which are considered separately; 3) the risk values of head tumors in three of the Interphone studies even fall off with increased duration of exposure to cellphones and/or latency time; – in Hardell’s studies, the trend for risk as a function of time of MP use is s.s. and the combined use of various types of MP raises the risk of developing head tumors; 4) in the Interphone the combination of these factors leads to strong underestimation of the risk, and acts such that the majority of risk values are below 1, often s.s.: in the 17 Interphone studies, out of 1084 risk values different from 1, 76% are below 1 and only 24% are above 1. The prevalence of OR values below 1 is extremely unusual in most of these studies: 100% in one study, more than 90% in two studies, more than 80% in five studies, more than 70% in three studies, and the probability of this asymmetric distribution of risk values – which seems to indicate a protective effect – being chance is very low in six of these studies, while in another six studies, as in the overall data, is practically zero; – in Hardell’s studies, over 90% of the risk values are above 1, of which 41% are s.s., and the probability of this asymmetric distribution – indicating a carcinogenic effect of MP use – being due to chance is almost zero.

<sup>12</sup> Association known and well documented, in 2007 by the Italian Association of Medical Oncologists, with specific reference to Hardell’s data, emphasized in his monograph “Guidelines for brain tumors” ([www.aiom.it](http://www.aiom.it)), which established “a doubling of the risk of brain gliomas and

There are therefore many bias and flaws in the non-blind Interphone protocol, giving rise to a systematic underestimate of the risk, whereas the blind protocol by Hardell producing positive results is without apparent errors, the results indicating a cause-effect relationship supported by biological plausibility (Box 3).

The discrepancy between the positive data of Hardell and the negative data from Interphone is also highlighted by the authors, who performed a meta-analysis of 24 case-control studies (26). These authors observed an s.s. positive association between MP use and increased head cancer risk in 10 studies using blinding ("high-quality studies", including seven studies by Hardell, just one by Interphone, and two by other groups), whereas a negative association (i.e. an apparent "protective

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acoustic neuromas among long-term (at least 10 years) users of cellular and cordless phones", recommending "caution in the use of mobile phones". Recently, even a judgment (614/2009 of the Appeal Court – Labor Section of Brescia, Italy) recognized for the first time the association between MP use and increased risk of head tumors. The case was a neurinoma of the trigeminal nerve on the left side of the head in a subject having been exposed for more than ten years and more than 15,000 hours on analog and digital cellulars and cordless phones. This subject was involved professionally in customer services of his company employer: he was right-handed and, during MP calls, used his right hand for making notes and the left hand for holding the MPs. As a result, this tumor was ipsilateral as are most of those Hardell identified. This case therefore concerned a personal situation where the experts – including one of us (AGL) – evaluated the pathology as a probable consequence of a causal link, even if weak, to the subject's exposure to MPs. This carried weight in the decision of the Court, which recognized that there was a link of causality, or at least of a contributing cause, in the sense that exposure in the workplace to wireless radiation from MPs contributed to the malignant pathology. And this led in turn to the recognition of and compensation for the suffering of a physical impairment, which in the present case was evaluated at 80%. There are two particularly interesting aspects of this sentence: 1) until 2008, non-ionizing EMF was included in the "tables of professional diseases", and for any employment involving possibility of exposure this covered an indemnity of unlimited duration for appearance of tumors. Certification of tumor and demonstration of there having been exposure to EMF radiation during work would therefore have been sufficient for the *Istituto Nazionale per l'Assistenza sugli Infortuni Lavorativi* (INAIL, national body aiding workplace incident sufferers) - or the labour Tribunal in the case of a legal hearing – to confirm payment of compensation. Through decree of 9.4.08 of the Italian Ministry of Labour and Social Welfare, non-ionizing EMF were removed from the tables of workplace diseases. However, through a deliberation of the Italian Constitutional Court (no. 179 of 18.02.88), welfare care was extended to include pathologies that, while omitted from the tables, were traceable to exposure in the workplace; here though, the worker has responsibility for demonstrating the cause-effect relationship. The person involved in fact has to show with reasonable certainty that the pathology has arisen through workplace exposure, and that there is therefore a high probability that the pathology in question has a workplace origin - *Cassazione Penale* (penal instance) no. 11087 of 15.5.07. The case cited here is the first in which a Labour Court has recognized this causal link for workplace exposure to EMF, despite this being omitted from the tables of workplace illnesses/diseases; 2) the literature gives wide documentation of increased risk of acoustic neuromas in long-term users of MPs (see above), while there is complete absence of cases showing correlation between exposure to MPs and increase in tumors of other cranial nerves, in particular the trigeminal. In this case, recognition of workplace disease is based on the fact, documented by consultants, that the acoustic nerve and the trigeminal nerve both originate in the same well-defined, limited area of the endocranial volume, clearly irradiated during the use of MPs. Instead, attempts have failed in the USA to have manufacturers held responsible in cases where cellphones caused tumors because of a lack of convincing demonstration of the existence of a causal link between the harm caused and the use of the cellphone (see *Motorola versus Ward*, 1996, and for a more updated overview see Capriotti 2002: "Is there a future for all phone litigation?", in [www.lexisnexis.com](http://www.lexisnexis.com) ). In a more recent case (*Murray versus Motorola*, 2009), it is clearly stated that the cell phone conformity to the technical standards for commercialization, set by the FDA in accordance with the Federal Communications Commission, categorically excludes the possibility of recognizing such products as defective, thus refusing to recognize the

effect") was observed in 14 studies not using blinding ("low-quality studies", including 12 by Interphone, two by other groups, anyone by Hardell). Elements in the method used to evaluate the "quality" of the studies were: a) blind or non-blind protocol; b) presence or absence of participation and selection bias of cases and controls; c) relevant or marginal MP exposed) adequate or inadequate latency or overall time of MP use; e) scrutiny of tumor laterality; f) funding by independent sources or by cellphone companies. The authors reach the following conclusion: "We feel the need to mention the funding sources for each research group because it is possible that these may have influenced the respective study designs and results"<sup>13</sup>.

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responsibility of the manufacturer in the case this should be harmful to the user's health (including where the harm is severe).

<sup>13</sup> The Hardell group was supported only by grants from public bodies, whereas the Interphone-related studies received funding through the Quality of Life and Management of Living Resources program of the EU and the International Union Against Cancer; but the latter received funding for the Interphone studies from the Mobile Manufacturers Forum (MMF, see footnote 16) and the Global System for Mobile Communication Association (27). In addition to the above funds, several authors participating in the Interphone study received further funding from their national MP companies (five studies) or other private companies (three studies), such that a substantial portion of the Interphone Funding funding came from the cellphone industry. Furthermore, other negative studies have been supported by the cellphone industry: two studies were funded by the Cellular Industry Telecommunications Association via Wireless Technology Research, while another was funded by TeleDanmark Mobil, Sonofon and the International Epidemiology Institute - a private company operating as a cellphone industry adviser - and one by Motorola. Nevertheless, of the 17 authors of the Interphone studies, ten do not make any declaration about conflict of interests, three state "conflict of interests: none declared" (it is not clear whether this is from the authors or from the editor), while four declare "conflicts of interests: none" (25)!

**BOX 3 : Methodology errors in the Interphone negative studies (20) on tumor risk from MP use, based on non-blind protocol. Reliability of positive Hardell studies on tumor risk from MP use, based on "double-blind" protocol (19).**

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- 1 **Interphone:** inadequate assessment of the "regular use of cell phones" defined as "at least 1 phone call /week, for at least 6 months": 2-5 minutes/day, often for less than 5 years. **Hardell:** MP use is significant: from over 16 to over 32 min/day for at least 10 years.
- 2 **Interphone:** inadequate exposure or latency time in relation to the time required for diagnosing the tumors concerned: less than 5% of cases have latency time of at least 10 years. **Hardell:** 18% of cases were exposed for or from 10-15 years.
- 3 **Interphone:** fails to include cordless users, even though they are exposed. **Hardell** includes them.
- 4 **Interphone:** fails to include people younger than 30, although they are exposed. **Hardell** includes them.
- 5 **Interphone:** fails to include people living in rural areas, although this group has high exposure. **Hardell** includes them.
- 6 **Interphone:** fails to include subjects who had died or were too weak to respond to the interview carried out during post-operative convalescence. **Hardell** includes them.
- 7 **Interphone:** fails to distinguish tumor laterality in relation to laterality of MP use. **Hardell:** tumor laterality is always considered in relation to MP-use laterality.
- 8 **Interphone:** fails to consider other types of malignant and benign head tumor, except of astrocytomas, neuromas and meningiomas. **Hardell:** other types of head tumor are considered separately.
- 9, 10 **Interphone:** participation and selection bias. The participation of the controls is reduced to 60%, at times < 40%, with prevalence of the exposed. **Hardell:** Exposed and non-exposed controls participate in equal proportion and in high percentage (nearly 90%). **There is no selection or participation bias.**
- 11 **Interphone:** delayed interviews: the controls are interviewed at a later stage than the cases (up to > 9 months). Also for this reason, given the rapid spread of MPs, the control group contains more exposed than the case group. **Hardell:** case and control interviews are both conducted with no delay.
- 12 **Interphone:** data collection bias. As it is impossible to collect responses from hospitalized cases that are frail, the information is collected from a relative (up to 40% of cases) with consequent data uncertainty. **Hardell:** the data are always provided by the subject concerned. **There is no collection bias.**
- 13 **Interphone:** attribution bias in laterality of MP use. The patient, interviewed face-to-face when still in a confused state during the post-operative period, may report the most recent laterality of use which, owing to the disturbances brought about by the tumor, may not actually be the side habitually used before the development of the tumor. **Hardell:** the data are double-blind collected through questionnaire sent to the home of the cases on their dismissal from hospital, when they are recovering. **There is no attribution bias.**
- 14 **Interphone:** documentation bias. In the bibliography cited to support the Interphone findings as reassuring, negative studies are widely reported and discussed; instead the positive studies of Hardell group are regularly ignored, under-evaluated, or even selectively chosen. **Hardell:** negative Interphone studies are always cited and criticized, and their significant data are included in the meta-analyses. **There is no documentation bias.**
- 15 **Interphone:** funding bias: the findings from Interphone, which is co-funded by the cellphone Companies, are publicized as fully reassuring - even though these at times include positive data indicative of increased carcinogenic risk, e.g. for only ipsilateral tumors, or only in the subgroup exposed for  $\geq 10$  years, or only in residents in rural areas (one study). **Hardell:** all studies are funded by public bodies. **There is no funding bias.**

## **5. STATISTICAL RELATIONSHIPS BETWEEN POSITIVE OR NEGATIVE RESULTS AND PUBLIC OR PRIVATE FUNDING, IN STUDIES ON EMF EFFECTS**

Notes have already been made of the degree of conflicts of interests commonly found among researchers, scientific consultants and international organizations, and the ensuing consequences this situation has on the spread of distorted information, favoring the interests of the funding industries. According to Tomatis, the method used was “the careful and systematic production of results, both experimental and epidemiological, whose sole purpose is to raise the background noise, increasing confusion and thereby making correct assessment of risk more difficult” (28) and “the best way to halt, or at least delay, a decision of public health issues is .... to inject doubts about the validity of data that are uncomfortably positive” (29)<sup>14</sup>. Conflicts of interests are particularly widespread in research on the effects of EMF. In fact, Hardell (30) reports the following data: 1) in 2001, out of 1386 articles, 16% were funded privately; 2) by 2004 the number of articles funded privately had increased to 33%; 3) in 2004, 25% of articles published in two of the world’s leading biomedical journals were signed by one or more authors with conflicts of interests involvement. According to Hardell, these data are an underestimate owing to the accepted and now widespread custom in many journals not to indicate – or to indicate only partially – the sources of funding for the work carried out. This state of affairs means that information produced by independent research on the environmental and health risks of EMF has almost no influence.

In an interview published in July 2007 by the Association "Liberterre", G. Carlo, author of the book “Cell Phones: Invisible Hazards in the Wireless Age”, stated that: 1) while perfectly aware of the health risks inherent in exposure to EMF, industry does nothing to alter this situation unless there is drastic intervention from governments and national and international agencies responsible for protection of health; 2) the “pollution” of scientific information due to funding given by industry to researchers, agencies and governments themselves has today reached unimaginable proportions: at least 50% of studies on the effects of EMF are funded by sector industries; 3) many scientists funded by these industries have stated that the results of their research, where unfavorable to the interests of the commissioner of the work, have been modified by this latter or deleted in full; 4) the likelihood of finding a no-effect result is six times higher in studies funded by the industry companies than in those funded by public bodies; 5) industry also controls the dissemination of scientific information about the effects of EMF, so also influencing the way the public perceives the dangers connected with the technologies in question.

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<sup>14</sup> This is precisely the picture found today as regards assessment of risks correlated to the use of MPs, and more generally to residential and occupational exposure to EMF, given that the “confusion” arising from the production of experimental and epidemiological data and their interpretation (open to scientific discussion) is fueled by the support given to this interpretation by the extraordinary web of some authors’ involvement in the agencies working in these areas, and who receive financial support from the mobile telephony companies. In just one example, A. Ahlbom, figure of leading authority of the Interphone “team” – set up and monitored by IARC and in the EU – plays major roles in ICNIRP, SCENIHR/EC, the Swedish Radiation Protection Agency, and in the WHO’s EMF Project.

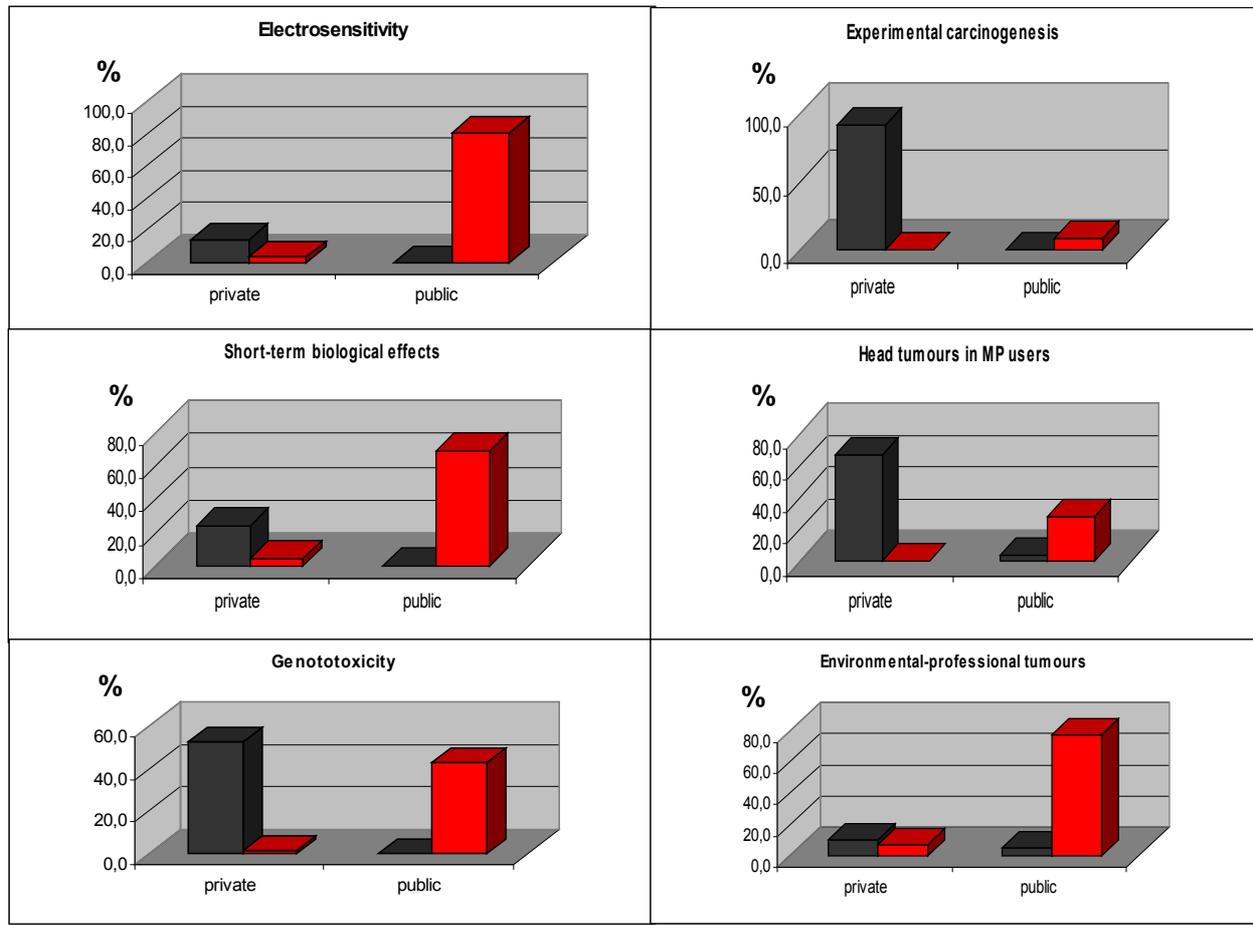
One significant item of data has been published by Huss (31), who selected particularly important articles about the biological and health effects of MPs. If 1 is the average probability of s.s. results in work funded by public bodies ( $p < 0.05$ ), the probability of at least one positive result in those funded by the cellphone companies is almost zero ( $OR = 0.11$ ;  $IC_{95\%} = 0.02-0.78$ ), that is just one positive result out of 10. The probability for studies with mixed funding sources falls in an intermediate position ( $OR = 0.56$ ;  $95\% CI = 0.07-3.80$ ), and even studies not citing any source of funding – increasingly common as a result of the permissive approach of too many editors – are affected by some influencing ( $OR = 0.76$ ;  $95\% CI = 0.12-4.70$ ). Huss concludes by recommending that "the interpretation of the results from existing and future studies of the health effects of RF radiation should take sponsorship into account".

A critical review of studies on the biological and health effects of RF/EMF carried out in December 2009 by one of us (AGL) found that out of 1056 articles published in peer-reviewed journals, 44% reported negative results (no effect), with 93% being funded by private bodies or did not cite any funding source. Instead, 56% of the articles reviewed reported some type of biological effect or harm to the health, with 95% funded by public bodies. As seen in Fig. 1, there is massive intervention by the private funders in expensive testing and testing that is long and difficult to perform, such as experimental carcinogenesis on animals, in genotoxicity testing which are predictive of possible carcinogenesis effect, and in epidemiological studies on head tumors in MP users, which is one of the today's most controversial debate involving a possible relevant risk for human health. The intervention of private funders is instead lower in less costly tests, for example short-term testing on biological effects in *in vitro* systems and in animals; epidemiological studies on tumors in small numbers of occupationally or residentially exposed subjects, and testing on electrosensitivity, which tends to use simple and quick tests on volunteers or statistical sampling on populations of limited size. Even so, there is a constant vast prevalence of negative results in studies funded by private bodies, and of positive results in those funded by public bodies, just as there is a constant almost zero probability that this difference be due to chance (Fisher test: P-value < 0.0001-0.0004).

## **6. EPIDEMIOLOGICAL STUDIES AIMED AT DEFENDING INDUSTRIAL INTERESTS: THE CASE OF EMF**

**6.1. Funding for EU programs on EMF effects.** The EU programs on the effects of EMF (besides Interphone these include Guard, CEMFEC, RAMP 2001, Perform A, EMF-NET, Reflex, etc.), as the EU itself recognizes (see "Health and Electromagnetic Fields", page 6: "Support from Industry", 2005), are all co-funded by the mobile telephony industries. In fact, as the document explains: "With strong public resistance to the siting of mobile antennae masts, the mobile telecommunications industry is naturally very concerned. The roll-out of new mobile technologies has been delayed and the wider take-up of beneficial new mobile services is slower than expected. The industry is well aware of the problems of risk communication and public perceptions and therefore contributes funds to research into the health effects of RF-EMF that is guided by the research priorities of the WHO's international

**Fig. 1. Relative percentage of results, negative (in black) and positive (in red), from all studies on health effects of RF/EMF of the individual topics, relative to the source of funding (public or private).**



**EMF Project's research priorities. Industry funding contributions to national and EU research projects is provided in such a way as to ensure complete scientific independence. Worldwide, industry funding for EMF health effects is comparable to public funding!**

**6.2. The quality of reassuring opinions on health risks due to EMF. All the major national and international agencies and commissions are compromised by conflicts of interests and as a result make reference only to studies with negative results, that is, that are reassuring, so confirming the complete inability of mobile telephony radiation to produced head tumors, disregarding, dismissing or even manipulating the results of Hardell's work and even those – despite their indication of increased cancer risk – reported in some of the same Interphone studies (see section 3)<sup>15</sup>.**

<sup>15</sup> This is taken from the UK's National Radiation Protection Board: vol. 15, no. 5: "Mobile Phones and Health", 2004; and W65: "A Summary of Recent Reports on Mobile Phones and Health: 2000-2004"); the ICNIRP (Ahlbom et al.: Environ. Med. 2004; 112:1741-54; Epidemiol. 2009; 20: 639-52); the EC (SCENIHR: "Possible Effects of Electromagnetic Fields on Human Health"; Final Resolution: 2007); the Swedish Radiation Protection Authority 2006: "Recent Research on EMF and Health Risks", [www.ssi.se](http://www.ssi.se)); the Health Council of the Netherlands ("No Indications for Health Effects of UMTS and DECT" 2007: [www.healthcouncil.nl](http://www.healthcouncil.nl)); Italy's Upper Health Institute (with the reports of S. Lagorio, P. Vecchia and

For the mobile telephony companies, a major role is played by the Mobile Manufacturers Forum (MMF), which co-funds the Interphone Project and WHO's EMF Project, as well as other international and national EMF programs; MMF is an umbrella body for the 12 main mobile telephony industries (Alcatel, Ericsson, Mitsubishi Electric, Motorola, Nokia, Panasonic, Philips, Sagem, Samsung, Siemens, Sony Ericsson and TCL & Alcatel Mobile Phones). Working alongside MMF in terms of financial support provided to the Interphone Project and other EU projects is the GSM Association, another strong lobbyist of the mobile telephony industries. And then linked to these two is the "Wi-Fi Alliance", which brings together the many industries involved in the uptake of new technologies and wireless services: there are 309 listed on the web site [www.wi-fi.org/our\\_members.php](http://www.wi-fi.org/our_members.php)!<sup>16</sup>

A. Polichetti at conferences organized by the "Consorzio Elettra 2000" and in the document on the "Progetto Camelet", promoted and funded by the Italian Health Ministry). Other national agencies and commissions have been found to be compromised by conflicts of interests which have influenced assessment of the health risks resulting from exposure to EMF: 1) the Zmirou Commission, set up in 2001 by the French General Directorate for Health: in 2005, following the resignation of Prof. Zmirou (who, along with the other members, declared himself free from conflict of interests), successor Prof. Paillotin declared to the senate that the conclusions of the commission (mobile telephony was harmless) should be considered invalid. In 2006, inquiries of the French Social Affairs and Environment General Inspectorate revealed "inadequacies, irregularities and links between some members of the commission and the mobile telephony operators"; 2) the Royal Society of Canada produced a document held secret for a long time ("Report of the Panel Monitoring Ontario Hydro's Electromagnetic Fields Risk Assessment Program. A Panel Report prepared at the request of the Royal Society of Canada for Ontario Hydro"): this reveals that the reassuring views about EMF emissions are compromised by the interests of private companies involved in the development and management of the technologies concerned (Hydro-Quebec and Gradient Corporation); 3) furthermore, there are conflicts of interests compromising WHO and ICNIRP – these are extremely serious, resulting in targeted choices and falsely reassuring data on the effects of EMF on human health. In fact, at least 50% of the funds for the WHO's EMF Project – which up to mid-2006 cost over US\$ 250 mn, come from electricity companies and mobile telephony operators: some of these funds (US\$ 150,000 for mobile telephony alone) are collected by the MMF and sent to the Royal Adelaide Hospital in Australia (where Repacholi is based) and then transferred to the WHO. Since 2006 Repacholi has no longer led the WHO's EMF Project, but has remained as Emeritus President of the ICNIRP, and was taken on as a consultant by several industries including two American electricity companies (Connecticut Light and Powers Co. and United Illuminating Co.), to bolster support against the Connecticut Department of Public Health's initiative to lower the ELF/EMF exposure limits. These actions all conflict with the founding principles of the two organizations: the WHO in fact "does not allow industries to participate in either setting the standards or in assessment of risks to human health". According to the WHO "the working groups established to set the standards may not contain industry representatives. The WHO working groups may not contain anyone who has or is subject to any influence that is favorable to a given industry, in particular where assessing the effects on human health of the products of this same industry is concerned". According to ICNIRP "all members of the commission are independent experts" and "they are often reminded that they must declare any interests that could compromise the principles of the statute of ICNIRP, as an independent consultation group. ICNIRP does not accept any funding from industry". The reader is also referred to the footnote 8 concerning report no. 238/2007 sponsored by the WHO and ICNIRP. Even though Repacholi is no longer ICNIRP President or WHO's EMF Project leader, the workings of these two organizations has not changed: his successors, P. Vecchia (ICNIRP) and E. van Deventer (WHO's EMF Project) continue their links with the producers and operators of electricity and wireless technologies, in particular mobile telephony.

<sup>16</sup> The aims of the MMF are set out on the web site ([www.mmfai.org](http://www.mmfai.org)): "The MMF is an international association of telecommunications equipment manufacturers with an interest in mobile or wireless communications. Established in 1998, the association's mission is to facilitate joint funding of key research projects and cooperation on standards, regulatory issues and communications

**6.3. Even some international science journals are involved in conflicts of interests.** A number of scientific journals are compromised by conflicts of interests leading to manipulation of data on EMF effects: for example, Suppl. no. 6, 2003 of "Bioelectromagnetics", one of the leading journals in the sector, was commissioned by the "Radiofrequency Committee" of the Institute of Electrical and Electronic Engineers (IEEE) to justify maintenance of the exposure limits set by ICNIRP. The supplement contains a full seven monographs, all funded by the USA air force and navy, and written by their employees, who maintain that RF is harmless. The monographs cover all possible effects (mutagenesis, teratogenesis, *in vitro* transformation, carcinogenesis, effects on the nervous, endocrine, immunological systems, etc.). Radiation Research (RR), another major journal in the field, published 21 of articles between 1997 and 2006 on the genotoxic effects of RF: 17 of these (81%) described negative results, and all were funded by the mobile telephony operators (Motorola: 10 articles) or the USA air force (7 articles). In 1991 J. Moulder became editor of RR, and was promoted to "Senior Editor" in 2000: all the while he acted as consultant to the electricity and mobile telephony industries (Electric Power Research Institute and Federation of the Electronics Industry, respectively), despite at the same time being a member of the UK's Independent Expert Group on Mobile Phones. In 2001 Vijayalaxmi joined RR's editorial committee, funded by the USA air force and by Motorola, for whom he published seven articles in RR, reporting negative results for the genotoxicity of RF.

These actions allow the international scientific agencies to postpone indefinitely any review of their opinions on the presumed harmlessness of EMF. Every 3-4 years, through one of the scientific journals funded by the operators of the technologies concerned, researchers employed or funded by these private companies are given the task of reviewing the effects of EMF. Through careful

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concerning the safety of wireless technology, accessibility and environmental issues. The MMF... is currently active in more than 30 countries, as well as supporting an extensive international research program. The MMF's goal in research is to promote the highest quality independent research that furnishes relevant data for the development of sound public policy. MMF funds research addressing important scientific questions. To achieve this, the MMF has responded to the research recommendations of the WHO's EMF Project and has coordinated its global activities to correspond with these recommendations. Only by enhancing the existing scientific database relating to RF/EMF will it be possible to perform an independent health risk assessment recognized by the scientific community as well as by government and statutory bodies... The MMF coordinates its inputs and contributes relevant expertise within standards-setting processes. The MMF commissions quality research in support of standards. The MMF's regulatory activities are focused on developing and presenting the views of the mobile industry to regulatory agencies and authorities in a globally coordinated manner. The MMF also responds to requests for information, or assistance, by national and international bodies in relation to the safety of wireless technology, accessibility and environmental issues.... The MMF supports national trade associations by providing a source of information that is based on the pooled resources and networks of our member companies". Members of the MMF include many prestigious bodies and agencies: MMF has links with some of the major international agencies overseeing the protection of health from the effects of EMF (WHO, EU, IARC, International Union Against Cancer, [Health Council of the Netherlands](#), [Swedish Radiation Protection Authority](#), [Norwegian Radiation Protection Authority](#), [UK Health Protection Agency](#), UK Independent Expert Group on Mobile Phones). This pool of mobile telephony industries distributes a series of information leaflets to disseminate serious and targeted misinformation, supporting an absence of risk from use of MPs, the pointlessness of taking precautionary measures even for babies, the inappropriateness of modifying the exposure limits set by ICNIRP, and the need to reassure public opinion.

choice of negative studies and particular interpretation of some of the positive work, a fully reassuring picture is produced. The following year the international agencies called on a group of scientists apparently above suspicion (Ahlbom, Feychting, Repacholi, Kheifets, van Deventer, Vecchia, etc.) to obtain – using the reviews produced as described – the support necessary to confirm their reassuring conclusions.

**6.4. Methods used to confound epidemiological results and compromise their consequences.** The most common bias identified are: 1) inadequate design of the epidemiological study; 2) lack of a standardized protocol; 3) incorrect reference population: wrong selection and combination and dilution of both cases and controls, e.g. inclusion of cases among the controls; 4) failure to choose the subjects most exposed and most sensitive; 5) a priori decision to study only a few and rare selected diseases, e.g. a few rare risk factors; 6) over-short follow-up for tumors with long-term latencies; 7) only high risks ( $OR > 2$ ) are taken into account, despite the relevance of even lower risks when exposure concerns high number of subjects; 8) undervaluation of the synergistic role of multiple risk factors (simply because law limits are respected); 9) the epidemiological study is considered only from a simple statistical point of view; 10) experimental data supporting the plausibility of harmful biological effects are systematically ignored; 11) flawed multicenter results are given too much weight overlooking the much more significant results produced by just one research center; 12) constant reference is made to unreliable results in order to bolster the interests of private corporations; 13) even when funding from industry is actually reported, conflicts of interests are often not declared; 14) Precautionary and Prevention Principles are both ignored; 15) there is preference to protect the economic status quo rather than public health.

The following consequences arise: 1) only reassuring results communicated; 2) expectation of absolute certainty, even though the risk has already been pointed out; 3) underestimation or even denial of the true risk to health; 4) Precautionary Principle set aside; 5) indefinite postponement of actions of primary prevention; 6) possible suggestion of initiatives solely of voluntary protection (prudent avoidance); 7) influencing of the media and bodies responsible for public health protection; 8) maintenance of obsolete standards and exposure limits and failure to respect the regular reviews required by law; 9) incentives for new forms of exposures; 10) harm to public health, damage to society, the economy, and the credibility of the public institutions concerned.

## **7. RECENT PRECAUTIONARY POSITIONS ON HEALTH RISKS OF EMF EXPOSURES**

Alongside the strongly cautionary stance regarding the risks due to EMF exposure put forward by D. Gee, "project manager of the emerging programs" of the EEA (set out in his chapter in BioInitiative Report on the applications of the Precautionary Principle (see footnotes 2 and 5), an appeal has been made in September 2007 and reiterated in January 2008 by the EEA's Executive Director, J. McGlade, calling for EU governments to lower the EMF exposure limits, especially for wifi emission, mobile telephony and their radio-base stations. In McGlade's words "There are many examples of the failure to use the Precautionary Principle in the past, which have resulted in serious and often irreversible damage to health and environments. Appropriate, precautionary and proportionate actions taken now to avoid plausible and potentially serious threats to health from EMF are likely to be seen as prudent and wise from future perspectives. We must remember that precaution is one of the principles of EU environmental policy". Mc Glade is convinced that: "Over the last two years the epidemiological evidence of possible cancer risk amongst the 10 year plus mobile phone user group, has got stronger. It is now also supported by preliminary scientific reports on the damaging effect to cells of RF and ELF EMF exposures. This is a cause for concern, given the widespread and generally rising exposure of the public to RF from mobile phone technology... For example, the French part of the WHO coordinated International Interphone study reported that the risk of head tumours is particularly evident in those mobile phone users who have had RF exposures at and above 460 hours per year for over 15 years. This evidence is supported by several other epidemiological studies carried out in Sweden, UK, Germany, and Israel, all of which find some evidence of increased risks of head tumours in the 10 year plus exposure groups". Furthermore, she underlines that: "The evidence, though necessarily limited at this point in time, is sufficient for health authorities to consider advising the reduction of RF exposures, where feasible. I note that such advice was issued by the German Federal Office for Radiation Protection (July 2007), and the French Ministry of Health (January 2008). It would also be prudent to reconsider the adequacy of the ICNIRP guidelines on exposure limits of 1998 to protect public health, especially of vulnerable groups".

Even stronger positions supporting the need for a cautionary approach to EMF exposure and more critical of the failure of the ICNIRP, WHO and EC to act are set out in two important documents, again from the EEA: one article by D. Gee (28), and one report by the EEA ("Radiofrequency EMF: EEA Commentary on the Evaluation of the Evidence") from 2008, ([http://report.eea.europa.eu/environment\\_issue\\_report](http://report.eea.europa.eu/environment_issue_report)). These two documents re-examine the history of the errors made in science and by public health in tackling the problems arising in the past by 15 chemical and physical agents found to be harmful to the human health, and underline what these "past lessons" can teach in terms of prevention of risks from EMF, in particular RF (mobile telephony). Furthermore, they also provide vital keys for a proper understanding of the status of knowledge and criteria for assessing the risks to human health from EMF exposure, and for drawing up the consequent, pressing cautionary measures.

On 19.12.2008, the Commission on the Environment, Public Health and Food Safety of the EP announced ([www.next-up.org](http://www.next-up.org)) a "Preliminary Report on Preoccupations Concerning the Effects on Human Health of Electromagnetic Fields". Among other statements, the report: 1) "reiterates its demand to the Council to update its recommendation 1999/519/CE in favor of more stringent exposure limits for all devices that emit electromagnetic radiation in the frequencies between 0.1 MHz and 300 GHz, taking into account the best available technology on the market"; 2) "asks the Commission to find a way to accelerate the enactment of the directive 2004/40/CE and thus to ensure that workers are protected effectively from EMFs"; 3) "draws attention to the appeal for prudence made by the coordinator of the Interphone study, E. Cardis, who, on the basis of current knowledge, recommends that children should not make unreasonable use of a mobile phone and should preferably use a landline phone"; 4) "suggests also to the Commission, prompted by concern for political and budgetary efficiency, a re-routing of the Community funding devoted to the study of EMFs towards a far-reaching campaign to educate young Europeans in the best ways to use a mobile phone, such as using a "hands-free" kit, making only short calls and using a phone in the areas where the reception is good"; 5) "proposes an addition to the mandate of the European group for Ethics in Science and New Technologies: the task of evaluating scientific integrity in order to help the Commission forestall possible situations of risk, conflicts of interests or even the frauds which tend to arise in a context of heightened competition among researchers"<sup>17</sup>; 6) "condemns certain marketing campaigns by the phone operators, which are particularly strident in the year-end holiday period, such as the sale of mobile phones designed exclusively for children, or the "free minutes" deals aimed at adolescents"; 7) "proposes that the Union includes in its policy regarding the quality of indoor air the study of wireless devices used in the home, such as wi-fi for internet access and cordless phones, which have multiplied these last few years in public places and in homes, exposing people to continuous microwave emission"; 8) "calls on the Council and the Commission, in coordination with member States and the Committee for the Regions, to work towards putting in place a single standard in order to minimize the exposure of those living nearby if there is an extension to the network of high-voltage power lines"; 9) "is very struck by the fact that the insurance companies tend to exclude cover for risks linked with EM fields from their policies of public liability, which means evidently that European insurers are already acting on the principle of precaution"<sup>18</sup>; 10) "charges the President to

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<sup>17</sup> This recommendation sits well with the scientific committees that have overseen the Interphone project (see Section 3) and all the other programs on EMF launched by the EU and co-funded by the mobile telephony companies (see Section 5.1).

<sup>18</sup> It has been known since 2004 that no insurance company in the world is prepared to insure businesses that manufacture cell phones since they refuse to take on the risk that a user or his heirs sue for damages (see "La Nazione" of 29.01.04, which reproduces a news item published on the front page of the "Suddeutsche Zeitung", one of Germany's most authoritative newspapers). Instead, it is little known that, from 2010, even cell phone manufacturers have begun to include warnings in their accompanying instructions about possible risks to health that these devices could cause. Consider, for instance, the easily-overlooked few lines of legalese found in the safety manual for Apple's iPhone4: "When using iPhone near your body for voice calls or for wireless data transmission over a cellular network, keep iPhone at least 15 mm away from the body, and only use carrying cases, belt clips, or holders that do not have metal parts and that maintain at least 15 mm separation between iPhone and the body". Similar warnings against carrying cell- and smartphones

transmit the present resolution to the Council, to the Commission, to the governments and parliaments of member States, to the Committee for the Regions and to the WHO". The Commission also states that: "This is the approach chosen by the EEA which in September 2007 courageously advised the public authorities of the 27 member States to take measures to provide better protection for the public, measures that are appropriate and in proportion in order to avoid serious dangers in the future. This represents a significant move forward on this issue, a call for action that contrasts with the status quo favoured by the WHO. In fact the WHO seems to want to play for time, offering us an appointment in 2015 for a full estimate of the impact of electromagnetic radiation of human beings" (see Section 2.2 and 5.2)!

On 4 September 2009, the EP approved in plenary session and with wide majority the text proposed by the Commission noted above ([www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P6-TA-2009-0216&language=IT&ring=A6-2009-0089](http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P6-TA-2009-0216&language=IT&ring=A6-2009-0089)), and at the same time issued a press release that, bearing the logos of the then-imminent European elections ([www.elezioni2009.eu-1/3](http://www.elezioni2009.eu-1/3)) assumed the sense of a real and proper program for the future parliamentary mandate.

## **8. HOW TO PROMOTE PROTECTION AGAINST THE HEALTH EFFECTS OF EXPOSURE TO EMF**

In view of the considerable volume of experimental data demonstrating the biological and health effects of EMF, plus possible mechanisms of action, the position held today by the WHO, EC, ICNIRP, IARC and other major national and international agencies appears unsustainable and without justification – this stance draws from guidelines drawn up at the end of the 90s and is based on theoretical assumptions from over 50 year ago. In fact, for defining the exposure limits, these guidelines are based on: a) health effects alone, thus ignoring the biological data that underpin them and help explain the mechanisms by which they arise; b) only effects that have been unequivocally demonstrated and accepted by the whole scientific community, quite overlooking the Precautionary Principle; c) thermal effects alone, while non-thermal effects, and in particular effects at low intensity are now well documented; d) short-term effects alone, disregarding long-term effect data found in the literature, in particular genetic and carcinogenic effects.

This position – also shared by the main bodies concerned with protection of human health, is *a priori* rigid, refutes historical evidence, declines scientific challenge, and appears to be influenced not by prudence but by conservation of clearly identifiable financial interests. Data in the scientific literature in fact clearly justify an urgent revision of national laws on EM pollution, in particular in terms of the principle of minimization through the preventative planning and programming

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in a tight pocket close to the body are found throughout the industry. The safety manual for Research in Motion's Blackberry 9000 phone tells users that: "they may violate Federal Communications Commission guidelines for radio-frequency energy exposure by carrying the phone outside a holster and within 2.5 cm of their body". In addition, the safety manual of the Motorola W180 phone tells users to "always keep the active device 2.54 cm (one full inch) away from their body, if not using a company-approved clip, holder, holster, case or body harness". Clearly cell phone manufacturers too apply the Precautionary Principle in order to cover themselves legally, since they are aware that long-term use exceeding the standards could lead to serious adverse effects.

by the Regions and Municipalities as regards development of EMF-emitting installations, along with information campaigns and participation of the citizen.

Quantifying the long-term risks is difficult for residential exposure to ELF/EMF because this requires conclusive data on the body of the population exposed and on the values of the magnetic fields present. As regards mobile telephony, our examination of the literature data (25) leads us to conclude that even today the risk of head tumors resulting from MP use is very high. Lloyd-Morgan [33], while underestimating by 50% the number of cell users, without considering the risk for cordless users and assuming a minimum latency time of 30 years, calculates "there would be about 1,900 cell-phone-induced brain tumors out of about 50,000 brain tumors diagnosed in 2004, increasing to about 380,000 cell-phone-induced brain tumors within 2019 in the USA alone", which would require "an increase in health costs of an annual US\$ 9.5 bn and the need for a 7-fold increase in number of neurosurgeons". An estimate of the incidence of head tumors must begin with the correct number of cell-phone users (5 billion subscriptions worldwide at mid 2010), should also consider the risk to cordless users, and assume at least a doubling of the incidence of head tumors and of acoustic neuromas as documented by Hardell already after a latency of at least 10-15 years, that gives about 750,000 new cases worldwide even today.

As if this were not enough, a number of factors raise our concern still further: the latency of head tumor induced by MPs can exceed 30 years; risk is higher in those starting MP use when young and who have not yet accumulated 10 years of latency; there is a continued rise in MP use by youngsters, attracted to new facilities from the MP companies (photography, listening to music, videophony, internet); the data by Hardell on the increase in other types of malign and benign head tumor – besides brain gliomas, astrocytomas, and acoustic neuromas – are for the main part today only indicative. Therefore, there is no doubt that today we are dealing with just the tip of an iceberg, and will have to wait one or two decades before its real dimensions come to light. But it is clear that a significant increase in tumor risk is already established, so that the use of MPs could lead to a health crisis of dramatic proportion (34).

While recognizing that mobile telephony is an extraordinary technology of inestimable value, responsible science must raise awareness of the risks involved.

As also expressed by the EEA and the EP, we thus conclude that there is sufficient epidemiological evidence to warrant application of the Precautionary Principle aimed at:

- setting exposure limits that are precautionary;
- limiting the spread of wireless technology in schools and highly frequented places (libraries, offices, hospital wards);
- providing accurate information about the risks from exposure to MPs, with low-cost voluntary options ("prudent avoidance") based on caution in the use of MPs and other devices emitting MF. A 10-point list of simple personal actions designed to substantially reduce to cell-phone radiation was produced by the Viennese Medical Officers in 2006, adopted in the same year by the French Agency on Radiofrequencies ([www.sante.radiofrequences.org](http://www.sante.radiofrequences.org)), by several international scientific committees (see footnote 5 and ref. 30), and through a document signed by of 20 scientists ([www.devradavis.com](http://www.devradavis.com), [www.truth-out.org/article/twenty-appeal-cell-phone](http://www.truth-out.org/article/twenty-appeal-cell-phone));

- awareness-raising in schools through a campaign on the use of the various wireless transmission technologies;
- discouraging the use of MPs by minors under 14 years;
- epidemiological monitoring of the possible harmful effects produced by residential and occupational EMF exposures.

Given the results and considerations set out in Section 3, it is small wonder that a number of scientists have maintained that "the long-term use of cellphones was leading to brain tumors and was more dangerous to health than smoking cigarettes" (35), and that "MPs could kill far more people than smoking or asbestos" (the reader is referred to Khurana – an Australian neurosurgeon who collaborated with Hardell in the meta-analyses showing increased risk of head tumors in MP users – interviewed by G. Lean for "The Independent", 30.03.08).

In conclusion, it is perfectly clear that an *ex-ante* evaluation of the overall impacts of today's technological innovations is not only compatible with the Precautionary Principle, but actually necessary, as also borne out in some of the Italian magistracy's statements (see Section 2.3) and the recommendations of the EP and of the EEA. This evaluation is particularly vital in the case of exposure to EMF, given the state of advancement of scientific knowledge about their possible/probably harmful effects on the human health. In fact, the Precautionary Principle was designed to justify actions to protect the public and the environment even in the absence of any significant knowledge, so it could be used to justify exposure reductions to EMF despite the amount of – seemingly but almost ever *ad hoc* produced – conflicting evidence of risks.

Should any doubt still remain, it is worth recalling the consequences of the four main scenarios facing us with EMF, especially with RF from mobile phones, underlined by D. Gee (32): "The first is similar to the case studies where much avoidable harm was not prevented. The second is where precautionary actions to reduce MF exposure prevent much potential harm, whilst stimulating more sustainable innovation in the production and use of MP technologies and energy systems. The third is where such precautionary actions to reduce exposures are taken but turn out to have been unnecessary, needlessly costly, and worrisome. The fourth is that no action is taken to reduce exposure and no convincing harm emerges from EMF exposure. We do not know which scenario will unfold, but we do know that a choice over current and future EMF exposures must be made now, if the costs of possibly being wrong are to be minimized. The choice is ours. Shakespeare might have described our dilemma thus: to know or not to know, to act or not to act?"

The tragedy is that the unfolding story of EMF looks set to become another case of history repeating itself – following in the tracks of ionizing radiation, asbestos, tobacco smoke, and many other now demonstrated human carcinogens where evidence of harm was officially recognized only a score or even more years after the initial warnings. In view of the evidence we already have, this time we can act early, rather than giving cause for future generations once again to regret our inaction – it is our duty and responsibility as scientists, in particular to our offspring!

## **9. CONCLUSIONS**

Disguising or playing down the evidence of harm to health is quite simple to do, but in turn can often be discovered with relative ease. To do so requires use of a few elements that can be found almost systematically in the formal studies of many corporations and government agencies. Studies often show an exposed population to be at lower incidence and/or mortality risk for all diseases than the control population (at least for the very few times the results are actually examined). But how is this reassuring although paradoxical conclusion possible? Authors usually try to argue that there has been no exposure at all, while the “*healthy worker effect*”<sup>19</sup> is unintentionally produced. Once the ways and means underlying the biases in scientific studies on public health have been identified, attempts can also be made to discover whether these limitations and errors are structurally inevitable, accidental or intentional. It is possible, however, that there is a *lucrative approach* in certain research areas, for example industrial chemicals, asbestos, vinyl chloride, beryllium, alcohol, cigarette tobacco smoke, diagnostics, some pharmaceuticals, and as we see here, electromagnetic fields. A recent communication (36) laid the groundwork for an initial, systematic identification of the criteria needed for a fast, transparent and shared assessment of voluntary counterfeit through the integrated evaluation of three elements: *quantity and direction of errors (or bias)*, and *size of the incorrect estimations present in each epidemiological study*. We believe that evaluating these three elements may help clarify many aspects: the deliberate manipulation and deviation of public health scientific studies in favour of economic and career interests, avoidance of the undesirable “a priori” mistrust of all epidemiological research, production of sound, evidence-based opinion, awareness of intrinsic methodological difficulties, and appreciation of the vital contribution epidemiology makes to a healthy society. In conclusion, today we have evidence that the image of scientific/technical innovations are being enhanced, such that these appear to actually improve human health, and that this inevitable covering up of the true picture can have serious consequences. Indeed, in many countries over the past two decades (data for Italy are available only up to 2008) the reported trend of improvement in healthy life expectancy - for many years showing an increased number of disease-free years of life (over six months) - came to an abrupt halt and reversed (37). Can we postulate [o “put forward”] other causes of the situation described in this chapter apart from the *business bias*?

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<sup>19</sup>The HWE is regularly produced in cohort studies when workers are wrongly compared to unselected general population instead of a proper control group (non-exposed and healthy selected workers). Consequently, the worker population exhibits [overall death \(or morbidity\) rates](#) lower than those of the [general population](#) due to the fact that the severely ill and disabled are ordinarily not included from [employment](#). General population is not selected at all, frequently sick and often exposed to other risk factors.

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