Radio Frequency Electro Magnetic Fields Radiations (RF-EMF) and Cancer

What do we know and why should we be especially worried about children?

(with a discussion of the IARC classification of carcinogenicity to humans)

Annie J. Sasco, MD, MPH, SM, DrPH, *HDR*

Epidemiology for Cancer Prevention
Bordeaux University, France
Retired – Volontary Worker

Past IARC-WHO Unit Chief
Former *Inserm* (French NIH) Director of Research

The opinions expressed in this talk are solely those of the speaker (AJS) and should not be considered as official positions of the *Inserm*, the Bordeaux University or the IARC-WHO

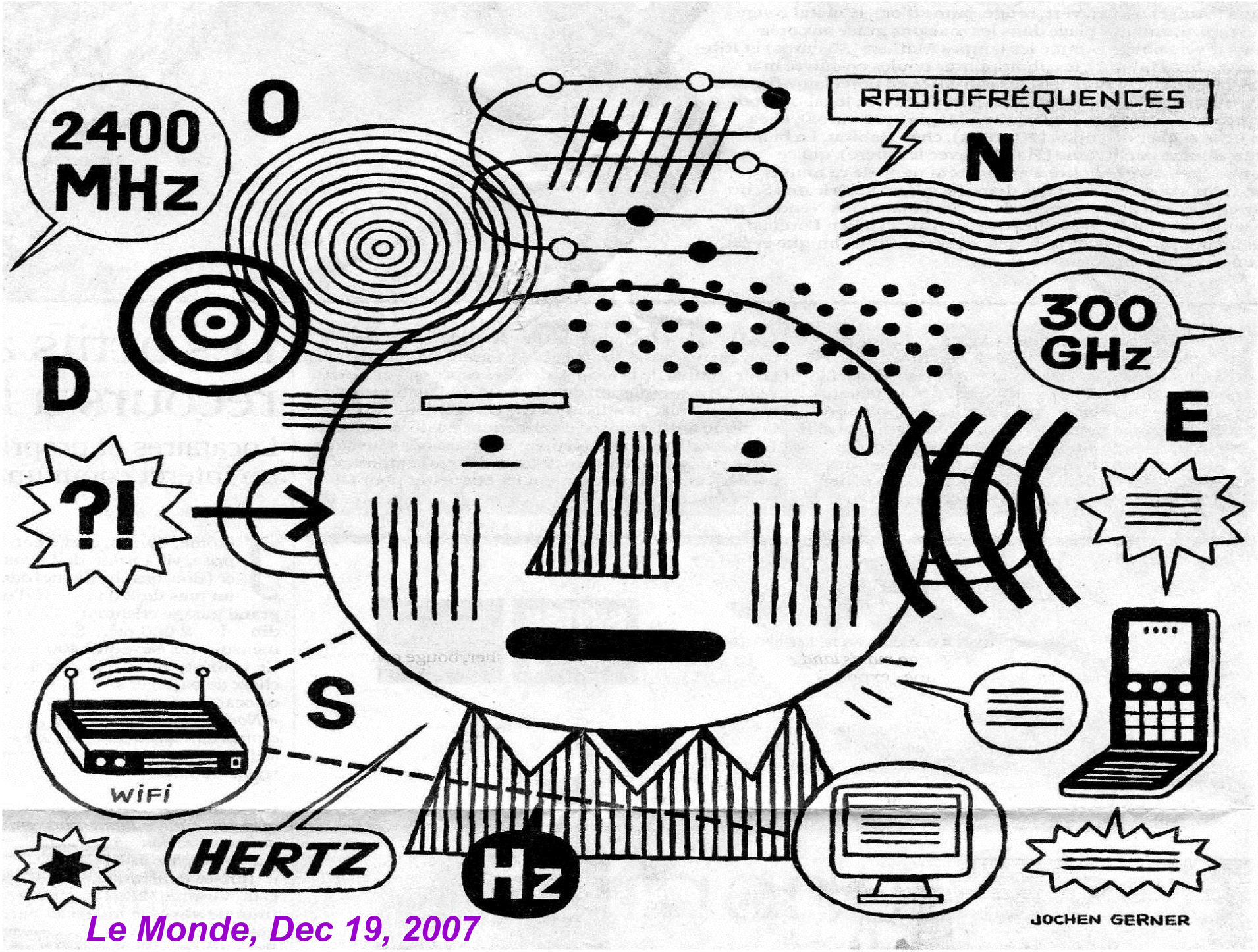
Conflict of interest

- No conflict of interest
- Work done on a volontary basis
- No honorarium received
- Travel and lodging expenses paid for by the organizers

Who am I?

- I am a physician having spent the last 38 years working as a cancer epidemiologist
- An MD and 3 Harvard degrees (MPH, SM Bio-Epi, DrPH Epi, Bio, Evaluation)
- Founder and Chief of the IARC Research Unit of Epidemiology for Cancer Prevention at the International Agency for Research on Cancer-World Health Organization
- Former Acting Chief of the WHO Programme for Cancer Control
- Former Director of Research at the *INSERM* (French NIH)
- Having been put on retirement but continuing on a volontary basis

- Over the decades switching from behavioral and life-style cancer risk factors to environmental ones



Le Monde, Dec 19, 2007

What do we know about 5G?

- Close to nothing and this is the problem
- But we know a lot about 2G and 3G and about RF-EMF in general
- What we do know makes us exceedingly worried about 5G

What is the question?
Identifying what is a cancer hazard

- Establishing the link between exposure and disease
  - human studies
    - epidemiological
    - clinical
    - other (ecological, trends, ...)
  - experimental studies
  - other studies (mechanisms of carcinogenesis, other studies)
- The IARC monographs on the evaluation of carcinogenicity to humans

The IARC programme of Monographs on the evaluation of carcinogenic risks to humans

- Initiated in 1969 at IARC, by Dr. Lorenzo Tomatis, with support of the NCI (United States of America) and the European Commission
- **Objective:** To prepare, with the help of international working groups of experts, and to publish in the form of Monographs:
  - Critical reviews of the literature
  - Evaluation of evidence on the carcinogenicity of a wide range of human exposures

Selection of agents[1] for the Monographs

Agents are selected based on two main criteria:

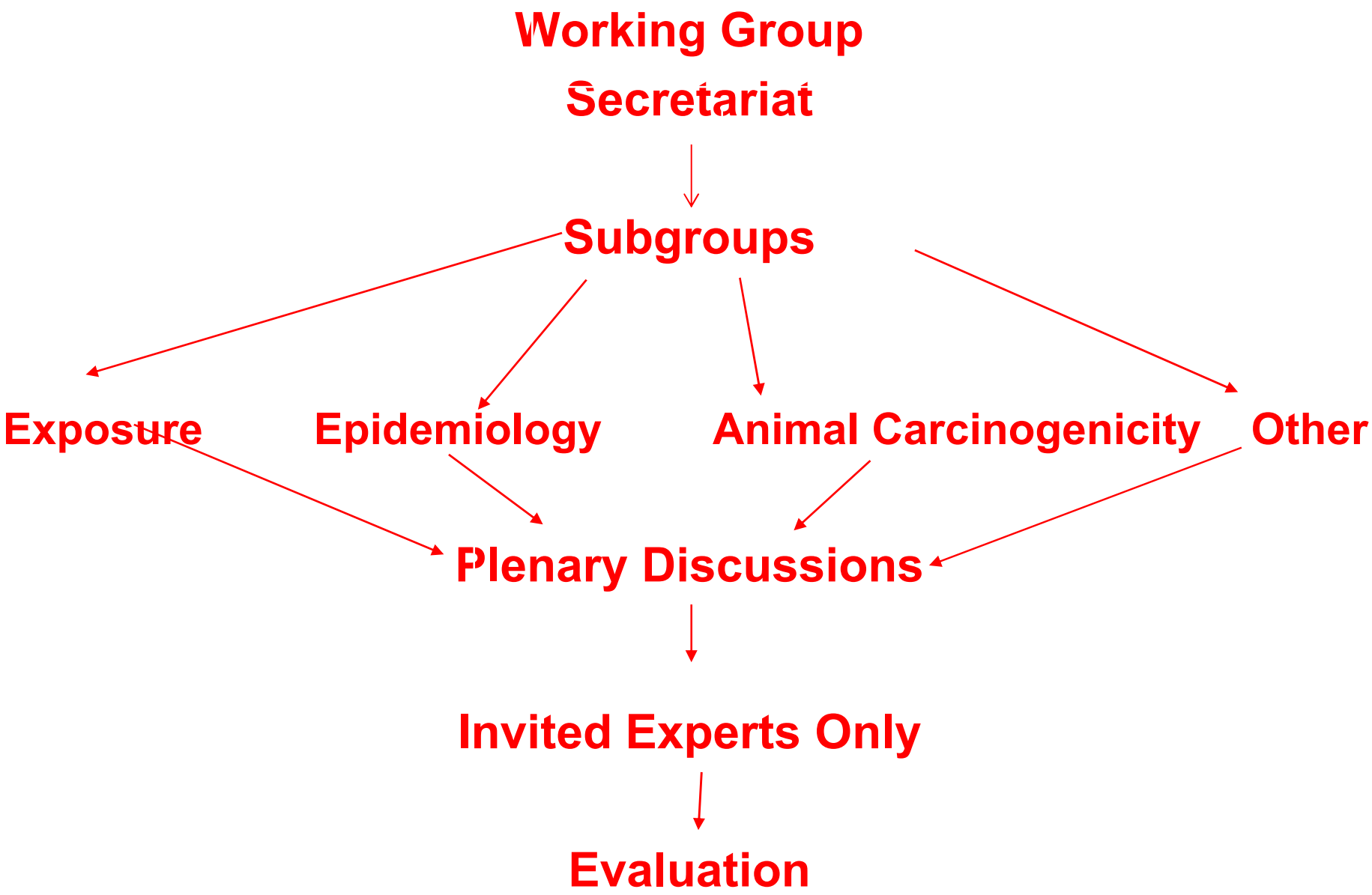
(a) there exist indications of human exposure

(b) there exist indications or suspicion of carcinogenicity

[1] The term "agent" covers individual chemical products, groups of chemical products, physical agents (such as radiations) and biological agents (ex: virus), or a mixture of agents; this term may also include chemical analogs and compounds similar to the elements suspected to be carcinogens

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans – Preamble, 2006, regularly updated, most recently in 2019

Monographs Meeting Structure



Summary of reported data

a. Exposure data

b. Carcinogenicity for humans

- results from epidemiological data

- sometimes, case reports and correlation studies

c. Carcinogenicity from experimental animal data

d. Mechanistic and other relevant data which can be used for the evaluation of carcinogenicity and its mechanisms

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans – Preamble, 2006, last update 2019

Summary of evidence required for classification (as in 2011)*

Group 1- Carcinogenic to humans

Sufficient evidence in humans

Group 2A - Probably carcinogenic to humans

Limited evidence in humans and sufficient evidence in animals

Group 2B - Possibly carcinogenic to humans

Limited evidence in humans, less than sufficient evidence in animals or inadequate evidence in humans, sufficient evidence in animals or inadequate evidence in humans, limited evidence in animals, with other relevant supporting data

Group 3 - Not classifiable as to carcinogenicity to humans

Inadequate evidence in humans and less than sufficient evidence in experimental animals

Group 4 - Probably not carcinogenic to humans

* These criteria have been slightly modified in 2019, in particular with the introduction of “Evidence relevant to key characteristics of carcinogens” in the mechanistic evidence section

IARC Monograph Programme for the evaluation of carcinogenic risk to humans

IARC Classification

Group		Number
1	: Carcinogenic to humans	120
2A	: Probably carcinogenic to humans	82
2B	: Possibly carcinogenic to humans	311
3	: Non classifiable as to carcinogenicity to humans	500
Total		1013

Prior to 2019, there was a Group 4 : Probably not carcinogenic to humans

IARC Monographs (Volumes 1-124), 2019

Identification of carcinogens

The IARC Monograph Programme for the evaluation of carcinogenicity to humans

IARC Monograph Vol. 102, realized in 2011, published in 2013

General remarks

- « The topic of this *Monograph* is the evaluation of the carcinogenicity in the radio-frequency (RF) range (30 kHz to 300 GHz) of the electromagnetic spectrum…..
- …. Although the preparation of this *Monograph* has been scheduled so as to include the results of the large international case-control study INTERPHONE on mobile phone use (conducted in 2000-2004; published in 2010), it should be emphasized that the evaluations in this volume address the general question of whether RF radiations causes cancer in humans or in experimental animals: it does not specifically or exclusively consider mobile phones, but rather the type of radiation emitted by mobile phones and various other sources. »

Cut and paste from the original publication, 2013

What was available in 2011?

- The most extensively investigated relation has been (and still is…) cell phone and brain tumors.
- At that time, 5 case-referent studies and 1 cohort study had been published and were evaluated.
- Almost all information came from 3 main studies or groups of studies: the Nordic studies by Hardell, the INTERPHONE international study by Cardis from IARC, the Danish cohort-study.
- The experimental animal studies gave somewhat discordant results (some positive, some negative). Yet they covered quite a range of types of studies, species of animals and studied outcomes.
- Other relevant studies did provide inconclusive evidence on potential mechanisms of carcinogenicity.

Nordic studies: pooled analysis on malignant brain tumors

- **Case-referent studies**
- **Population based**
- **1251 cases of malignant brain tumors**
- ***Hardell L, Carlberg M, Hansson Mild K. Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. Int J Oncol 2011; 38 (5): 1465-1474.***

Results Mobile phones

	All malignant (n=1251)		Astrocytoma (n=952)	
	Ca/Co	OR, CI	Ca/Co	OR, CI
Mobile phone	574/963	1.3 1.1-1.5	439/963	1.4 1.2-1.7
< 20 years old	19/14	2.9 1.3-6.0	15/14	4.9 2.2-11
20-49 years old	347/581	1.3 1.1-1.6	249/581	1.5 1.2-1.9
>= 50 years old	208/368	1.2 0.998-1.5	175/368	1.3 1.02-1.6

Hardell L, Carlberg M, Hansson Mild K, 2011

Conclusion

The pooled analysis showed an increased risk for malignant brain tumours and use of mobile or cordless phones. This study also demonstrated an increase in risk with increasing cumulative call time and found a higher risk with ipsilateral use of mobile phone.

Highest risk was found in the group with first use of a mobile or wireless phone before 20 years of age.

What is the INTERPHONE study ?

- The largest ever conducted epidemiological study on cell phones and selected tumors
- Concept of the study proposed by Elisabeth Cardis at IARC-WHO in the mid 90's
- Original hypothesis: promoting rather than initiating role in tumor development. Could serve as a justification for a study to be started early in the history of exposures of human populations to cell phone
- Very extensive feasibility phase and intense pilot testing of several aspects of the protocol (in particular questionnaires to be used) with numerous validation studies
- Demonstrated need for a very large study

Study design and implementation

- **Methodology: Case-referent study**

  Study of persons with the tumor to be studied (cases) and comparison with persons without these tumors (referents) with regard to their history of cell phone use and other pertinent information
- **Study coordinated by IARC-WHO and conducted in 13 countries (Australia, Canada, Denmark, Finland, France, Germany, Israel, Italy, Japan, New Zealand, Norway, Sweden, United Kingdom)**
- **Common core protocol with possibility of center specific (additional) investigations**

Study funding

- Total cost well over 20 million US $, of which at least 6 from the industry
- Mixture of public (mostly European Fifth Framework Program) and private (Mobile Manufacturers' Forum and GSM Association) funding, the latter being provided at the international level through the UICC
- Conflict of interest stated as limited

Study description

- About 6600 cases and about 7800 population referents
- 2708 gliomas, 2409 meningiomas, 1105 acoustic neuromas and around 400 parotid gland tumors
- Study subjects recruited between 1999 and 2004, *i.e.* at a time when use of cell phones was still limited to selected population groups and individual use was modest in terms of duration of exposure
- Collection of information through questionnaires to the subjects themselves or to proxies

Publication of study results

- **First publications were from selected national investigators (at least for 9 countries and some combinations of countries), with a first publication in 2004**
- **First publication of the pooled data at the total international level only appeared in May 2010, *i.e.* 5 years after they were first analyzed at IARC**
- **First international publication on brain tumors**
- ***The INTERPHONE Study Group. (corresponding author: Dr Elisabeth Cardis, CREAL but prior IARC). Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. Int J Epidemiol 2010; 39: 675-694.***

Main results on brain tumors

- "**Results**: A reduced odds ratio (OR) related to ever having been a regular mobile phone user was seen for glioma [OR 0.81; 95% confidence interval (CI) 0.70–0.94] and meningioma (OR 0.79; 95% CI 0.68–0.91), **possibly reflecting participation bias or other methodological limitations.** No elevated OR was observed 10 or more years after first phone use (glioma: OR 0.98; 95% CI 0.76–1.26; meningioma: OR 0.83; 95% CI 0.61–1.14). ORs were <1.0 for all deciles of lifetime number of phone calls and nine deciles of cumulative call time. **In the 10th decile of recalled cumulative call time, 1640 h or more, the OR was 1.40 (95% CI 1.03–1.89) for glioma, and 1.15 (95% CI 0.81–1.62) for meningioma; but there are implausible values of reported use in this group.** ORs for glioma tended to be greater in the temporal lobe than in other lobes of the brain, **but the CIs around the lobe-specific estimates were wide.** ORs for glioma tended to be greater in subjects who reported usual phone use on the same side of the head as their tumour than on the opposite side."

Cut and paste from the original publication, 2010

Conclusions as from the publication

- "**Conclusions: Overall, no increase in risk of glioma or meningioma was observed with use of mobile phones. There were suggestions of an increased risk of glioma at the highest exposure levels, but biases and error prevent a causal interpretation. The possible effects of long-term heavy use of mobile phones require further investigation.**"

Cut and paste from the original publication, 2010

What does it mean?

- **Technically speaking, the study shows an overall protective effect of cell phones (users of cell phones have a reduced risk of brain tumors)**
- **BUT there is in fact an increased risk for the ones who were the heaviest phone users (at least 1640 hours). This increase is clearer for temporal gliomas on the side of the head to which the phone was usually held, *i.e.* the risk is found exactly where it was expected**
- **Further analyses in the Annex 2 confirm an increased risk (around 2) for the most exposed**

So, what do I (and some others) conclude?

- Better safe than sorry
- Be cautious
- The INTERPHONE study is biased (in particular as far as the participation of referents is concerned), but despites that, it is NOT negative and shows risk for the heaviest users
- The heavy users of yesterday are the light users of today
- The worst may be for people exposed at a young age

INTERPHONE study on acoustic neuroma

- **1105 acoustic neuroma (vestibular schwannoma) cases and 2145 referents in 13 countries using a common protocol**
- ***The INTERPHONE Study Group (corresponding authors: Dr Elisabeth Cardis (CREAL but prior IARC) and Dr Joachim Schüz (IARC). Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. Cancer Epidemiology 2011; 35: 453-464.***

Main results on acoustic neuroma

- "***Results:*** **The odds ratio (OR) of acoustic neuroma with ever having been a regular mobile phone user was 0.85 (95% confidence interval 0.69-1.04). The OR for >= 10 years after first regular mobile phone use was 0.76 (0.52-1.11). There was no trend of increasing ORs with increasing cumulative call time or cumulative number of calls, with the lowest OR (0.48 (0.30-0.78) observed in the 9th decile of cumulative call time. In the 10th decile (>= 1640 h) of cumulative call time, the OR was 1.32 (0.88-1.97); there were, however, implausible values of reported use in those with >= 1640h of accumulated mobile phone use. With censoring at 5 years before the reference date the OR for >= 10 years after first regular mobile phone use was 0.83 (0.58-1.19) and for >= 1640 h of cumulative call time it was 2.79 (1.51-5.16), but again with no trend in the lower nine deciles and the lowest OR in the 9th decile. In general, ORs were not greater in subjects who reported usual phone use of the same side of the head as their tumour than in those who reported it on the opposite side, but it was greater in those in the 10th decile of cumulative hours of use."**

Cut and paste from the original publication, 2011

Conclusions as from the publication

- "*Conclusions:* **There was no increase in risk of acoustic neuroma with ever regular use of a mobile phone or for users who began regular use 10 years or more before the reference date. Elevated odds ratios observed at the highest level of cumulative call time could be due to chance, reporting bias or a causal effect. As acoustic neuroma is usually a slowly growing tumour, the interval between introduction of mobile phones and occurrence of the tumour might have been too short to observe an effect, if there is one.**"

Cut and paste from the original publication, 2011

Results for EMF – May 2011

- Evidence in humans: limited based on glioma and acoustic neuroma
- Evidence in experimental animals: limited
- Weak mechanistic evidence relevant to RF-EMF induced cancer in humans
- Group 2 B

2A / 2B – Why we do care?

- 2A: Probable human carcinogen
- 2B: Possible human carcinogen
- Almost the same words
- BUT
- Very different implications:
- For several countries, 2A automatically leads to actions being taken: listing as a carcinogen, legislation or reglementation, compensation, warnings, *etc*
- For 2B: usually nothing

Why is it especially important to worry about children when discussing RF-EMF and in particular 5G?

Cancers in Childhood and Adolescence

- These cancers have been increasing all over the world for the past two or three decades. Overall the increase is about 1.5 % per year, be it for solid tumors or for leukemia/lymphoma with some differences between children and adolescents
- 2018: All cancers 0.54% increase *per* year in children
  0.96% increase *per* year in adolescents

Stelianova-Foucher et al. (IARC), 2018

Leukemia 0.60% increase *per* year
Lymphoma 1.04% increase *per* year

CNS 0.47% increase *per* year

based on Straif (IARC), Church House, 2018

The increase is more marked in countries of the South
(3% *per* year in Africa for solid tumors) and in selected places

based on Straif (IARC), Church House, 2018

The situation in Italy is particularly worrisome with one of the highest incidence in the world

based on Gentilini and Ridolfi, 2018

What do we know on RF and Cancers?

IARC Monographs for the Evaluation of Carcinogenicity to Humans

- **Extremely Low Frequencies and Cancer *(Volume 80, 2002)***

➢ **ELF: Group 2B - *Possible Carcinogen***

Increased Risk of Childhood Leukemias for Exposure to electrical lines, including at home ("dirty electricity") and more importantly HPL and VHPL

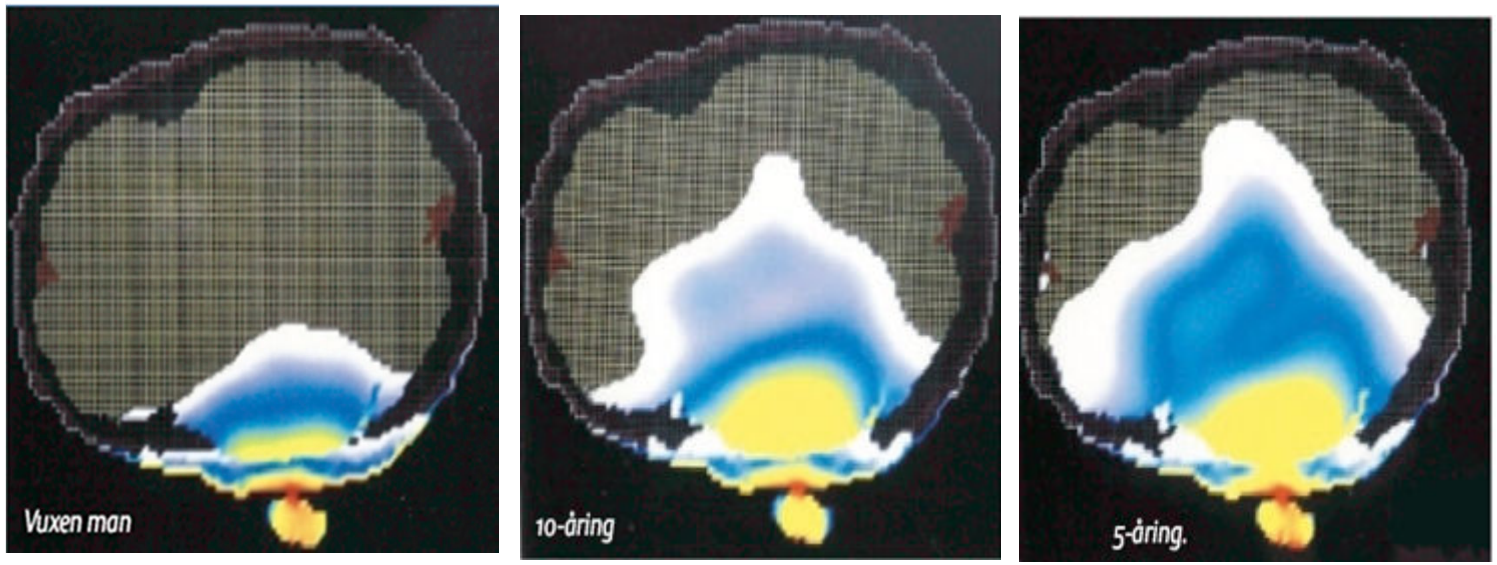
- **ElectroMagnetic Fields and Cancer *(Volume 102, 2013)***

➢ **EMF - Group 2B - *Possible Carcinogen***

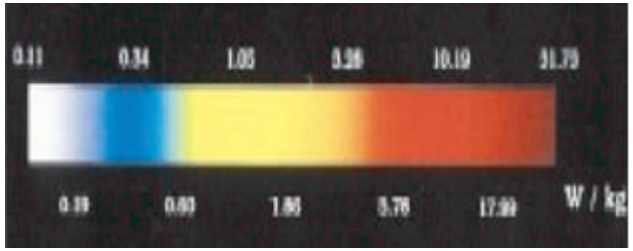
Increased Risk of brain tumours in adults (glioma, schwannoma)

No study about cancer in children and adolescents in that Monograph

Penetration of EMF in the brain



Adult man **Child 10 years** **Child 5 years**



Courtesy of Om Gandhi

CEFALO – Brain tumors in children and adolescents

Aydin D, Feychting M, Schüz J, Tynes T, Veje Andersen T, Samso Schmidt L, Poulsen A H , Johansen C, Prochazka M, Lannering B, Klaebe L, Eggen T, Jenni D, Grotzer M, Von der Weid N, Kuehni CE, Röösli M. Mobile phone use and brain tumors in children and adolescents; a multicenter case-control study. J Natl Cancer Inst 2011; 103: 1-13.

Note: study first submitted February 9, 2011

revised March 27, 2011

accepted June 7, 2011

published July 27, 2011

IARC Monograph meeting May 2011

Not included in the Monograph

Study design, implementation and funding

- **Methodology: Case-referent study**

  Study of children and adolescents aged 7 to 19 years diagnosed between 2004 and 2008 (352 cases of brain tumor) and comparison subjects randomly selected from population registries and matched by age, sex, and geographical region (646 referents) with regard of their history of mobile phone use collected by face to face interview of the child or adolescent, whenever possible accompanied by at least one parent (preferably the mother). For deceased cases, interview of the parents. Access to traffic data from mobile phone network operators whenever possible
- **Study conducted in Denmark, Norway, Sweden, and Switzerland**
- **Mix of public and private origin funding (details not given)**
- **Some authors with clear conflicts of interest**

Main results of CEFALO

- **"Results: Regular users of mobile phones were not statistically significantly more likely to have been diagnosed with brain tumors compared with non users (OR = 1.36: 95% CI = 0.92 to 2.02). Children who started to use mobile phones at least 5 years ago were not at increased risk compared to those who had never regularly used mobile phones (OR = 1.26, 95% CI = 0.70 to 2.28). In a subset of study participants for whom operator recorded data were available, brain tumor risk was related to the time elapsed since the mobile subscription was started but not to amount of use. No increased risk of brain tumors was observed for the brain areas receiving the highest amount of exposure."**

Cut and paste from the original publication, 2011

Conclusions as from the publication

- **“Conclusion: The absence of an exposure-response relationship either in terms of the amount of mobile phone use or by localization of the brain tumor argues against a causal association.”**

Cut and paste from the original publication, 2011

ORs in Cefalo do not support the conclusion of a negative study

- 116 ORs in the 6 tables of the paper. 97 ORs (84%) are greater than 1, from 1.09 to 6.19. Seven are statistically significant . None of these are cited in the abstract and only 1 in the text at 2.15 (1.07-4.29) for the ones with the longest period since first subscription based on data from the phone company.

- Several ORs demonstrate dose-response effects (cumulative duration of calls, cumulative number of calls, cumulative duration of subscription)

- 13 from the 19 which are lower than 1 make sense as they refer to tumors of central or unknown location in the brain

What do I (and some others) conclude ?

- There is a risk and it is highest among the longest duration users
- This risk is observed with a very light (by today's standards) definition of a regular user as anyone having an average of at least one call per week for at least 6 months
- Almost of the ORs presented in the tables are greater than 1
- The subjects with the longest period since first subscription have an OR of 2.15 (1.07-4.29)
- How do they dare to write: "short-term use of mobile phones does not cause brain tumors in children and adolescents." ???
- If there had been a few more subjects in the study, this study would have allowed EMF to be classified as a Group 1 carcinogen

What about MOBI-KIDS?

- **Methodology: multinational case-referent study**
- **Study of the risk of brain tumors diagnosed in 10 to 24 years old to study the impact of exposure to EMF from mobile phones and other sources of RF**
- **Study conducted between 2010 and 2015 in 14 countries (Australia, Austria, Canada, France, Germany, Greece, India, Israel, Italy, Japan, Korea, New Zealand, Spain, The Netherlands)**
- **Protocol close to the one of Interphone but re-adapted and validated. A number of the investigators are also common with Interphone, in particular the Principal Investigator (Elisabeth Cardis, now at the Barcelona Institute for Global Health)**

Results from MOBI-KIDS?

- Final Report submitted to the European Commission on 13 January 2017
- 898 cases and 1912 referents matched on age, reference date and study region
- Description of quality assurance data, exposure assessment, database management and analysis
- Data bases were closed in December 2015

Il deserto dei Tartari (Dino Buzzati)
En attendant Godot (Samuel Beckett)

- **January 13th 2017: "Analyses of the association between mobile phone use and brain tumour risk, as well as between estimated RF and ELF exposure at the location of the tumour and risk of brain tumour have been conducted and a publication is in preparation. Results however cannot be made public until publication in a peer-reviewed scientific journal." (page 11 of Report)**
- **January 13th 2017: "Regarding the dissemination and exploitation of the results, since the final analyses are ongoing, the main results of the study are not published yet. Documents to inform the general public about the main results of the study will be prepared as soon as the final results are available. Due to the widespread usage of communication devices such as mobile phones, the results of the study regarding potential detrimental health effects will most likely receive a considerable degree of public attention and can potentially have significant societal implications. So far, the extensive use of very different means of communication has contributed to increase the public understanding regarding electromagnetic fields and their potential impact on health." (page 15 of Report)**

Cut and paste from the final report, 2017

- **<u>Almost three years later: no results published</u>!**

Absolute priority for evaluation

- **Request the publication of the results of the Mobi-kids study !!!! NOW!**
- **After the Mobi-kids results are published, request a re-evaluation of carcinogenicity by IARC**
- **Now is our time to put pressure on the institutions which conducted Mobi-kids and ask them to release the results. They have been mostly produced with public funding and therefore they belong to all of us!**

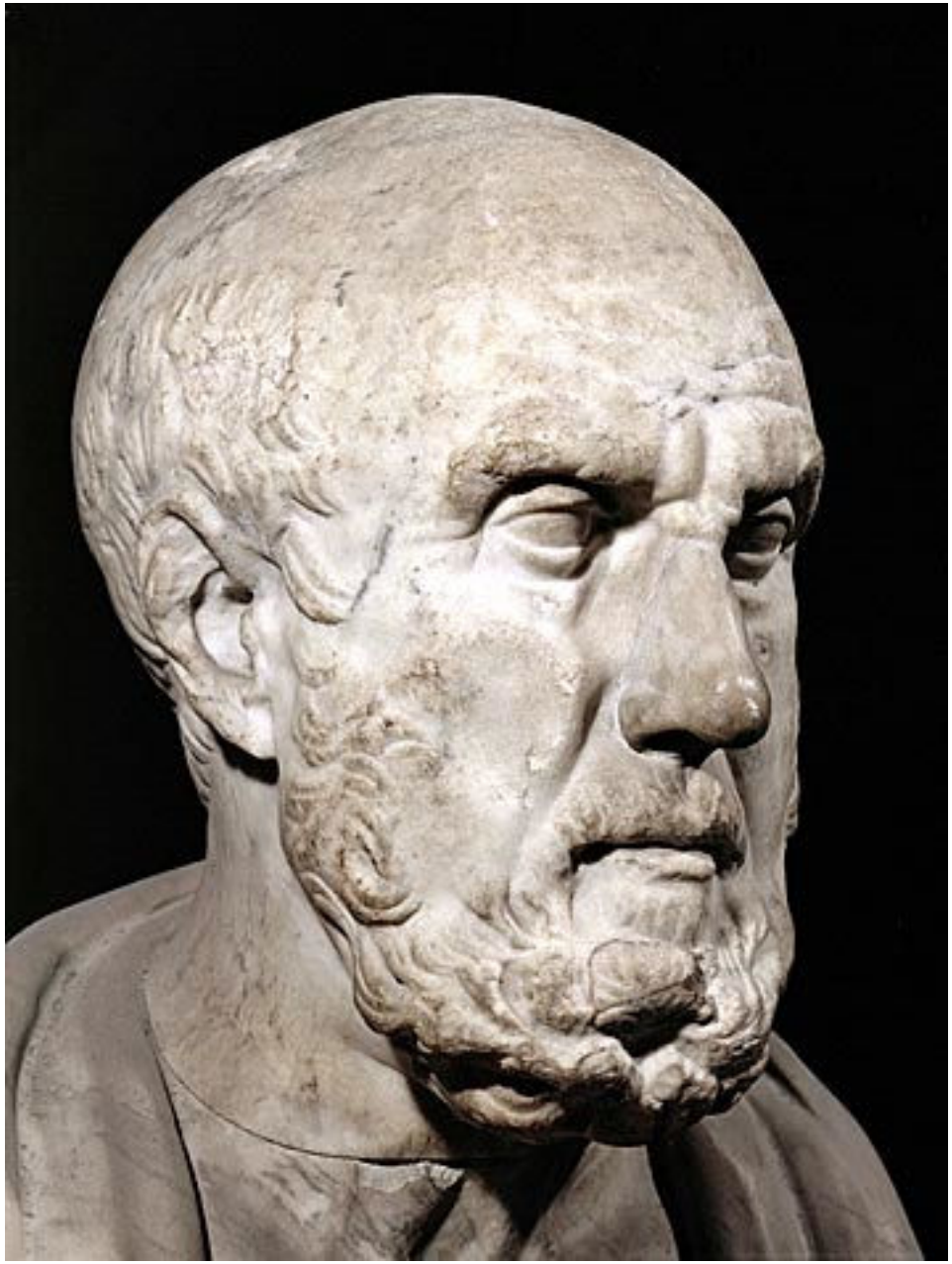
And in the mean time?

- We do have more than enough to impose on governements the absolute need to protect populations, including the most vulnerable
- With an exposure such as 5G which will be ubiquitous, leaving absolutely no one unexposed, the only way is to protect all populations, not limited to humans
- We do have enough evidence to act for prevention
- It is no longer « only » a question of precaution!

FRANCE, DECEMBER 2008

Some pictures of a population health campaign which was conducted in the city of Lyon, France, just before Christmas to let the public know buying a cell phone for a child was not a good idea for a present.
Ten years later, how many kids less than 12 are the owners of a cell phone?
We need to do more!

Photo by Sasco, 2008



Hippocrates

Primum non nocere

First do no harm

Epidemics (I,5) around 410 BC

Translation in the 2008 context: precautionary principle

David Servan-Schreiber-Annie Sasco appeal on cell phones

Today : more than time to move from precaution to prevention

Some last thoughts collected last week

- **Silence is not neutrality, it is complicity.** ***(Lemen, 2019)***

- **When public institutions fail to fulfill their obligations, it is the scientists' duty to remind them what their responsabilities are. The future of our society is too important to be entrusted to the short-term interests of companies and institutions.** ***(Sik, 2019)***


THANK
YOU