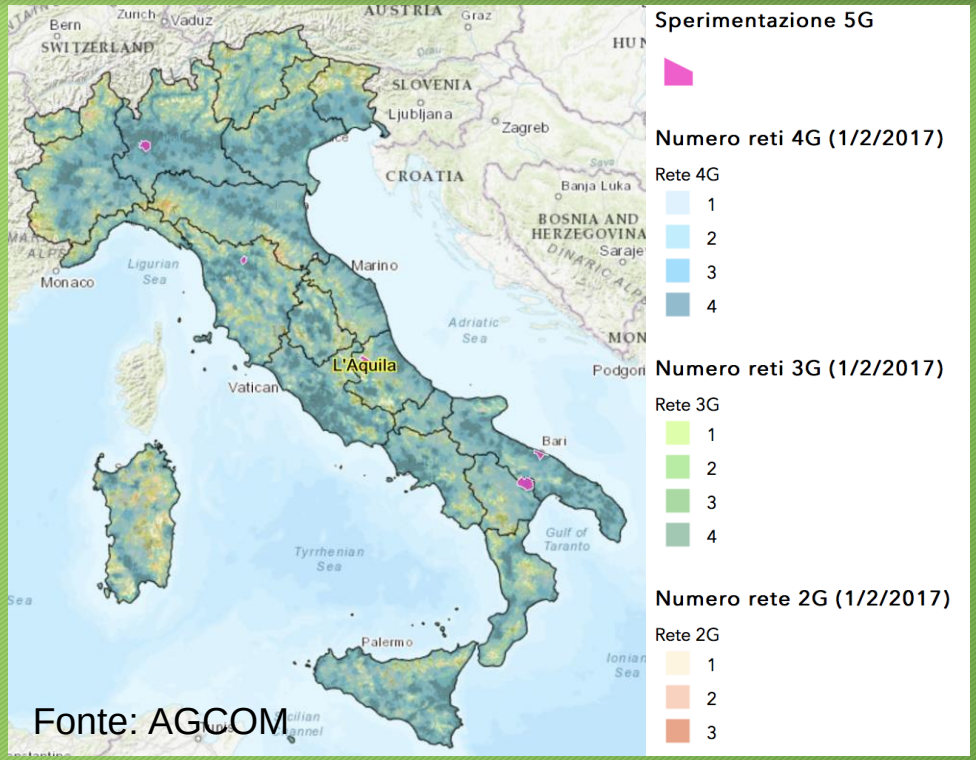
Arezzo, 5 aprile 2019

Verso il 5G: possibili rischi sanitari

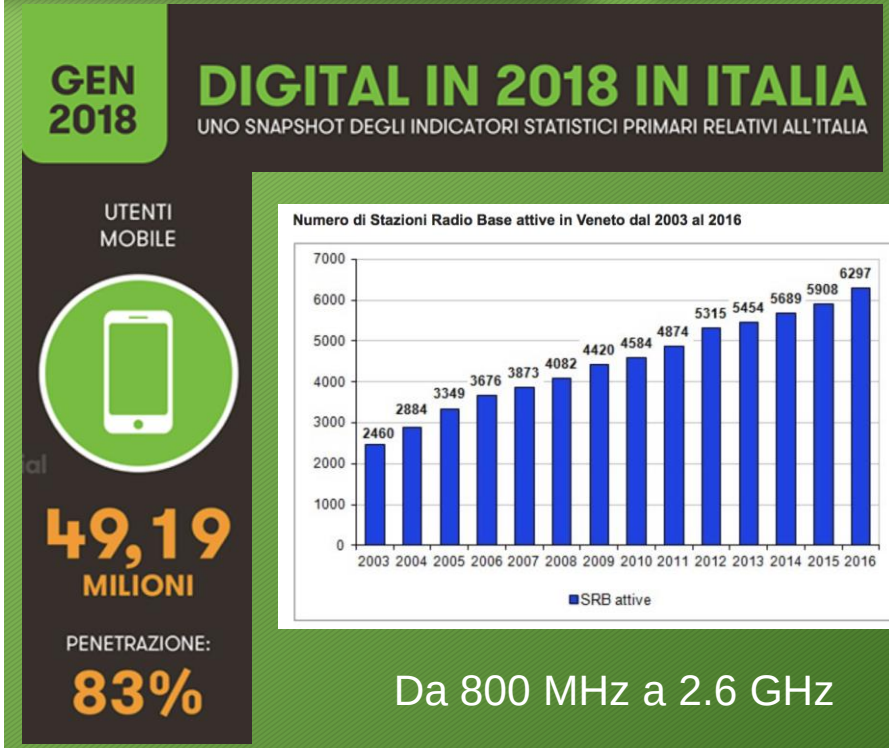
Agostino Di Ciaula

Presidente Comitato Scientifico ISDE

La distribuzione dei RF-EMF è rapidamente in crescita



Fonte: AGCOM



Da 800 MHz a 2.6 GHz

CORRIERE DELLA SERA

LA RICERCA

Digitale, i bambini passano sette ore al giorno su tablet e computer

Lo rivela una sconvolgente ricerca effettuata dall'Associazione centro studi «Impara digitale» su 1300 genitori intervistati. Più il titolo di studio dei familiari è elevato, però, meno ore il bambino trascorre online nei giorni feriali

di VALENTINA SANTARPIA

di Valentina Santarpia

- ✓ Il primo cellulare tra le mani ad un anno
- ✓ Il 17% dei bambini tra 4 e 10 anni usa smartphone (auditel-censis)

L’esposizione a RF-EMF induce stress ossidativo

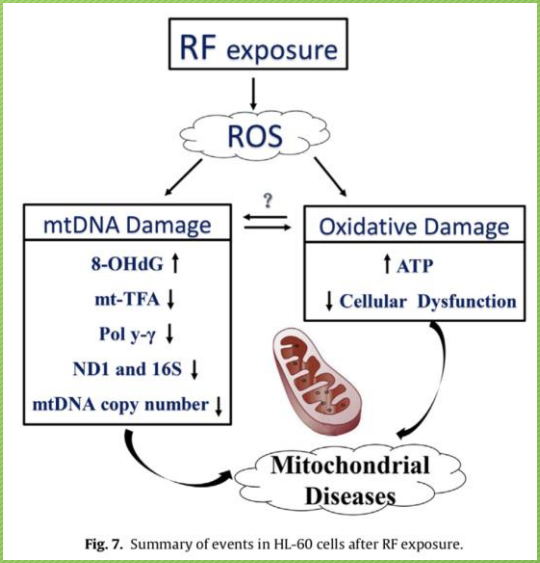
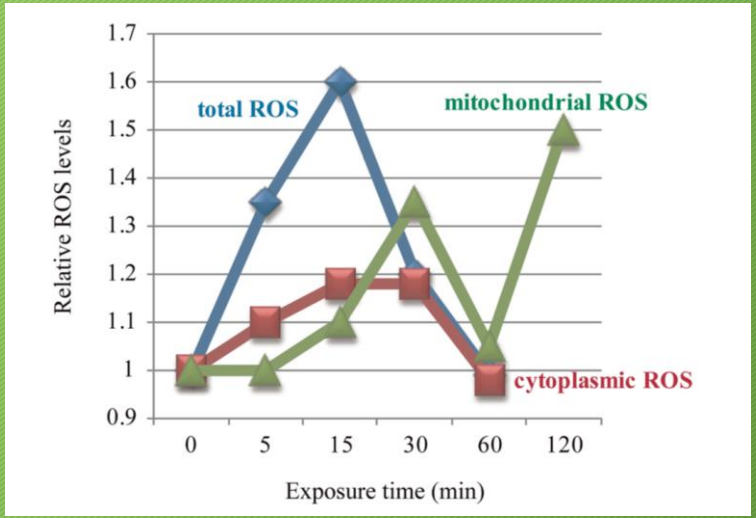


Fig. 7. Summary of events in HL-60 cells after RF exposure.

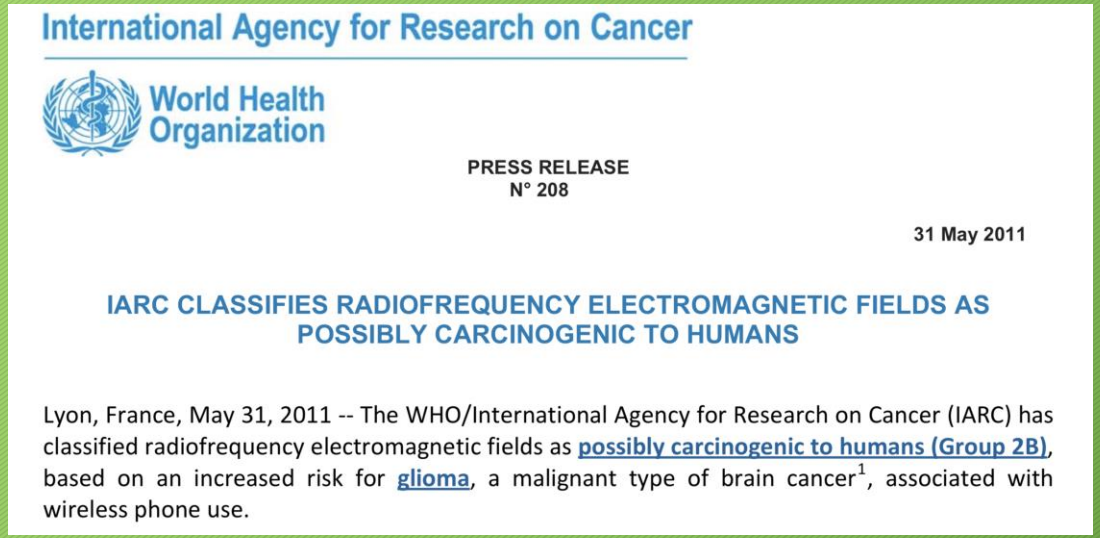
Sun Y et al., 2017



EMF-induced ROS level changes are time-dependent (Wang H & Zhang X, 2017)

- Dasdag e Akdang, 2016
- Yakymenko et al, 2016
- Chauhan et al., 2017
- Friedman et al., 2007
- Houston et al., 2016
- Kazemi et al., 2015
- Kesari et al., 2011
- Oyewopo et al., 2017

IARC Group 2B, anno 2011



International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

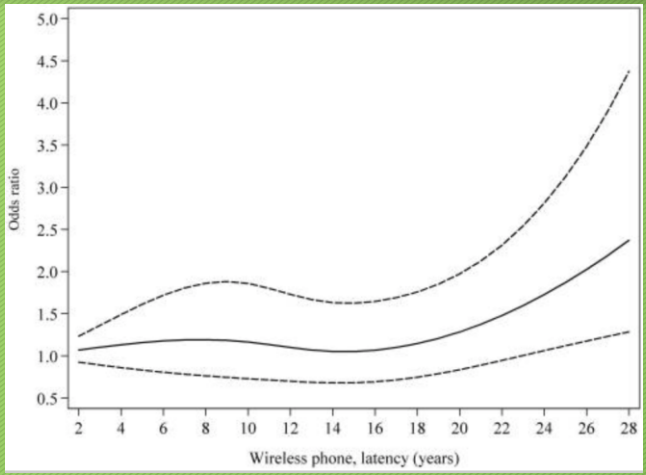
Lyon, France, May 31, 2011 -- The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.

“The conclusion means that there could be some risk, and therefore we need to keep a close watch for a link between cell phones and cancer risk."

"Given the potential consequences for public health … it is important that additional research be conducted into the long- term”

Dopo il 2011…

Rischi oncologici

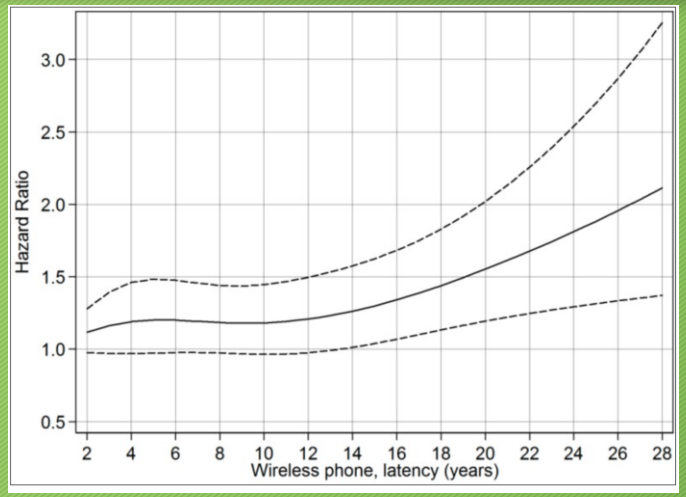


Restricted cubic spline plot of the relationship between latency of wireless phones and malignant brain tumours. The solid line indicates the OR estimate, the broken lines represent 95% CI. Adjustment was made for age at diagnosis, gender, SEI-code and year of diagnosis.

A case-control study has documented an increased risk of brain tumor in mobile phone users or after cordless phone use (latency >15-20 years) (Hardell et al, 2013).

Dopo il 2011…

Rischi oncologici



Restricted cubic spline plot of the relationship between latency of wireless phones and astrocytoma grade IV. The solid line indicates the HR estimate, the broken lines represent the 95% CI. Adjustment was made for age, gender, year of diagnosis, SEI-code, study, and age as a time-dependent covariate

A large study on 1678 patients with glioma demonstrated a decreased survival per year of latency for mobile phone use (Carlberg L, Hardell L 2014)

Dopo il 2011…

Rischi oncologici

International Journal of Occupational Medicine and Environmental Health 2017;30(1):27–43
https://doi.org/10.13075/ijomeh.1896.00802

MOBILE PHONE USE AND RISK FOR INTRACRANIAL TUMORS AND SALIVARY GLAND TUMORS – A META-ANALYSIS

ALICJA BORTKIEWICZ[1], ELŻBIETA GADZICKA[1], and WIESŁAW SZYMCZAK[2]

[1] Nofer Institute of Occupational Medicine, Łódź, Poland
Department of Work Physiology and Ergonomics
[2] University of Lodz, Łódź, Poland
Faculty of Educational Sciences, Institute of Psychology, Chair of Psychological Research Methodology and Statistics

A meta-analysis exploring papers published until the end of March 2014 (24 studies, 26,846 cases, 50,013 controls) reported a higher risk of intracranial tumor (mobile phone use over 10 years) and for the ipsilateral location (Bortkiewicz et al., 2017)

Dopo il 2011…

Rischi oncologici

A re-analysis (correcting for possible biases) of Canadian data from the multinational INTERPHONE study demonstrated ***an odds ratio of 2.2 for glioma***, and an ***increased risk of meningioma, acoustic neurinoma and parotid gland tumors*** in relation to mobile phone use (Momoli 2017)

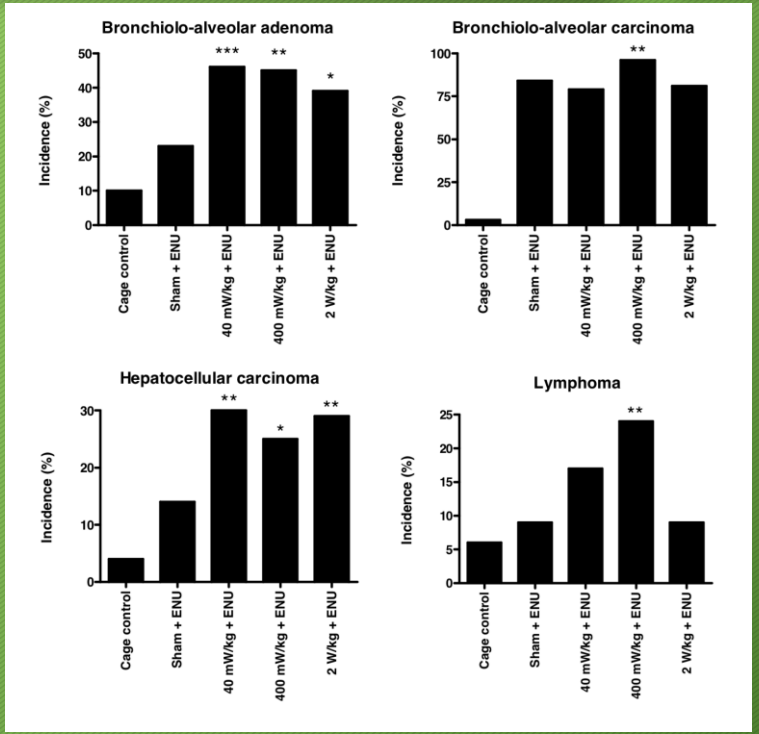
Table 5. Conditional Logistic and Bias-Adjusted Odds Ratios for Phone Use by Tumor Type, Interphone Study, Montréal, Ottawa, and Vancouver, Canada, 2001–2004

Tumor Type and Exposure Metric	No. of Cases	No. of Controls	OR[a]	95% CI	Bias Modeling Adjustment					
					Bias Due to Recall Error[b]		Selection Bias[b]		Recall and Selection Biases, With Random Error	
					OR	95% Limits	OR	95% Limits	OR	95% Limits
Glioma										
Reference level[c]	89	339	1.0	Referent	1.0	Referent	1.0	Referent	1.0	Referent
Regular use	81	314	1.0	0.7, 1.5	NA[d]	NA	1.1	1.0, 1.2	1.1	0.7, 1.6
Cumulative no. of hours										
<40	14	77	0.9	0.4, 1.7	0.8	0.7, 0.9	1.0	0.7, 1.3	0.9	0.4, 1.8
40–558	35	163	0.7	0.4, 1.2	0.7	0.6, 0.8	0.8	0.6, 1.0	0.8	0.4, 1.4
>558	32	74	2.0	1.2, 3.4	2.0	1.8, 2.1	2.3	1.9, 2.8	2.2	1.3, 4.1

Dopo il 2011…

Rischi oncologici

An experimental study documented cancer-promoting effects of RF-EMF on mice (tumors of the lung, liver, lymphomas) at low to moderate exposure levels (0.04 and 0.4 W/kg SAR), well below current exposure limits (Lerchl et al, 2015) .



Dopo il 2011…

Rischi oncologici

National Toxicology Program
U.S. Department of Health and Human Services

High Exposure to Radio Frequency Radiation Associated With Cancer in Male Rats

News Release

Archive - New Contact Information

For more information about this archival news release, please contact Christine Flowers, Director, Office of Communications & Public Liaison at (919) 541-3665.

FOR IMMEDIATE RELEASE
Thursday, November 1, 2018, 10:00 a.m. EDT

Contact: Virginia Guidry, NIEHS
919-541-1993

What did the studies find?

The NTP studies found that high exposure to RFR used by cell phones was associated with:

- **Clear evidence of tumors in the hearts of male rats.** The tumors were malignant schwannomas.
- **Some evidence of tumors in the brains of male rats.** The tumors were malignant gliomas.
- **Some evidence of tumors in the adrenal glands of male rats.** The tumors were benign, malignant, or complex combined pheochromocytoma.

Dopo il 2011…

Rischi oncologici

Table 2
Long-term bioassay on 1.8 GHz base station RFR, administered at various doses to male (M) and female (F) Sprague-Dawley rats (Experiment BT 1CEMRF): results on pre-neoplastic and neoplastic lesions of the heart.

Group No.	Dose GSM-RFR	Animals		Hyperplasia Schwann cells		Endocardial Schwannoma		Intramural Schwannoma		Total Schwannoma	
	1.8 GHz (V/m)	Sex	No.	No.	%	No.	%	No.	%	No.	%
I	0	M	412	3	0.7	0	0.0	0	0.0	0	0.0
	(control)	F	405	2	0.5	0	0.0	4	1.0	4	1.0
		M+F	817	5	0.6	0	0.0	4	0.5	4	0.5
II	5	M	401	2	0.5	2	0.5	1	0.2	3	0.7
		F	410	0	0.0	2	0.5	7	1.7	9	2.2
		M+F	811	2	0.2	4	0.5	8	1.0	12	1.5
III	25	M	209	1	0.5	1	0.5	0	0.0	1	0.5
		F	202	0	0.0	0	0.0	1	0.5	1	0.5
		M+F	411	1	0.2	1	0.2	1	0.2	2	0.5
IV	50	M	207	5	2.4	2	1.0	1	0.5	3	1.4*
		F	202	2	1.0	1	0.5	1	0.5	2	1.0
		M+F	409	7	1.7	3	0.7	2	0.5	5	1.2

* Statistically significant $p < .05$ using Fisher exact test.

A statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m) (Falcioni et al, 2018).

Dopo il 2011…

Rischi sanitari non-oncologici

Alterazioni Riproduttive

- ✓ Alterata morfometria e funzionalità spermatica
- ✓ Alterazioni testicolari
- ✓ Alterazioni ovociti
- ✓ Alterata follicologenesi
- ✓ Alterazioni ormonali

Alterazioni Neurologiche

- ✓ Astrogliosi
- ✓ Alterata maturazione neuronale
- ✓ Alterato flusso cerebrale
- ✓ Demielinizzazione neuroni corticali
- ✓ Alterazioni comportamentali
- ✓ Alterazioni della memoria
- ✓ Danno neuronale
- ✓ Riduzione neuroni dopaminergici
- ✓ Alterazioni vescicole sinaptiche
- ✓ …

Alterazioni Metaboliche

- ✓ Alterata espressione geni regolatori trasporto di glucosio
- ✓ Effetti su metabolismo del glucosio e sull'insulina
- ✓ Alterazioni lipidiche
- ✓ Alterata proliferazione cellule staminali derivate da adipociti
- ✓ Alterazioni epatiche e pancreatiche

PubMed.gov
US National Library of Medicine
National Institutes of Health

Dopo il 2011…

BioInitiative Report

il BioInitiative Report, sulla base delle evidenze disponibili indica la necessità di adottare un nuovo livello precauzionale per l'esposizione cronica a RF-EMF (0.3-0.6 nW/cm2, corrispondente a **0.04 V/m**), che è centinaia di volte inferiore ai limiti internazionali indicati dalla ICNIRP (41 Vm per 900 MHz, 58 V/m per 1800 MHz, 61 V/m per 2100 MHz)

“5G for Europe: An Action Plan”

Settembre 2016

EUROPEAN
COMMISSION

Brussels, 14.9.2016
COM(2016) 588 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

5G for Europe: An Action Plan

{SWD(2016) 306 final}

Obiettivo: introdurre il 5G entro il 2018 e la commercializzazione su larga scala entro il 2020

Avvio sperimentazioni con frequenze > 6GHz (onde centimetriche) prima dell’introduzione (medio-lungo termine) delle frequenze tipiche del 5G (>30GHz, “onde millimetriche”), mai impiegate prima con un numero di dispositivi così elevato e su scala così ampia in aree urbanizzate

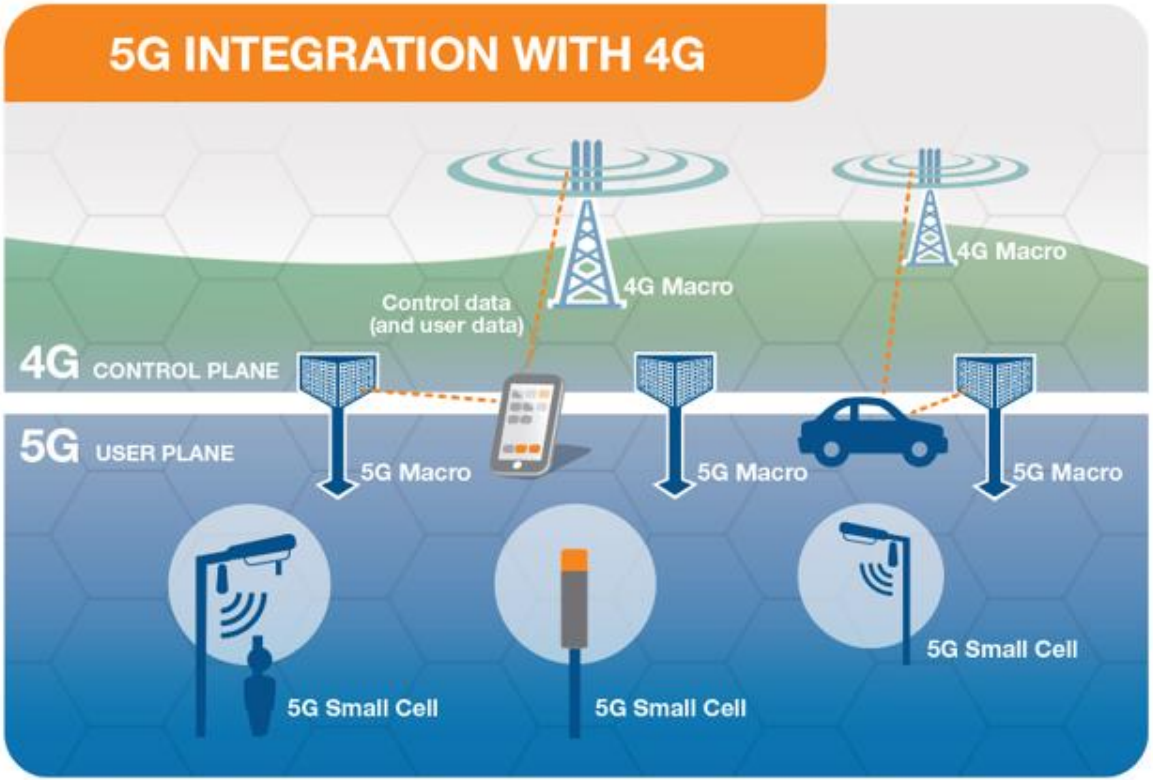
AGCOM, 28 marzo 2017

Autorità per le Garanzie nelle Comunicazioni

INDAGINE CONOSCITIVA CONCERNENTE LE PROSPETTIVE DI SVILUPPO DEI SISTEMI WIRELESS E MOBILI VERSO LA QUINTA GENERAZIONE (5G) E L'UTILIZZO DI NUOVE PORZIONI DI SPETTRO AL DI SOPRA DEI 6 GHZ AI SENSI DELLA DELIBERA N. 557/16/CONS

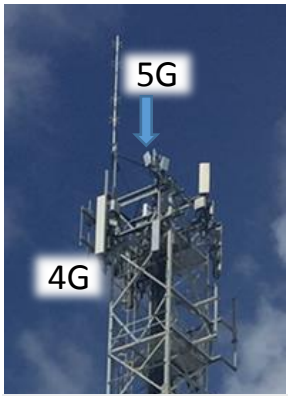
65. Come osservato precedentemente, le reti 5G dovranno servire un numero elevato di clienti/apparati e connettere, secondo le ipotesi prevalenti alla base degli sviluppi di standardizzazione in corso, un ordine di 1 milione di *devices* per Km^2. Tale densità di apparati provocherà un incremento del traffico e la necessità di realizzare celle di dimensioni sempre più piccole per consentire di fornire idonee prestazioni di connettività, con conseguente aumento della densità di antenne installate. La

How does 5G work?



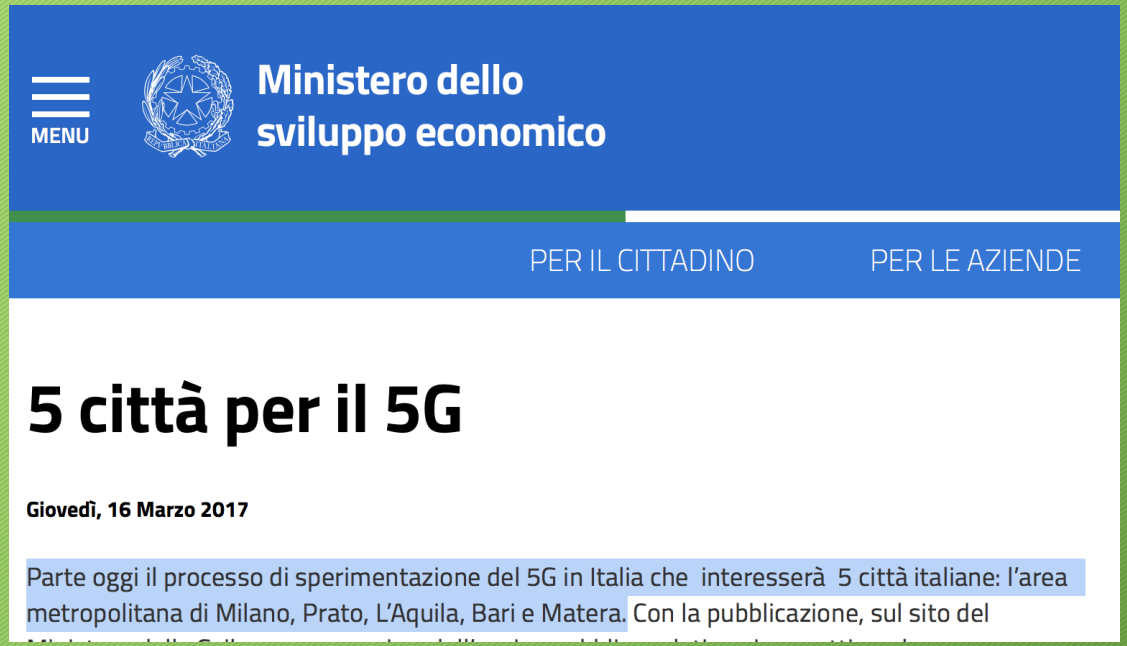
- 5G works together with 4G (initially non standalone NSA)
- 4G acts as control plane
- 5G acts as data/user plane
- 5G will operate stand alone in later releases

5G - 3.5GHz



5G – mmWave 27GHz

La sperimentazione 5G



MENU

Ministero dello sviluppo economico

PER IL CITTADINO PER LE AZIENDE

5 città per il 5G

Giovedì, 16 Marzo 2017

Parte oggi il processo di sperimentazione del 5G in Italia che interesserà 5 città italiane: l'area metropolitana di Milano, Prato, L'Aquila, Bari e Matera. Con la pubblicazione, sul sito del

Circa 4 milioni di italiani esposti a campi elettromagnetici ad alta frequenza addizionali rispetto all'esistente, con densità espositive e frequenze sino ad ora inesplorate su così ampia scala

Il 5G in Italia

MENU

la Repubblica.it

Economia & Finanza con Bloomberg

Seguici su

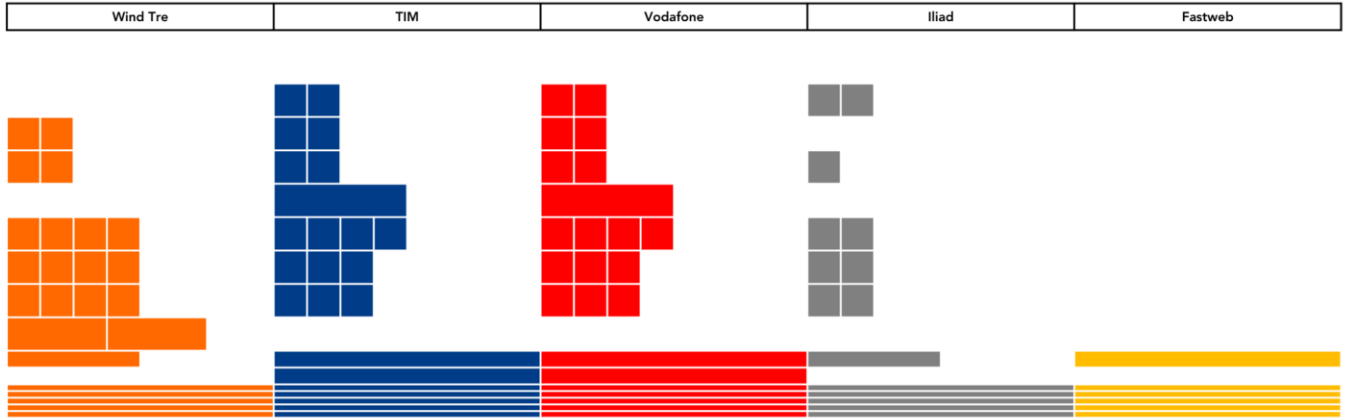
Asta 5G, incasso da Superenalotto: lo Stato avrà 6,55 miliardi per le frequenze

Tim e Vodafone si aggiudicano 80 megahertz nella banda più ambita (la 3,6-3,8). Wind Tre e Iliad conquistano i lotti da 20. La legge di Bilancio aveva ipotizzato entrate da 2,5 miliardi

Ottobre 2018: si chiude l'asta per il 5G, con la quale lo Stato ha incassato oltre 6,5 miliardi vendendo a privati le bande di frequenza che serviranno per questo scopo

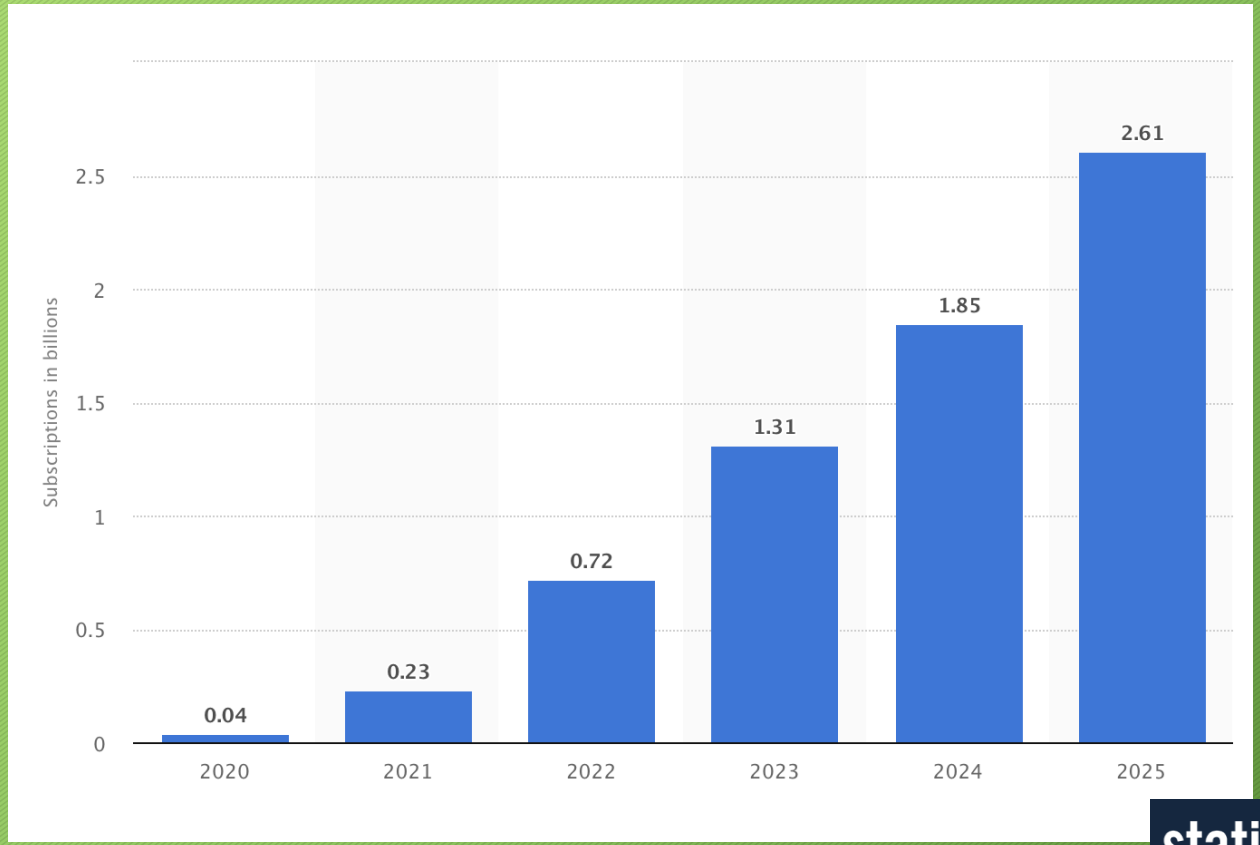
Il 5G in Italia

Bande di frequenza italiane				
Frequenza	Banda	Tecnologia	Rete	Ampiezza Blocchi
700 MHz	28	FDD	5G	5+5 MHz (down+up)
800 MHz	20	FDD	4G	5+5 MHz (down+up)
900 MHz	8	FDD	2G/3G	5+5 MHz (down+up)
1500 MHz	32	SDL	4G	20 MHz (down)
1800 MHz	3	FDD	2G/4G	5+5 MHz (down+up)
2100 MHz	1	FDD	3G/4G	5+5 MHz (down+up)
2600 MHz	7	FDD	4G	5+5 MHz (down+up)
2600 MHz	38	TDD	5G	15 MHz (down&up)
3700 MHz	77	TDD	5G	20--80 MHz (down&up)
26 GHz	258	TDD	5G	200 MHz (down&up)



"bande pioniere" 5G" "prima di pervenire all'impiego … delle bande… identificate nelle gamme di frequenze più alte, … con particolare riferimento alle onde millimetriche… **nella gamma tra 24.25 e 86 GHz**" (*AGCOM, Action Plan 5G*)

Forecast number of 5G subscriptions worldwide from 2020 to 2025 (in billions)



statista
The Statistics Portal
Statistics and Studies from more than 22,500 Sources

5G e RF-EMF: rischio sanitario e ambientale emergente

European Commission

Scientific Committee on Health, Environmental and Emerging Risks

SCHEER

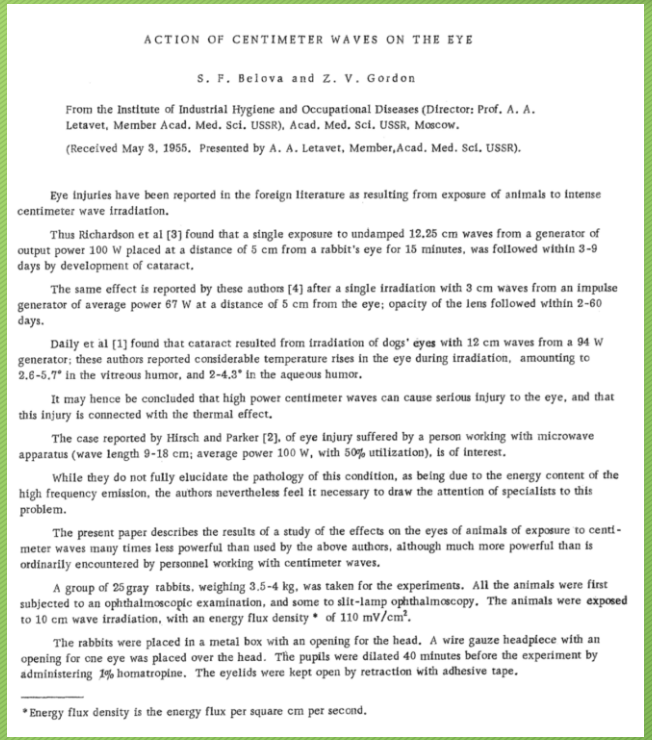
Statement on emerging health and environmental issues (2018)

Topic	**Potential effects on wildlife of increases in electromagnetic radiation**
Initiator(s)	Marian Scott
Sources **Causative factors** **(see section 2section 2 of this document)**	2 e "On the horizon, a new generation of even shorter high frequency 5G wavelengths is being proposed to power the Internet of Things (IoT). The IoT promises us convenient and easy lifestyles with a massive 5G interconnected telecommunications network. However, the expansion of broadband with shorter wavelength radiofrequency radiation highlights the concern that health and safety issues remain unknown. Controversy

Background including reliability of data, a key reference if possible any other reasons for concern.	5G networks will soon be rolled out for mobile phone and smart device users. How exposure to electromagnetic fields could affect humans remains a controversial area, and studies have not yielded clear evidence of the impact on mammals, birds or insects. The lack of clear evidence to inform the development of exposure guidelines to 5G technology leaves open the possibility of unintended biological consequences.

Gli studi sulle “nuove” frequenze

Le onde centimetriche



ACTION OF CENTIMETER WAVES ON THE EYE

S. F. Belova and Z. V. Gordon

From the Institute of Industrial Hygiene and Occupational Diseases (Director: Prof. A. A. Letavet, Member Acad. Med. Sci. USSR), Acad. Med. Sci. USSR, Moscow.

(Received May 3, 1955. Presented by A. A. Letavet, Member, Acad. Med. Sci. USSR).

Eye injuries have been reported in the foreign literature as resulting from exposure of animals to intense centimeter wave irradiation.

Thus Richardson et al [3] found that a single exposure to undamped 12.25 cm waves from a generator of output power 100 W placed at a distance of 5 cm from a rabbit's eye for 15 minutes, was followed within 3-9 days by development of cataract.

The same effect is reported by these authors [4] after a single irradiation with 3 cm waves from an impulse generator of average power 67 W at a distance of 5 cm from the eye; opacity of the lens followed within 2-60 days.

Daily et al [1] found that cataract resulted from irradiation of dogs' eyes with 12 cm waves from a 94 W generator; these authors reported considerable temperature rises in the eye during irradiation, amounting to 2.6-5.7° in the vitreous humor, and 2-4.3° in the aqueous humor.

It may hence be concluded that high power centimeter waves can cause serious injury to the eye, and that this injury is connected with the thermal effect.

The case reported by Hirsch and Parker [2], of eye injury suffered by a person working with microwave apparatus (wave length 9-18 cm; average power 100 W, with 50% utilization), is of interest.

While they do not fully elucidate the pathology of this condition, as being due to the energy content of the high frequency emission, the authors nevertheless feel it necessary to draw the attention of specialists to this problem.

The present paper describes the results of a study of the effects on the eyes of animals of exposure to centimeter waves many times less powerful than used by the above authors, although much more powerful than is ordinarily encountered by personnel working with centimeter waves.

A group of 25 gray rabbits, weighing 3.5-4 kg, was taken for the experiments. All the animals were first subjected to an ophthalmoscopic examination, and some to slit-lamp ophthalmoscopy. The animals were exposed to 10 cm wave irradiation, with an energy flux density * of 110 mV/cm^2.

The rabbits were placed in a metal box with an opening for the head. A wire gauze headpiece with an opening for one eye was placed over the head. The pupils were dilated 40 minutes before the experiment by administering 1% homatropine. The eyelids were kept open by retraction with adhesive tape.

*Energy flux density is the energy flux per square cm per second.

3 maggio 1955

“…Centimeter waves can cause serious injury to the eye…”

Gli studi sulle “nuove” frequenze

Le onde centimetriche

JPRS 57209

10 October 1972

HYGIENIC PROBLEMS OF THE EFFECT OF MICROWAVE ELECTROMAGNETIC FIELDS ON THE BODY

By

M. P. Troyanskiy

JOINT PUBLICATIONS RESEARCH SERVICE

Investigations into the effect of a microwave field on the human body and animals primarily confirm the fact that microwave radiations possess a high biological effectiveness over a wide range of wavelengths. The nature

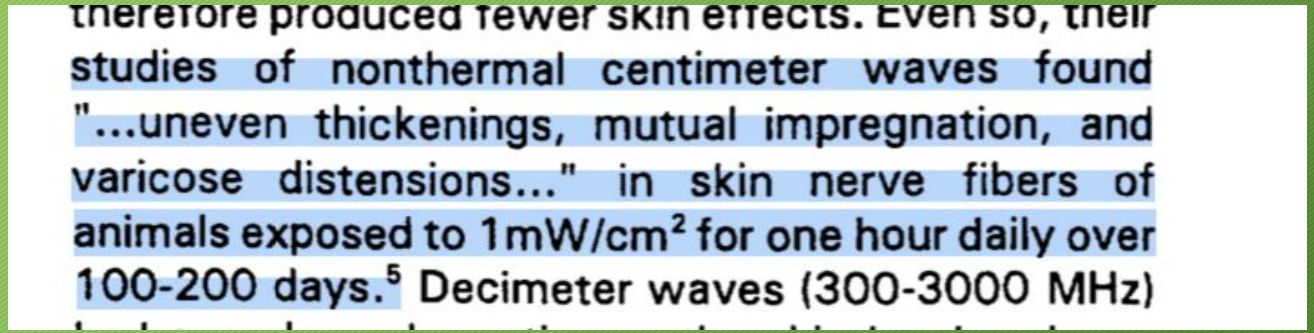
continuous, in a fixed beam or rotating antenna mode, and so on). The greatest interest as well as the most practical value lies in data on non-thermal -- specific -- microwave field effects*. In its most general form, the specific effect of a microwave field appears in functional changes in the nervous, cardiovascular, and other systems. This is confirmed in an experiment on animals using conditioned reflex procedures, electroencephalo-

Data obtained by studying volunteers is of great value. An analysis of the body changes under the influence of microwave irradiation indicates that the damage pattern is primarily determined by the changes in the nervous system. It is therefore natural that the attention of researchers,

Gli studi sulle “nuove” frequenze

Le onde centimetriche

Letavet, A.A. and Z.V. Gordon, eds. The Biological Action of Ultrahigh Frequencies. USSR: Academy of Medical Sciences, 1960.



therefore produced fewer skin effects. Even so, their studies of nonthermal centimeter waves found "...uneven thickenings, mutual impregnation, and varicose distensions..." in skin nerve fibers of animals exposed to 1mW/cm^2 for one hour daily over 100-200 days.[5] Decimeter waves (300-3000 MHz)

Gli studi sulle “nuove” frequenze

Le onde centimetriche

1970

79. Prevention of the pathogenic effects of centrimetric radiation

PEPERSACK J. P., *Belgium*

The centrimetric radiation emitted by radar apparatus may have thermal and biological effects on the human organism. Beyond a certain threshold these effects may become dangerous, particularly to the eyes, testicles, lungs, bladder and digestive tract.

Accordingly, preventive measures are necessary. Operators must be protected as much as possible from the harmful radiations by using screens and special materials.

Their working conditions should be accurately examined. Periodical medical examination is necessary in order to detect any damage that may nevertheless occur.

Gli studi sulle “nuove” frequenze

Le onde centimetriche

Soviet and Eastern European Research on Biological Effects of Microwave Radiation

DONALD I. MCREE

Jan 1980

TABLE II

SOME RESULTS OF EXPERIMENTAL STUDIES ON THE BIOLOGICAL EFFECTS OF VERY LOW INTENSITY MICROWAVES (UP TO 150 $\mu W/cm^2$) [6]

Investigated Function	Radiation intensity $\mu W/cm^2$	Character of Changes	Investigator
Body Weight	150	Lag in weight (chronic experiment)	V. V. Markov
Arterial Pressure	150	Biphasic course with marked hypotension (chronic experiment)	V. V. Markov
Reproductive Function	150	Decreased fertility, decreased litter size, increased number of defective progeny, increased embryonic mortality etc. (chronic experiment)	A. N. Bereznitskaya *et al.*
Central nervous system	10–20 and higher	1) EEG changes with predominant synchronization (acute experiment)	Z. V. Gvozdikcova *et al.*
	150	2) Bivariant shifts with predominance of activation (acute experiment)	
	150	3) Bivariant shifts in the subcortical-basal structures (chronic experiment)	
Electromyography	150	Increased electrical activity of active unit	V. V. Markov
Hypothalamus-adrenal cortex system	150	1) Weight change of endocrine glands hypophysis adrenals)	N. K. Demokidova
		2) Change in the neurosecretory function of the hypothalamus	
		3) Tendency for increased levels of norepinephrine in the adrenals	
Metabolism	150	Changes in water and electrolyte metabolism (Na, K, water, and total nitrogen excretion)	N. K. Demokidova
Immunology	150	Inhibition of neutrophils phagocytic activity	A. P. Vokova and V. V. Markov

Fino alla fine degli anni ’70

- Limite URSS 0.010 mW/cm2 (19 V/m)
- Limite USA 10 mW/cm2 (190 V/m, 1000 volte superiore)

The Moskow Signal

ADVANCED RESEARCH PROJECTS AGENCY
WASHINGTON, D. C. 20301

20 December 1966

MEMORANDUM FOR THE RECORD

SUBJECT: Project PANDORA - Initial Test Results

Reference: PANDORA-BIZARRE Test Results - Memo dated 15 Dec 66

I. BACKGROUND

For more than five years, the American Embassy in Moscow has been radiated with low level electromagnetic signals (the Moscow Signal) on a more or less daily basis for several hours a day. These signals, in the "S" and "L" band spectrum, have been in part recorded and are of complex modulation with a pattern of variation, some of which seems to be random.

The White House has directed, through USIB, that intensive investigative research be conducted within the State Department, CIA and DOD to attempt to determine what the threat is. The National Program has been coordinated by the State Department, under code name, "TUMS." ARPA is represented and is conducting research on a selective portion of the overall program concerned with one of the potential threats, that of the effects of low level electromagnetic radiation on man. This memorandum summarizes the initial test results obtained from this program called PANDORA.

L'Ambasciata USA a Mosca fu irradiata (microonde) dal 1953 ad Aprile 1979.
La vicenda fu tenuta segreta dagli USA fino al 1972, quando furono informati gli impiegati

Gli studi sulle “nuove” frequenze

Anni ’50-’80:
Risultati derivati da osservazioni cliniche / anatomo-fisiologiche e non biologico-molecolari ma concordanti su due punti fondamentali:

- ✓ Presenza di effetti biologici INDIPENDENTI dall’effetto termico (l’unico valutato da ICNIRP)
- ✓ Effetti SISTEMICI

Gli studi sulle “nuove” frequenze

Le onde centimetriche

Electromagnetic Biology and Medicine, 31(3): 223–232, 2012
Copyright © Informa Healthcare USA, Inc.
ISSN: 1536-8378 print / 1536-8386 online
DOI: 10.3109/15368378.2012.700293

informa
healthcare

2012

Impact of Microwave at X-Band in the aetiology of male infertility

Sanjay Kumar[1,2], J. Behari[1] & Rashmi Sisodia[2]

[1]*Bioelectromagnetic Laboratory, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India, and* [2]*Department of Zoology, Neurobiology Laboratory, University of Rajasthan, Jaipur, India*

Reports of declining male fertility have renewed interest in assessing the role of environmental and occupational exposures to electromagnetic fields (EMFs) in the aetiology of human infertility. Testicular functions are particularly susceptible to electromagnetic fields. The aim of the present work was to investigate the effect of 10-GHz EMF on male albino rat's reproductive system and to investigate the possible causative factor for such effect of exposure. The study was carried out in two groups of 70-day old adult male albino rats: a sham-exposed and a 10-GHz-exposed group (2 h a day for 45 days). Immediately after completion of the exposure, animals were sacrificed and sperms were extracted from the cauda and caput part of testis for the analysis of MDA, melatonin, and creatine kinase. Creatine kinase results revealed an increased level of phosphorylation that converts creatine to creatine phosphate in sperms after EMF exposure. EMF exposure also reduced the level of melatonin and MDA. It is concluded that microwave exposure could adversely affect male fertility by reducing availability of the above parameters. These results are indications of deleterious effects of these radiations on reproductive pattern of male rats.

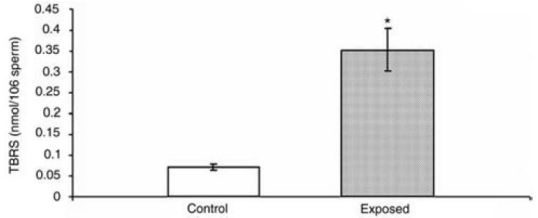


FIGURE 2 Effects of electromagnetic field on MDA production in sperm. Data were presented as mean ± SEM. *significantly different form the control ($P < 0.05$).

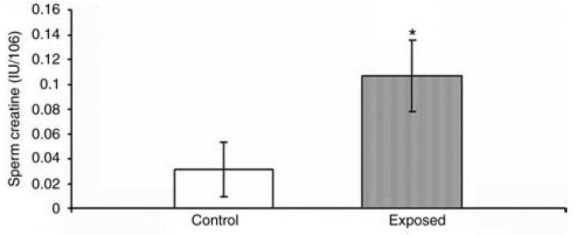


FIGURE 4 Creatine kinase activity in sperm fractions of control and 10 GHz-exposed group. Results expressed as IU/106 spermatozoa ± standard deviation. *Significantly different form the control ($P < 0.05$).

Gli studi sulle “nuove” frequenze

Le onde centimetriche

Journal of Radiation Research, 2015, 56, 261–268
doi: 10.1093/jrr/rru097 Advance Access Publication 30 October 2014

Effects of fetal microwave radiation exposure on offspring behavior in mice

Yanchun ZHANG, Zhihui LI, Yan GAO* and Chenggang ZHANG

2015

Topi esposti in utero a 9.4 GHz durante la gravidanza:

- aumento comportamenti di tipo ansioso
- riduzione apprendimento e memoria (maschi)

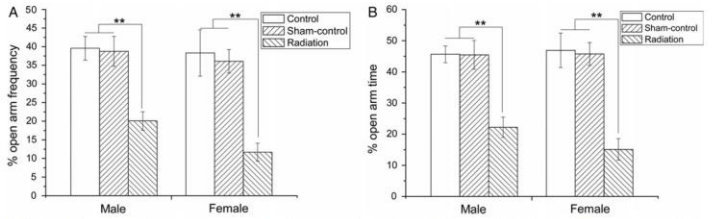


Fig. 2. The effect of fetal microwave exposure on anxiety as determined using EPM. Compared with the Control and Sham-control mice, the offspring of exposed mice had a lower percent open arm frequency (**A**) and percent open arm time (**B**), suggesting anxiety-related behavior, in accordance with the OFT. Data are means ± SEM, 12 animals per group; $^{**}P < 0.01$, vs corresponding values in Control and Sham-control groups.

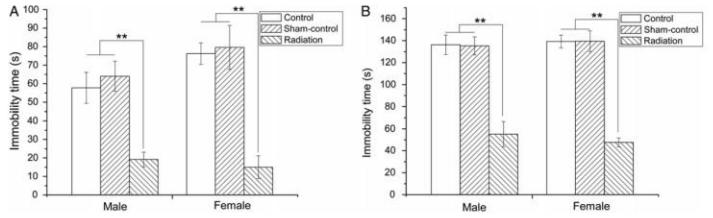
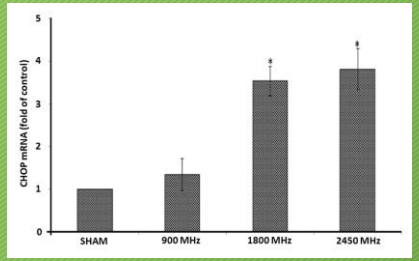
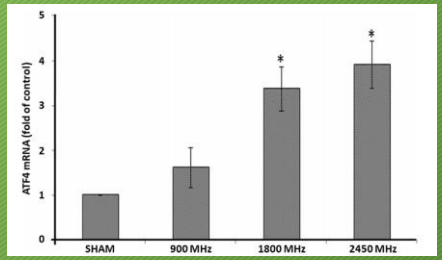


Fig. 3. The effect of fetal microwave exposure on depression based on the TST and FST. Radiation exposure decreased the immobility time compared with the Control and Sham-control mice in TST (**A**) and FST (**B**), illustrating the decreased depression-related behavior. Data are means ± SEM, 12 animals per group; $^{**}P < 0.01$, versus corresponding values in Control and Sham-Control groups.

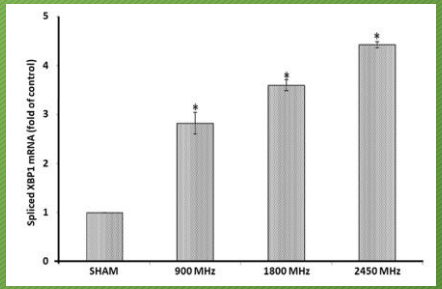
Gli studi sulle “nuove” frequenze

Male Wistar rats exposed to microwave radiation for 30 days at 900 MHz, 1800 MHz, and 2450 MHz frequencies





Altered mRNA expression of transcription factors ATF4, CHOP, and XBP1 with increasing microwave frequency

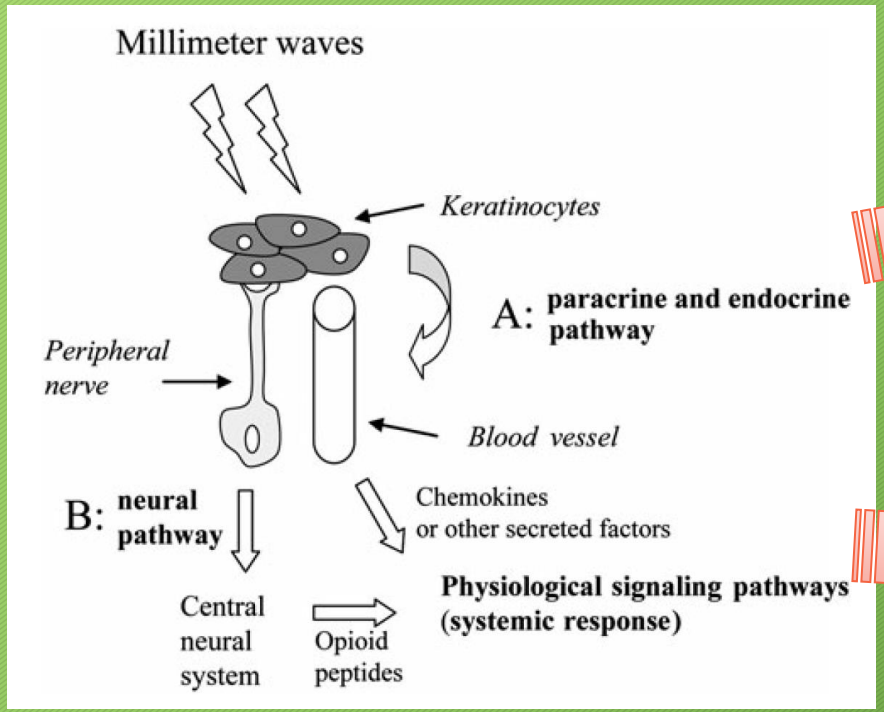


“alterations … might be the possible cause for cognitive impairment and memory dysfunction”

(Kumar et al, 2019)

Gli studi sulle “nuove” frequenze

Le onde millimetriche



Effetti locali

Effetti sistemici

Gli studi sulle “nuove” frequenze

Le onde millimetriche

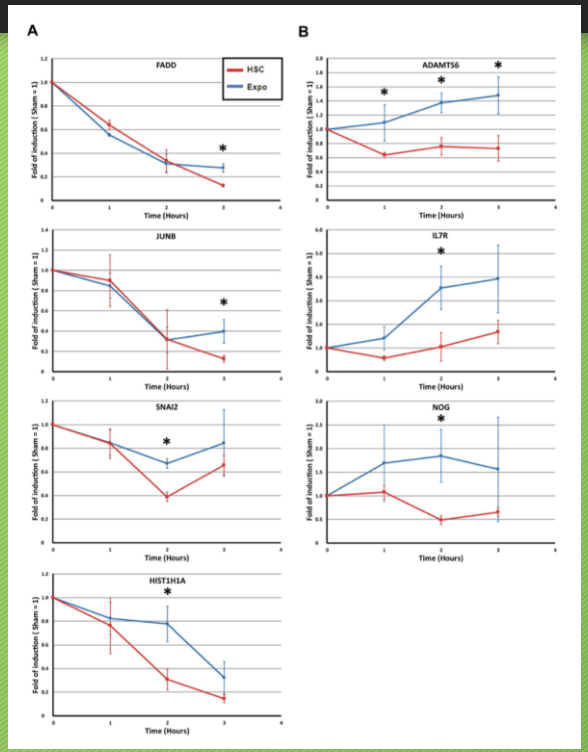
Pubblicazioni ultimo decennio

- Alterazioni dell’espressione genica
- Incremento della temperatura cutanea
- Stimolazione proliferazione cellulare
- Alterazione funzionalità membrana cellulare
- Alterazioni neuro-muscolari

PubMed.gov
US National Library of Medicine
National Institutes of Health

Gli studi sulle “nuove” frequenze

Le onde millimetriche



In cheratinociti umani le MMW

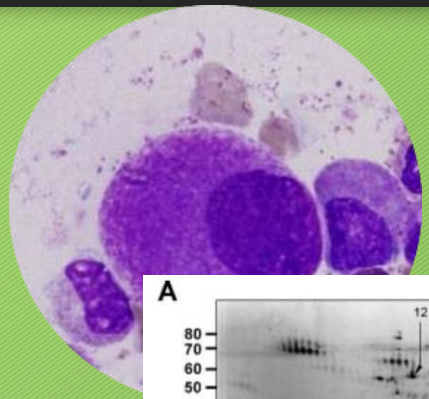
- alterano l’espressione di 7 geni (ADAMTS6, NOG, IL7R, FADD, JUNB, SNAI2, HIST1H1A)

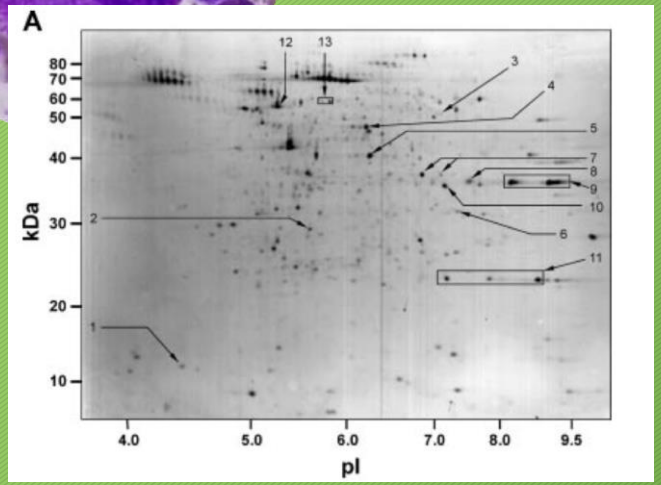
- 3 di questi geni (ADAMTS6, NOG, IL7R) codificano l’espressione di proteine specificamente indotte da MMW e coinvolte nella sintesi proteica e nell’omeostasi del reticolo endoplasmico

Habauzit et al, 2014

Gli studi sulle “nuove” frequenze

Le onde millimetriche



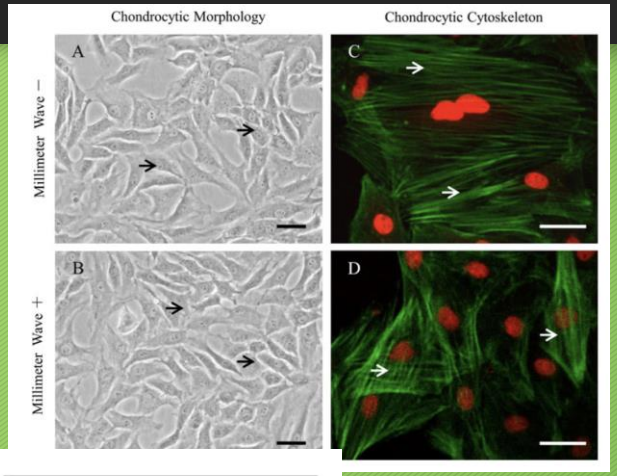


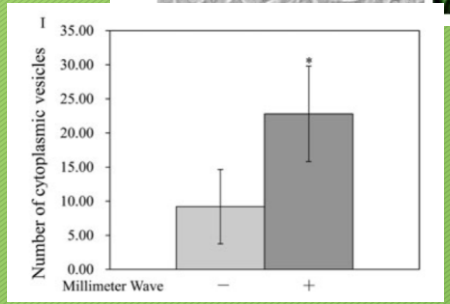
I macrofagi di ratti esposti a MMW (35 GHz) mostrano aumentata espressione genica di 11 proteine e alterazioni strutturali in 3 proteine coinvolte in processi infiammatori, stress ossidativo e metabolismo energetico

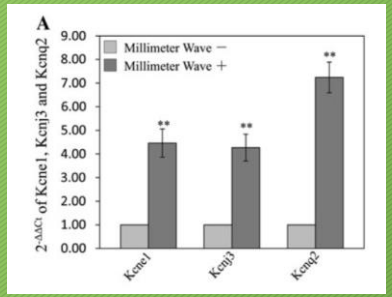
Sypniewska et al, 2010

Gli studi sulle “nuove” frequenze

Le onde millimetriche







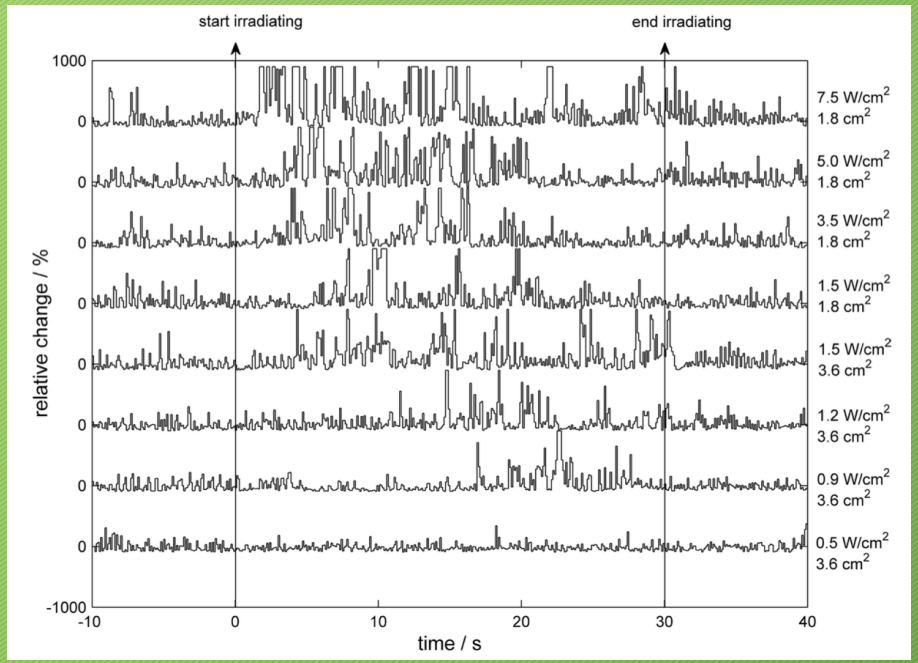
Le MMW stimolano la proliferazione cellulare di condrociti (alterati morfologicamente per espansione dei mitocondri e del RER) e la sintesi di matrice extracellulare regolando l’attività dei canali del K+

Effetti espressione dell’alterata omeostasi del metabolismo energetico

Li X et al 2013

Gli studi sulle “nuove” frequenze

Le onde millimetriche

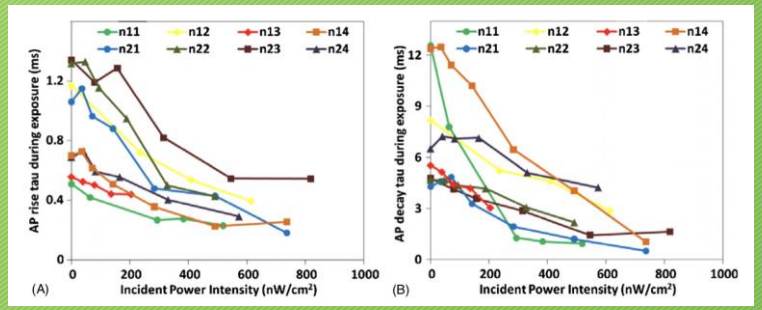


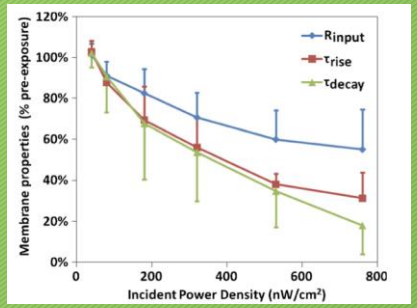
L’irradiazione di ratti con MMW causa incremento temperatura cutanea e reazioni EEG da stress

Xie T et al, 2011

Gli studi sulle “nuove” frequenze

Le onde millimetriche





In neuroni corticali piramidali l’applicazione di MMW a livelli di intensità molto inferiori ai limiti di legge alterano la funzionalità neuronale e le proprietà di membrana

L’effetto non è spiegabile con il solo aumento di temperatura ed è legato all’assorbimento delle MMW da parte del tessuto nervoso, attraverso interazioni dirette con la membrana plasmatica neuronale

Pikov V et al, 2010

Gli studi sulle “nuove” frequenze

Le onde millimetriche

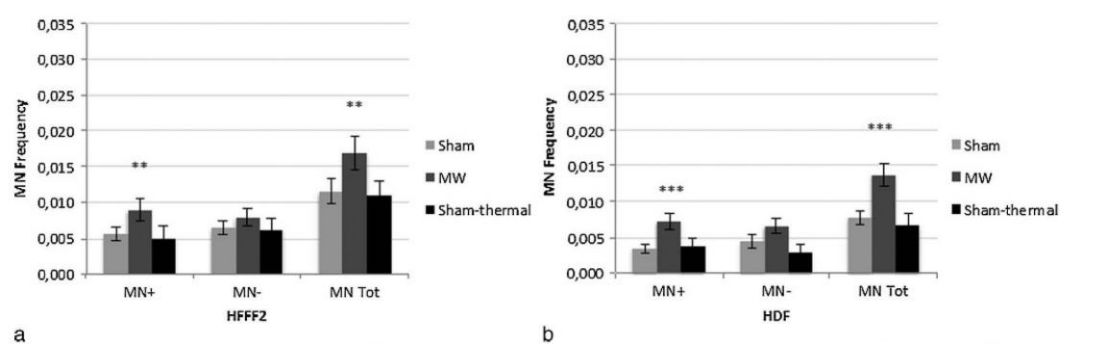


Fig. 6. CREST analysis. A significant increase in MN+ and MN total (Tot) in irradiated samples was observed in (a) fetal and (b) adult fibroblasts. Data are representative of four independent experiments and bars denote SE, $^{**}p < 0.01$, $^{***}p < 0.001$.

L’esposizione di fibroblasti umani (adulti e fetali) a 25 GHz per 20 minuti determina effetti sui cromosomi (aneuploidia) ben noti come predisponenti al cancro

“The increased number of aneuploid cells seems to predispose cells to malignant transformation”

Considering everyone’s constant daily exposure to MW radiation, the results … obtained in this study could contribute to the evaluation of the risks for human health”

Franchini V et al, 2018

Conclusioni (1)

Le evidenze sugli effetti biologici dei RF-EMF si stanno progressivamente accumulando e, nonostante la presenza di aspetti ancora da chiarire, dimostrano l'esistenza di interazioni a più livelli tra RF-EMF e sistemi biologici e la possibilità di effetti oncologici e non oncologici (soprattutto riproduttivi, metabolici, neurologici)

Effetti biologici sono stati documentati anche per esposizioni molto inferiori ai limiti vigenti, che non appaiono dunque in grado di tutelare al meglio la salute pubblica

Conclusioni (2)

Particolari preoccupazioni derivano dall'ampia diffusione dei campi RF-EMF, dall'aumentata vulnerabilità in età pediatrica e dagli effetti a livello cellulare e molecolare (stress ossidativo, danno al DNA, alterazioni dell'espressione genica, influenza sulla riproduzione cellulare)

Nonostante siano necessari ulteriori studi, sottostimare i risultati già disponibili non appare eticamente accettabile, perché significherebbe accettare che un pericolo potenziale possa essere verificato solo a posteriori, dopo che gli effetti dei campi RF-EMF avranno avuto tempo e modo di generare danni

Conclusioni (3)

I risultati già disponibili sono sufficienti ad invocare il principio di precauzione, anche considerato l'elevato numero di soggetti esposti e vulnerabili e le possibili interazioni con sorgenti inquinanti di altro tipo

Il rispetto del principio OMS "health in all policies" dovrebbe imporre, prima dell'avvio del 5G su larga scala:

- il coinvolgimento degli enti deputati alla tutela della salute pubblica (Ministero Salute, ISPRA/ARPA)
- una revisione in senso più cautelativo della normativa vigente
- l'adozione di tutte le misure utili a ridurre l'esposizione

THURSDAY, 04 APRIL 2019

THE BRUSSELS TIMES

Radiation concerns halt Brussels 5G development, for now

Monday, 01 April 2019 10:54

© Belga

Plans for a pilot project to provide high-speed 5G wireless internet in Brussels have been halted due to fears for the health of citizens, according to reports.

"I cittadini di Bruxelles non sono cavie la cui salute possa essere venduta per profitto".

Céline Fremault, Ministro per l'Ambiente, Belgio

Grazie per l'attenzione

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