Are Cellphones Dangerous?

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Disclosures

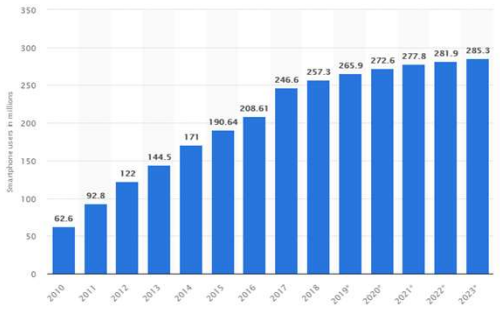
- I have no conflicts of interest for this talk

Contents

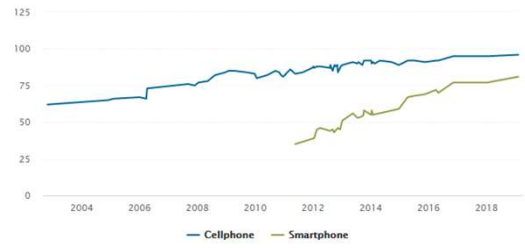
- Scope of problem
- Generations
- What's new in the Fifth generation
- Radiation Safety of prior generations
- Safety of 5G radio transmission (millimeter wave)
- Other Hazards of 5G cell phone use
- Conclusions

Is It Safe

U.S. Smart Phone Users



Percent of U.S. adults who own the following devices



https://www.pewresearch.org/internet/fact-sheet/mobile/, accessed 12/9/19.

Cell Phone Usage

- Expected to require support for 24 billion devices by 2024
  - 3 devices for every individual in the world

Cell Phone Fun Facts

- Average time spent on cell phones/day – 2.51 hours
  - If you include tablets – 4.33 hours
- Of smartphone users, 22% check every few minutes
  - 51% check a few times/hour
- Time spent on social apps – 1 hour, 16 minutes
- Number of times phone is tapped/day – 2,617

Cell Phone Fun Facts

- Average smartphone user checks phone 63 times/day
- 86% of cell phone users check their phone while interacting with others
- 58% tried to limit use
  - 41% were successful
- 87% check phone within 1 hour of going to bed
  - 69% within 5 minutes

Cell Phone Fun Facts

- 71% of people sleep with or next to their cell phones.
- **35% of people think of their cell phones when they wake up while only 10% of people think of their significant others.**
- 44% of 18-24 year olds have fallen asleep with their phone in their hand.
- 36% of people check their phones constantly, while 54% of young adults are checking constantly.
- Nearly 40% of people never disconnect from cell phones, even while on vacation.
- 44% of Americans say they couldn't go a day without their mobile devices.

What does "G" Refer to?

- G = Generation
  - Created by the International Telecommunications Union (ITU)
    - Agency of the United Nations
  - Be careful because now people are discussing 10 G transmission in which the G stands for Gigabyte (or Gigabyte/second) – a transmission speed.
- 1G
  - Created in 1979
  - Voice only
  - Analog service
    - Advance Mobile Phone System launched by US
  - Limited to 1 country
  - Maximum speed – 2.4 kbps

2G

- Started in Finland, 1991
- Digital as well as analog
- Digital voice
- Call/text encryption
- SMS, picture messaging, MMS
- Maximum speed – 64 kbps
- Semi-global facility

3G

- Requirements
  - 200 kbit/s peak speed
- Started in 1998
- More data
- Video calling
- Mobile internet
  - E-mail, PDA, information surfing, on-line shopping
- Max speed - 2 mbps when stationary, 384 kbps when moving
- Global roaming

4G

- Developed in 2010
  - Peak speed of 100 Mbits/sec for high mobility, 1 Gbit/sec for low mobility
- Easy roaming
- Current standard in most places
- Supports high-definition mobile TV, video conferencing
- Max speed – 10's of mbps when moving, 100's when stationary (500 times faster than 3G) – up to 400 Mbps

Phone Uses

Other Standards

- 3.5G
- 3.95G
- 4G LTE
- 4G LTE-A

5G Specifications

- Up to 10Gbps data rate - > 10 to 100x improvement over 4G and 4.5G networks
- 1-millisecond latency
- 1000x bandwidth per unit area
- 99.999% availability
- 100% coverage
- 90% reduction in network energy usage
- Up to 10-year battery life for low power IoT device

Differences Between 4G and 5G

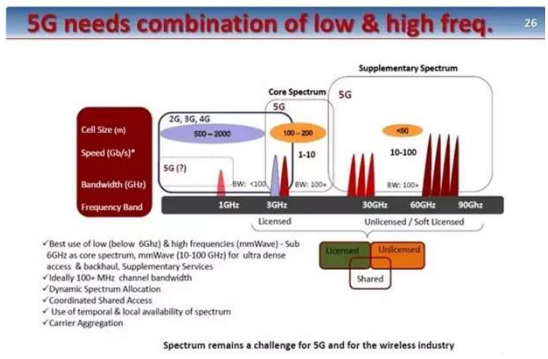
- Peak capacity will be up to 50 times faster (in gbps)
- Latency (the time that passes from the moment information is sent from a device until it is used by the receiver is greatly reduced
  - Results in faster uploads and downloads
  - 20-30 milliseconds for 4G, <10 milliseconds for 5G
- Bandwidth size is greater
  - Should be able to stream a 4K video in seconds.
  - 4G supports 4,000 devices vs. 1,000,000/km^2 for 5G
- Less interference

Differences between 4G and 5G

- Frequency range is higher
  - 4G is up to 6 GHz
  - 5G is up to 300 GHz
- Penetration is less for 5G
  - More difficult to get reception in buildings
- Limited reach
  - More towers are required
    - Every 100 – 200 meters vs. Kilometers apart
  - Lower heights for towers (closer to people)
- Transmitted power is less as distances are closer
  - Batteries last longer
  - Better efficiency

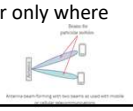
5G Spectrum

- Three portions
  - <1 GHz
  - 1-6 GHz
    - Core Frequency
  - 6-300 GHz (Supplementary)
    - Millimeter wavelength
    - Enables extremely high data rate
    - Limited range, penetrability
    - Small cells



Innovations in 5G

- Duplex Transmission
  - Both up and downstream transmission simultaneously
- Millimeter wavelength
- Massive MIMO
  - With millimeter wavelengths can have many small antennas
- Beam Forming
  - Phased array so that you beam the power only where it is needed (not circumfentially)



5G Tower

Capabilities of 5G

- Use a 5G WIFI router instead of broadband
- Enable remote operators of robotics
  - Factories, mines, surgery
- Establish connected/smart cities
- Autonomous vehicles
- Healthcare applications (patient monitoring)
- Drones
- The internet of things (IoT)

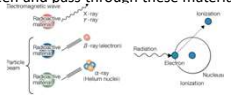
Hazards of Cell Phone Use (1G – 5G)

- Radiation
- Other

Electromagnetic Spectrum

Definitions

- **Ionizing radiation** is a form of energy that acts by removing electrons from atoms and molecules of materials that include air, water, and living tissue. Ionizing radiation can travel unseen and pass through these materials.



- **Non-ionizing** (or **non-ionising**) **radiation** refers to any type of electromagnetic radiation that does not carry enough energy per quantum (photon energy) to ionize atoms or molecules—that is, to completely remove an electron from an atom or molecule. Instead of producing charged ions when passing through matter, non-ionizing electromagnetic radiation has sufficient energy only for excitation, the movement of an electron to a higher energy state.

One Equation

- $E = h\nu$
  - Where E is energy
  - h is Planck's constant
  - ν is frequency
  - Equivalently $E = h/\lambda$
  - λ is wavelength
- Therefore, the higher the frequency, the greater the energy
  - And, the shorter the wavelength, the greater the energy

Examples

- Ionizing Radiation
  - X-rays
  - Gamma-rays
  - Far ultra-violet

Non-ionizing Radiation

- Does not cause changes in DNA
- Does not cause cancer directly
- Does warm the skin with limited penetration
  - Can cause skin burns, corneal damage
- Lower penetration with higher frequencies
  - May reflect off skin

Examples

- Non-ionizing Radiation
  - Near UV
  - Visible light
  - Infrared/Thermal radiation
  - Microwave/mm wavelength
  - Radio waves

Sources of Radiation

- Tower
  - Downstream
- Handsets
  - Upstream

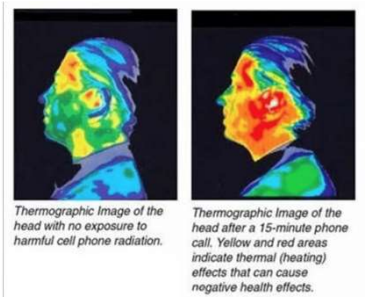
Question

- If radiation is non-ionizing, how can it cause damage?
  - Thermal effects
  - Other
    - These are not well characterized, and are not used in limit setting
    - Can include impacts on cell growth, proliferation rates, activity of enzymes, state of cell genetic apparatus, function of excitable membranes/peripheral receptors, rates of stress reactions, rates of tissue repair/regeneration, gene expression, other.

Thermal Thresholds

- Humans can detect 0.1 °C temperature increase
- 1 °C is considered safe
- 10 °C increase causes pain
- > 10 °C can cause thermal injury

Thermographic Changes



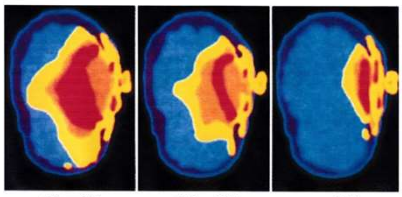
Thermographic Image of the head with no exposure to harmful cell phone radiation.

Thermographic Image of the head after a 15-minute phone call. Yellow and red areas indicate thermal (heating) effects that can cause negative health effects.

Penetration Varies by Age

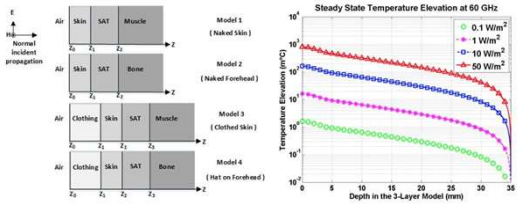
Microwave Cellphone Effects

Absorption in the Brain According to Age



5 Year Old **10 Year Old** **Adult**

Image courtesy of Dr. Om Gandhi, University of Utah, 1996, IEE Publication



How do we Quantify the Amount of Radiation?

- Specific Absortion Rate (SAR) (<6 GHz)
  - Power absorbed per kilogram
    - Watts/Kg
- Power Density (PD) (>6 GHz)
  - Power per unit area
    - Watts/square meter
- Temperature increase

Guidelines for Non-Ionizing Radiation: What's Safe?

- International Commission on Non-Ionizing Radiation Protection (ICNIRP)
  - 1998, 2019.
- IEEE C95.1, "IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields"
  - Developed by the IEEE International Committee on Electromagnetic Safety.
  - 2005, 2019
  - Covers the spectrum between 3 kilohertz and 300 GHz.
  - The Future Networks report goes into detail about the various exposure limits for the body listed in those documents.

Limits on SAR
Frequencies < 6 GHz

- The FCC's limit for mobile phones is a specific absorption rate (SAR) of 1.6 watts per kg (1.6 W/kg) of mass
  - Much less than amount required to warm up your body by 1 °C.
  - Smartphones marketed in the U.S. must demonstrate compliance with this limit before they go on sale.
  - Developed in conjunction with IEEE, FDA
- ICNIRP guidelines (used for frequencies < 10 GHz) used in Europe and most other countries set this limit at around 2.0 W/kg.

FCC Use of SAR

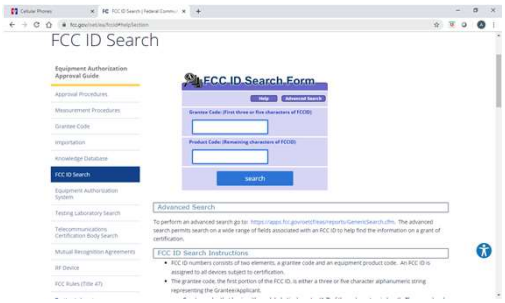
- FCC hasn't updated its SAR level recommendations in nearly 25 years
  - It has been reviewed by other groups
  - Specifically, In March of last year, the engineering group IEEE recommended the safety levels remain about the same as they have been since 1996.
  - In August 2019, FCC said they would remain the same

47 CFR §1.1310

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	* 100	6
3.0-30	1842/f	4.89/f	* $900/f^2$	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* 100	30
1.34-30	824/f	2.19/f	* $180/f^2$	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

How to Find the SAR



Guidelines for Non-Ionizing Radiation

- ICNIRP and IEEE limits for radiation were revised downward this year in the > 6 GHz band
  - Local field decreased from 40 W/m^2 to 20 W/m^2 for averaging over 4 cm^2 and 60 W/m^2 to 40 W/m^2 for averaging over 1 cm^2
  - Far field decreased from 100 W/m^2 to 10 W/m^2 for 30-300 GHz
  - Other countries have lower limits
    - Belgium, India, Russia

Table 2.1: The variations of exposure limits on PD to RF radiation in several countries [17].

Country/Guidelines	PD Restrictions for General Public in W/m^2	Frequency Range (GHz)
ICNIRP (1998)	10	2-300
FCC (1996)	10	1.5100
China (1987)	0.10	0.3-300
Russia (2003)	0.10	0.3-300
Switzerland (2000)	0.10	1.8-300
Italy (2003)	0.10	0.0001-300

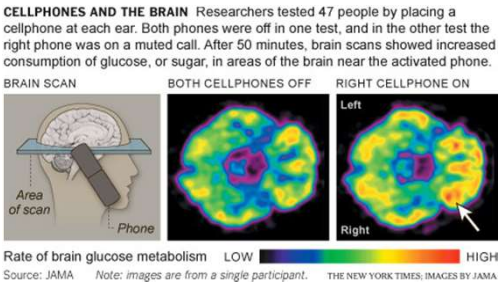
Table 2.2: Comparison of the FCC and ICNIRP local SAR limits in the head and trunk for the general public. [17].

Exposure Standard	SAR limit for RF Near field exposure (W/kg)	Frequency Range (MHz)
ICNIRP	2	10-10000
FCC	1.6	0.1-6000

Additional Mechanism of Damage

- Suppose it isn't just thermal energy that is the problem?
- In 93/100 studies, non-ionizing radiation caused excessive reactive oxygen species
- Overproduction leads to free radicals.
- Free radical (such as hydrogen peroxide) can lead to damage in DNA, proteins, membrane lipids and mitochondria
- This could result in cancer

Glucose Metabolism Changes



Cell Tower Studies

- British study compared about 1,000 families of young children with cancer against a similar group of families of children without cancer.
  - No link between a mother's exposure to the towers during pregnancy and the risk of early childhood cancer.
- 2,600 children with cancer were compared to a group of similar children without cancer.
  - If they lived in a town that could have exposed them to higher than average RF radiation from cellular phone towers in the previous 5 years, they had a slightly higher risk of cancer, although not of any certain type of cancer (like leukemia or brain tumors).
- DNA damage was no worse in people who lived near a cell phone tower as compared with those didn't.

What do the Studies Show for Prior Generations

- National Toxicology Program
- Used rats exposed to 3G radiation
- Showed increased incidence of:
  - Heart tumors
  - Brain tumors
  - Adrenal tumors
  - Only in males
- Level and duration of radiation was greater than that found in cell phone users (4x)
  - Entire body irradiated
- Irradiated rats lived longer than controls
- The study is not very informative

Cell Phone Studies

- INTERPHONE study
  - Compared 5,000 people who developed brain tumors (gliomas or meningiomas) and a similar group of people without tumors.
  - The study found no link between brain tumor risk and the frequency of calls, longer call time, or cell phone use for 10 or more years.
  - Suggestion of a possible increased risk of glioma, and a smaller suggestion of an increased risk of meningioma, in the 10% of people who used their cell phones the most.
  - Researchers noted that the shortcomings of the study prevented them from drawing any firm conclusions, and that more research was needed.
  - Also compared more than 1,000 people with acoustic neuromas to more than 2,000 people without tumors, who served as matched controls.
    - As with gliomas and meningiomas, there was no overall link between cell phone use and acoustic neuromas.
    - There was again a suggestion of a possible increased risk in the 10% of people who used their cell phones the most, but this was hard to interpret because some people reported implausibly high cell phone use, as well as other issues.

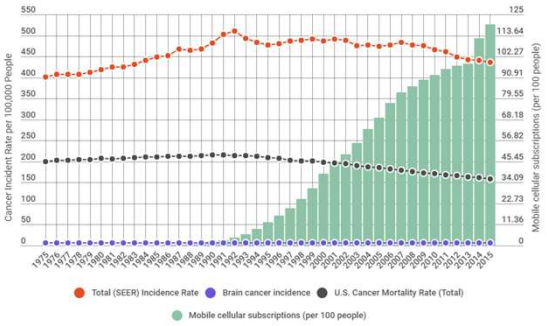
Cell Phone Studies

- Danish Cohort Study
  - Compared all of the people in Denmark who had a cell phone subscription between 1982 and 1995 (about 400,000 people) to those without a subscription to look for a possible increase in brain tumors
  - More recent update of the study followed people through 2007.
  - Cell phone use, even for more than 13 years, was not linked with an increased risk of brain tumors, salivary gland tumors, or cancer overall, nor was there a link with any brain tumor subtypes or with tumors in any location within the brain.

Cell Phone Studies

- Million Woman Study
  - Prospective study
  - 800,000 women in the UK
  - examined the risk of developing brain tumors over a 7-year period in relation to self-reported cell phone use at the start of the study.
  - This study found no link between cell phone use and brain tumors overall or several common brain tumor subtypes, but it did find a possible link between long-term cell phone use and acoustic neuromas.

U.S. incidences of cancer and cellular subscriptions



Limitation of Cell Phone Studies

- Need to follow for a long time
- Variables change
  - Generation
  - Power
- Impact on children
- Estimate only of usage
  - Peoples memory are biased
- May only be a small impact – hard to detect

https://www.cancer.org/cancer/cancer-causes/radiation-exposure/cellular-phones.html#additional_resources, accessed 12/25/19

WHO statements

- in 2011, the World Health Organization said cellphones might cause some brain cancers
  - Just for reference, coffee and pickled vegetables are in the same "possibly carcinogenic" category as RF.
- In 2014 **the World Health Organization (WHO) said that "no adverse health effects have been established as being caused by mobile phone use"**.

Most Recent WHO Statement

- Recent surveys have indicated that RF exposures from base stations and wireless technologies in publicly accessible areas (including schools and hospitals) are normally thousands of times below international standards … From all evidence accumulated so far, no adverse short- or long-term health effects have been shown to occur from the RF signals produced by base stations.

FDA

- Based on our ongoing evaluation of this issue, the totality of the available scientific evidence continues to not support adverse health effects in humans caused by exposures at or under the current radiofrequency energy exposure limits.

NIH

- … although many studies have examined the potential health effects of non-ionizing radiation for radar, microwave ovens, cell phones, and other sources, there is currently no consistent evidence that non-ionizing radiation increases cancer risk in humans.

FCC

- …there is no evidence to support that adverse health effects in humans are caused by exposures at, under, or even in some cases above, the current RF limits. Indeed, no scientific evidence establishes a causal link between wireless device use and cancer or other illnesses.

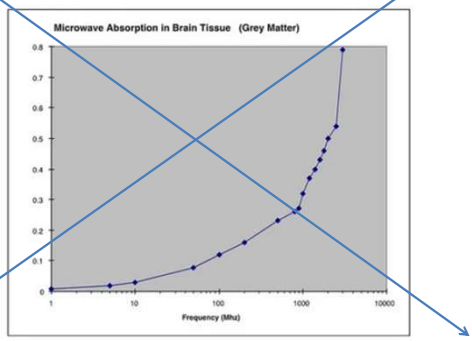
Additional Institutional Assessments

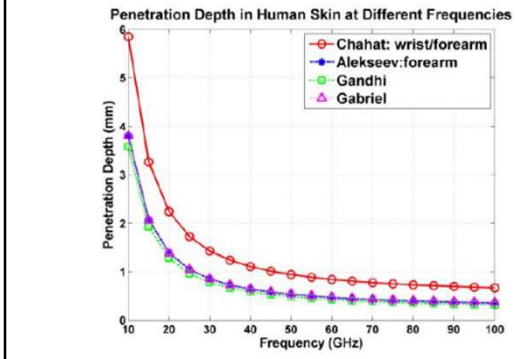
- **International Agency for Research on Cancer (IARC)**
  - possibly carcinogenic to humans," based on limited evidence of a possible increase in risk for brain tumors among cell phone users, and inadequate evidence for other types of cancer.
- **US Environmental Protection Agency (EPA)** and the **National Toxicology Program (NTP)**
  - No formal classification of cell phones as to their cancer-causing potential.
- **Centers for Disease Control and Prevention (CDC)**:
  - "At this time we do not have the science to link health problems to cell phone use. Scientific studies are underway to determine whether cell phone use may cause health effects."
- **National Institute of Environmental Health Sciences (NIEHS)**
  - "Current scientific evidence has not conclusively linked cell phone use with any adverse health problems, but more research is needed."
- **National Cancer Institute (NCI)**:
  - "Studies thus far have not shown a consistent link between cell phone use and cancers of the brain, nerves, or other tissues of the head or neck. More research is needed because cell phone technology and how people use cell phones have been changing rapidly."

What is Unique about 5G?

- New Frequency Band
  - **–Millimeter Wavelength**
- Beam Forming
  - – Lower exposure if not in direct path
  - – Lower overall radiated energy
- Duplex Transmission
- Massive MIMO
  - – More connections

This Graph Caused a Stir – Appeared in NY Times





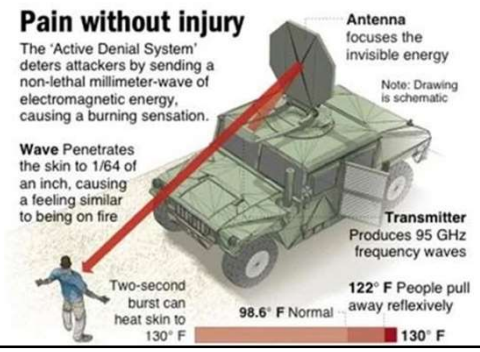
Uses of Millimeter Wavelengths

- Airport Security Devices
- WiFi
- Microwave Ovens
- Radar
- Cordless Phones
- Riot Control
- In Russia, for therapy
  - Ulcers, CV disease, respiratory illness, skin diseases/wounds

Weaponizing the Frequency

- The Department of Defense sponsored some studies in the late 1990s and early 2000s looking at the use of millimeter wavelengths as a non-lethal weapon.
- The "active denial" technology that the military employs uses very high-frequency millimeter wavelengths, above 94GHz, to produce an intense burning sensation that barely penetrates the skin and stops when the transmitter is switched off or when the individual moves out of the beam.
- The IEEE and the International Commission on Non-Ionizing Radiation Protection have used this research to set safety limits for the use of 5G millimeter wave, which are well below these levels, Foster said.

Weapon Using This Technology



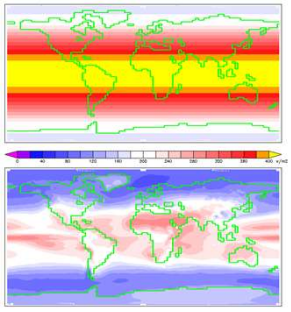
Crowd Control

- 11,000 exposures
- 8 second degree burns
- All recovered fully
- Absorption was in first few millimeters

What are the limits for 5G radiation

- Different than other generations because of frequency band (> 6 GHz)
  - most energy is deposited in first few mm; averaging over gram is inappropriate
- Expressed as Power Density
  - FCC and ICNIRP are similar
  - Far Field - 10 watts/m^2 for general public, 50 watts/m^2 for occupational group
  - Local Field - 20 W/m^2 for averaging over 4 cm^2 and 40 W/m^2 for averaging over 1 cm^2

Comparison to Solar Radiation



The shield effect of Earth's atmosphere on solar irradiation. The top image is the annual mean solar irradiation (or insolation) at the top of Earth's atmosphere (TOA); the bottom image shows the annual insolation reaching the Earth's surface after passing through the atmosphere. Note that the two images use the same color scale

- A 60 GHz mmWave outputting 50 W/m2 of power (which would exceed FCC regulations) only raises skin temperature by 0.8 °C, which is below the IEEE standards temperature threshold of 1 °C for mmWave radiation guidelines.

How Hot Can It Get?

- At the levels used for 5G (and earlier mobile technologies) the heating effects are not harmful, per Prof Rodney Croft,
  - adviser to the International Commission on Non-Ionizing Radiation Protection (ICNIRP).
- "The maximum radio frequency level that someone in the community could be exposed to from 5G (or any other signals in general community areas) is so small that no temperature rise has been observed to date."

Study results of MMWave Radiation

- No impact on gene expression
- May suppress cellular proliferation
- May activate NK cells, killing cancer cells
- Can interfere with orientation of charged molecules in membranes
- Can enhance immune system
- Can heal skin without scars

A Review of Studies to 2000

- Considered impact on Skin
  - Acute effect is superficial burning
- Considered impact on Eyes
  - Can produce cataracts at high power
  - Limited by reflexive eye closure
- Considered possibility of cancer
  - Most studies do not show carcinogenic potential
    - But, repeated heating of skin by any means may be carcinogenic

Ryan KL, et. al. Radio Frequency Radiation of Millimeter Wave Length: Potential Occupational Safety Issues Relating to Surface Heating. Health Phys. 78(2):170-181;2000.

One Review of all Quality Studies Between 6 and 100 GHz up to 2018

- Data is sparse
  - Much more research needed
  - 94 studies included
- Conclusion
  - No clear evidence of health effects with exposures below guidelines
  - No clear evidence of any mode of action for "non-thermal" effects
  - Too few studies fulfill minimal quality criteria for additional conclusions

Simko M, Mattsson MO. 5G Wireless Communication and Health Effects – A Pragmatic Review Based On Available Studies Regarding 6 to 100 GHz. Int J Environ Res Public Health. 2019 Sep;16(18): 3406.

Susceptible Tissues

- Skin
  - Most of energy is deposited in the dermis
- Eyes
  - 10 mW/cm^2 at 60 GHz for 8 hours results in no damage
  - 2 W/cm^2 at 35 Hz for 1.5-5 seconds resulted in corneal damage that healed in 24 hours.
  - 50 mW/cm^2 at 35 GHz for 15-80 minutes showed epithelial, stromal edema
  - 1898 mW/cm^2 at 60 GHz for 6 minutes showed corneal edema and dessication
  - Worry about cataracts
- Testes?

Voices Against 5G

- 180 scientists from 36 countries (EU)
  - Support Resolution 1815 of the Council of Europe, asking for independent task force to reassess health risks
- Martin Pall
  - Describes 9 effects of 5G radiation
    - DNA attacks
      - Single strand breaks
      - Double strand breaks
      - Oxidized bases in cellular DNA
    - Lowered fertility, libido, sperm count
    - Neurological/neuropsychiatric effects
    - Apoptosis
    - Oxidative stress
    - Endocrine effects
    - Increased intracellular calcium
    - Cancer causation
    - Therapeutic impacts

https://einarflydal.files.wordpress.com/2018/04/pall-to-eu-on-5g-harm-march-2018.pdf, accessed on 12/25/19

Voices Against 5G

- Mailon HM, Nesson ET. The Association Between Mobile Phones and the Risk of Brain Cancer Mortality: A 25-year Cross-Country Analysis. 4 Dec 2019. Contemporary Economic Policy
- Findings
  - Mobile phone subscription rates are positively and statistically significantly associated with death rates from brain cancer 15–20 years later. I
  - In falsification tests, there were few positive associations between mobile phone subscription rates and deaths from rectal, pancreatic, stomach, breast or lung cancer or ischemic heart disease.
  - differential effects models suggest that mobile phone subscription rates are associated with brain cancer deaths 15–19 years later relative to deaths from other causes.
- Journal impact factor is 0.482
- It is Peer Reviewed
- Other publications by these authors:
  - Do Pimples Pay? Acne, Human Capital, and the Labor Market,
  - The Economics of Faking Ecstasy
  - A Diamond is Forever' and Other Fairy Tales: The Relationship Between Wedding Expenses and Marriage Duration,

Foreign Influences / Fake News

- A New York Times article published in March noted that the Russian propaganda network RT America has been at the forefront of running stories about harm from 5G.
  - https://www.nytimes.com/2019/05/12/science/5g-phone-safety-health-russia.html?action=click&module=RelatedLinks&pgtype=Article

Set up for Conspiracy Theories

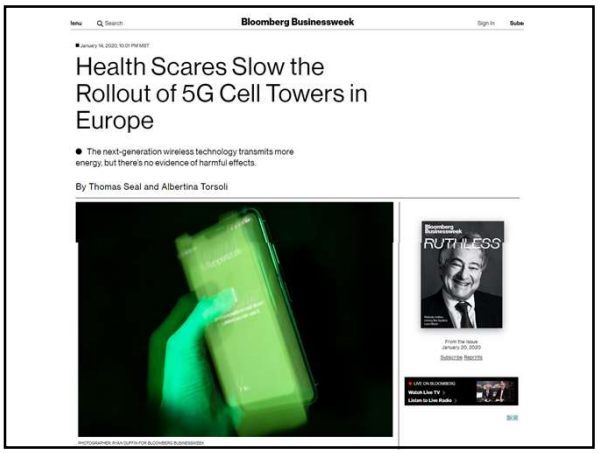
- Insufficient quantity and poor quality of research
- Technology panned by Russia
- Trump is strongly for it
- FCC head is from Verizon
- Is there a cover up?

Purported Impacts of 5G

- Nausea
- Hair loss;
- Swelling;
- Low energy;
- Appetite loss;
- Bone marrow damage;
- Depression;
- Organs damage;
- Confusion;
- Incapacitation and death; and
- Infections.
- Cancer
- Infertility

Actions Taken Against 5G

- In April, the Belgian government halted a 5G test in Brussels over concerns that radiation from the base stations could be harmful.
- Members of Parliament in the Netherlands are also calling on the government to take a closer look at 5G.
- Switzerland is taking steps to monitor 5G's impact on people.
- In the US, New Hampshire is considering establishing a commission to study the health effects of 5G networks. Several leaders in Congress have written to the Federal Communications Commission expressing concern about potential health risks.
- In Mill Valley, California, the city council blocked the deployment of new 5G wireless cells.



Bloomberg Businessweek

Health Scares Slow the Rollout of 5G Cell Towers in Europe

- The next-generation wireless technology transmits more energy, but there's no evidence of harmful effects.

By Thomas Seal and Albertina Torsoli

Montgomery County, Maryland

- Appealed the Small Cell Order based on safety of RF
- Is FCC violating the National Environmental Policy Act and Administrative Procedure act by failing to conduct an environmental analysis of the RF standards and potential 5G health risks?

Methods to Mitigate Radiation Risk

- Use cell phone less (use land lines)
- Hold phone away from head (speakerphone)
- Use a protective device (may impact performance)
- Use cell phone when signal is stronger (outside buildings, vehicles, etc..)
  - Your phone emits more power when needed
- Do not carry your cell phone on your body

Specific Agency Recommendations

- To reduce our exposure to RF-EMFs, the Food and Drug Administration (FDA)Trusted Source suggest cutting down how much time we spend on our cell phones, as well as using speaker mode or a hands-free kit to create more distance between our devices and our heads.
- The American Academy of Pediatrics (AAP) recommend limiting the time that kids and teenagers spend on mobile devices.

Electromagnetic hypersensitivity syndrome

- Michael McKean's behavior on "Better Call Saul"
- Rare individuals (1:1,000,000) with health problems related to EMF
- Symptoms (vary from one individual to next)
  - Dermatologic (Redness, tingling, burning)
  - Headaches, Neurasthenic
  - Vegetative (Fatigue, concentration difficulties, dizziness, palpitations, GI symptoms)
  - In testing, not correlated with EMF exposure!!!
- WHO workshop – 2004
- No clear toxocologic or physiologic basis
- Treatment is psychological

Rubin GJ, et.al. Electromagnetic hypersensitivity: a systematic review of provocation studies. Psychosom Med. 2005 67(2):224-32
Rubin GJ, et.al. Idiopathic Environmental Intolerance Attributed to Electromagnetic Fields. Bioelectromagnetics 2010 31(1): 1-11.

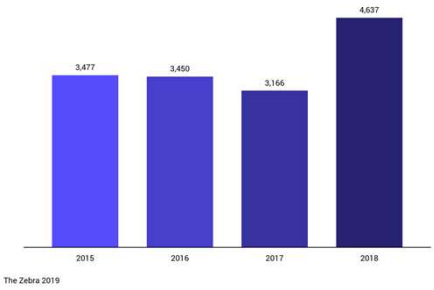
Cell phones and MVA's

- 1.6 million crashes are caused by cell phone use
- 391,000 drivers injured in distracted driving crashes
- 3,242 lives were lost due to cell phone use during driving in 2017; 4,637 in 2018
- 13.3% of distracted driving crashes are due to cell phone use
- 21% of drivers admit to texting while driving
- At any given moment, 3.2% of drivers are texting
- Distracted driving was a factor in 8.5% of fatal vehicle crashes in 2019

Cell phones and MVA's

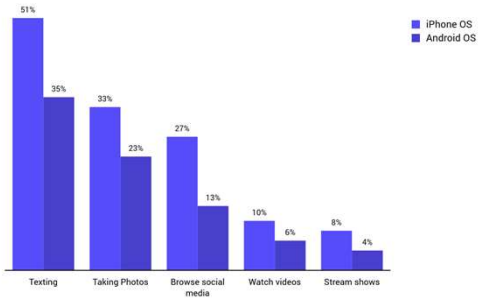
- One in three female drivers took photos while driving
- 10% of iPhone users admitted watching videos on YouTube while driving (4% on Androids).
- ¼ car accidents in the U.S. are caused by texting while driving

Distracted Driving Deaths



The Zebra 2019

Distracted Driving Behaviors by Operating System



The Zebra 2019

When you enter this place of worship, it may be possible that you hear the "call of God."

However, it is unlikely that he will call you on your mobile phone.

Thank you for turning off your phone.

If you want to talk to God, enter, choose a quiet place and talk to Him.

If you want to see Him, send Him a text while driving.

Head and Neck Injuries associated with Cell Phone Use

- Emergency department visits between January 1998 and December 2017 to examine "the incidence, types, and mechanisms of head and neck injuries associated with cell phone use."
- Retrospective cross-sectional, using national databases.
- 2,501 people aged 13–29 presented at the emergency department with head and neck injuries related to cell phone use. Based on these data, the researchers estimated a national total of 76,043 people with similar injuries.
- A third of the injuries occurred in the head and neck area, and another third were facial injuries, including eyes, eyelid area, and nose. Over 12% of the injuries were to the neck.
- "The most common injury diagnosis," write the study authors, "included laceration (26.3% of estimated total), contusion/abrasion (24.5%), and internal organ injury (18.4%)."

Head and Neck Injuries Associated With Cell Phone Use
Roman Povolotskiy, BA[1]; Nakul Gupta[1]; Adam B. Leverant[1]; et al
JAMA Otolaryngol Head Neck Surg. Published online December 5, 2019.

National Safety Council Recommendations for Walking, Texting

- Do not walk, talk, and text.
- If you have to talk or text, move out of the way of others and to the side of the walkway.
- Do not cross or walk in the street while using an electronic device.
- Do not walk with headphones in your ears.
- Be aware of your surroundings, especially in congested areas.

Penalties for Texting, Walking

- In 2012, Fort Lee, a municipality in New Jersey, banned texting while walking. Violations come with an $85 ticket.
- A ban on pedestrians looking at mobile phones or texting while crossing the street will take effect in Hawaii's largest city in late October. Fines will start at $15 and go as high as $99 for multiple violations.
- London, England found a slightly more polite way to handle it—by padding lampposts.
- Legislators in Arkansas, Illinois, and New York State have been trying to pass laws banning the use of mobile devices while walking.
- Stamford, Connecticut, may be the next city to fine you for texting and walking; they may include talking on the phone or listening to music with headphones while crossing the street.

Is there cell phone addiction?

- Nomophobia – a fear of not being with your phone.
- Warning signs
  - Do you have difficulty completing chores or work due to concentration issues?
  - Seclusion from family and friends or using your phone when in conversation
  - Do you mask your smartphone use, e.g. sneak off to the bathroom at work?
  - Do you worry that you're missing out on something when you're not with your phone?
  - Do you feel anxious or irritable if you're not with your phone?
  - Do you have sleep problems?

Cell Phone Addiction

Cell Phone Addiction

- Some major signs and symptoms of smartphone addiction include:
  - Tolerance.
  - Withdrawal.
  - Failed attempts to cut back on smartphone use.
  - Loses track of time when using mobile phone.
  - Uses cell phone in order to deal with unwanted emotions.
  - Text neck.
  - Digital eye strain.

Conclusions

- Unclear if non-ionizing radiation emitted from cell phone is dangerous
  - No clear evidence of harm
    - Lack of studies, especially for 5G millimeter frequency bands, and long-term exposure
  - Possible to mitigate the risk
- Clear danger from inappropriate use of cell phone
  - Driving
  - Walking
  - Overuse injuries
  - Social isolation

Conclusions

- Absence of proof is not proof of absence
  - More studies are needed

Texting Perils

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Resources

- **American Cancer Society**
- Home page: cancer.org
- **Centers for Disease Control and Prevention**
  Frequently Asked Questions about Cell Phones and Your Health
  Website: www.cdc.gov/nceh/radiation/cell_phones_FAQ
- **Environmental Protection Agency**
  Home page: www.epa.gov
  Understanding radiation: www.epa.gov/radiation/understanding-radiation-overview.html
- **Federal Communications Commission**
  RF Safety Program, Office of Engineering and Technology
  Website: www.fcc.gov/oet/rfsafety
- **Food and Drug Administration**
  Home page: www.fda.gov
  Radiation-emitting products: Cell phones: www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/default.htm
- **National Cancer Institute**
  Toll-free number: 1-800-422-6237 (1-800-4-CANCER)
  Home page: www.cancer.gov
  Cellular telephone use and cancer risk: www.cancer.gov/cancertopics/factsheet/Risk/cellphones
- **National Institute of Environmental Health Sciences**
  Home page: www.niehs.nih.gov
  Electric and magnetic fields: www.niehs.nih.gov/health/topics/agents/emf/index.cfm
- **World Health Organization**
  Electromagnetic fields and public health: base stations and wireless technologies
  Website: www.who.int/mediacentre/factsheets/fs304/en/index.html