CELL PHONES CANNOT CAUSE CANCER

Why do (some) epidemiologists say that more research is needed?

Bernard Leikind

September 21, 2011
Proof that cell phones cannot cause cancer

• Physicists know exactly what happens when any atom or molecule absorbs microwave radiation -- heating
  – Microwave frequency $\ll$ collision frequency

• Everyone knows many other biological processes that do the same thing, but more so
  – Basal metabolism, exercise, ski cap, hot soup,…

• None of these other processes cause cancer
Usual physicist’s argument

- UV, X-rays, and gamma rays cause cancer
- These photons break chemical bonds
- No other forms of electromagnetic radiation can break any chemical bond
- Therefore, these cannot cause cancer
- Medical researchers believe the first three points, but not the fourth, AND that
  - “Physicists don’t understand cancer”
Metastatic dissemination

Parenthyma

Invasive Cancer Cells (CSC)

Cancer Cells (CSC)

Invasive Cancer Cells (CSC) of micro-metastases

Cancer Cells (CSC) of micro-metastases

2nd wave of metastasis

Parenchyma

Invasive Cancer Cells (CSC)

Cancer Cells (CSC)

Invasive Cancer Cells (CSC) of micro-metastases

Recruitment of stromal cells to the lesion

Heterotypic interactions fueling concerted progression

Recruitment of stromal cells to seeded metastasis

Heterotypic signaling of metastatic growth

Stroma

Stromal reservoirs in tissue & bone marrow

Necrotic stroma of 1st tumor

Supportive stroma of 1st tumor

Normal stroma +/- permissive niche

Necrotic stroma of metastasis

Supportive stroma of metastasis

Primary Tumorigenesis

Metastasis
Biochemistry's Energy World

Gray line shows relative number of molecules at each energy level. These are thermal motions—random kinetic energy. The average molecule's energy at room temperature is about 2.5 kJ/mole.

<0.0000000001 kJ/mole
AC power photons

<0.001 kJ/mole
Cell phone photons

Roughly 100 to 500 kJ/mole
Energy range of covalent bonds
General range of uncatalyzed reaction activation barriers. Bonds tend to be stable at these energy levels and require an enzyme to break.

about 4-30 kJ/mole
Weak bonds

roughly 30-100 kJ/mole
Reaction activation energy barriers

240 kJ/mole
Green light photons

370 kJ/mole
C-C covalent bonds

>480 kJ/mol
UV light photons, X-rays, gamma rays. Known carcinogens.

High energy photons on this end of the scale in the shaded area can break chemical bonds.
Biochemistry's Low Energy World

The gray line shows the relative number of molecules at each energy level. These are thermal motions—random kinetic energy. The average molecule’s energy at room temperature is about \(2.5 \text{ kJ/mole}\).

- **About 4-30 kJ/mole**
  - Weak bonds: hydrogen bonds, van der Waals bonds, Electrostatic bonds

- **<0.001 kJ/mole**
  - Cell phone photons

- **<.0000000001 kJ/mole**
  - AC power photons

Energy in kiloJoules/mole
Further evidence

• Cell phones do not cause skin cancer
• Cell phones do not break chemical bonds
• Brain tumors not associated with habitual location of cell phone
• Cell phones do not cause benign tumors
• Cell phone microwave power $\ll$ power of many natural and safe biological processes
WHO Interphone Study

- Major international case-control study with 6000 brain cancer patients.
- Cell phone use did not increase the risk of brain cancer (statistically significant).
- Sub-group analysis in an appendix asserted that a sub-group’s risk was above average (not statistically significant).
- “More research is needed”
WHO IARC

• IARC declared cell phone microwaves to be “possibly carcinogenic”
• Same category as many chemicals, pickles, carpentry
• “possibly carcinogenic” means IARC believes evidence of carcinogenicity is weak but likely to strengthen and show risk
Danish case-control study

- Nationwide cohort included 420,095 persons
- First cellular telephone subscription was between 1982 and 1995
- Cohort followed through 2002 for cancer incidence
- 14,249 cancers observed (SIR = 0.95; 95% confidence interval [CI] = 0.93 to 0.97 -- 15,001 cases were expected
- Cellular telephone use was not associated with
  - brain tumors (SIR = 0.97),
  - acoustic neuromas (SIR = 0.73),
  - salivary gland tumors (SIR = 0.77),
  - eye tumors (SIR = 0.96), or
  - leukemias (SIR = 1.00).
- Cellular telephone use was not associated with increased risk for brain tumors (SIR = 0.66, 95% CI = 0.44 to 0.95) in long-term subscribers of 10 years or more
Meta-analysis (<5 yrs phone use)
Meta-analysis (> 5 yrs phone use)
Bayesian Considerations

New Probability = Old Probability \times \text{New Data}

\begin{align*}
0 \leq 1 \quad & 0 \leq 1 \\
\end{align*}

Extraordinary claims require extraordinary evidence

Cromwell’s Principle – Prior \neq 0 \text{ or } 1

Allow for possible mistakes

Hume’s Principle – Evidence for a miracle is always less than evidence for natural law
What is the responsibility of epidemiologists?

• Epidemiological evidence of risk is weak
• Epidemiological evidence of safety is strong
• No known mechanism
• Physicists strongly assert there is no unknown mechanism
• Does the precautionary principle apply?