



THE OFFICIAL SPONSOR OF BIRTHDAYS®

## Cellular Phones

Cellular (cell) phones first became widely available in the United States in the 1990s, but their use has increased dramatically since then. According to the Cellular Telecommunications & Internet Association, there were an estimated 270 million cell phone subscribers in the United States as of December 2008, representing about 87% of the total population.

Based on the large and still growing number of cell phone users (both adults and children), and the fact that cell phones give off radio-frequency (RF) waves, some concerns have been raised about the safety of cell phone use. With respect to cancer, concern focuses on whether cell phones might increase the risk of brain tumors or other tumors in the head and neck area.

## How do cell phones work?

Cell phones communicate with nearby cell towers through RF waves, a form of energy located on the electromagnetic spectrum between FM radio waves and microwaves. Like FM radio waves, microwaves, visible light, and heat, they are a form of non-ionizing radiation. They cannot cause cancer by directly damaging DNA. RF waves are different from stronger types of radiation such as x-rays, gamma rays, and ultraviolet (UV) light, which can break the chemical bonds in DNA.

At very high levels, RF waves can heat up body tissues. (This is the basis for how microwave ovens work.) But the levels of energy given off by cell phones are much lower, and the warmth from a cell phone does not damage body tissues.

## How are people exposed?

The RF waves from cell phones come from the antenna, which is part of the body of a hand-held phone. The waves are strongest at the antenna and lose energy as they travel away from the phone. The phone is typically held against the side of the head when in use. The closer the antenna is to the head, the greater a person's expected exposure to RF energy.

Many factors can affect the amount of RF energy to which a person is exposed, including:

- The amount of time the person is on the phone
- The model of phone being used: different phones give off different amounts of energy
- Whether or not the person is using a hands-free device
- The distance and path to the nearest cell phone tower: being farther away from the tower requires more energy to get a good signal, as does being inside a building
- The amount of cell phone traffic in the area at the time

Other factors may also affect exposure. For example, older cell phones (analog models) used more energy than newer, digital phones.

The amount of RF energy absorbed from the phone into the user's local tissues is known as the *specific absorption rate* (SAR). Different cell phones have different SAR levels. Cell phone makers are required to report the SAR level of their product to the Federal Communications Commission (FCC). This information is sometimes listed inside the battery compartment on the phone. The upper limit of SAR allowed in the United States is 1.6 watts per kilogram (W/kg) of body weight.

## Do cell phones cause tumors?

Because cell phones are held near the head when in use, the main concern has been over whether they might cause or contribute to tumors in this area, including:

- Malignant (cancerous) brain tumors such as gliomas
- Non-cancerous tumors of the brain such as meningiomas
- Non-cancerous tumors of the nerve connecting the brain to the ear (acoustic neuromas)
- Non-cancerous tumors of the salivary glands

---

## What do studies in humans suggest?

About 30 studies have looked at possible links between cell phone use and tumors. Most of these studies have focused on brain tumors. Many of these have been case-control studies, in which patients with brain tumors (cases) were compared to people free of brain tumors (controls), in terms of their past use of cell phones.

In general, these studies have yielded similar results:

- In most studies patients with brain tumors do not report more cell phone use overall than the controls. This finding is true when all brain tumors are considered as a group, or when specific types of tumors are considered.
- Most studies do not show a "dose-response relationship" -- a tendency for the risk of brain tumors to increase with increasing cell phone use, which would be expected if cell phone use caused brain tumors.
- Several studies published by the same research group in Sweden report increased risk of tumors on the side of the head where the cell phone was held, particularly with 10 or more years of use. It is hard to know what to make of these findings because studies by other researchers have not had the same results, and there is no overall increase in brain cancer in Sweden during the years that correspond to these reports.

The 13-country INTERPHONE study, the largest case-control study done to date, looked at cell phone use among more than 5,000 people who developed brain tumors (gliomas or meningiomas) and a similar group of people without tumors. Overall, 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. There was a 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. But this finding was difficult to interpret because of some people reporting implausibly high cell phone use, as well as other issues. The researchers noted that the shortcomings of the study prevented them from drawing any firm conclusions, and that more research was needed.

A large, long-term study following more than 420,000 cell phone users in Denmark between 1982 and 2002 had findings similar to those of the case-control studies. Cell phone use, even for more than 10 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. This type of study (following a large group of people going forward in time and not relying on people's memories about cell phone use) is generally thought to be stronger than a case-control study. But there are still limits as to how well this study might apply to people using cell phones today. For example, while the cell phones used at the time of the study tended to require more power than modern cell phones, people also probably used the phones less than they do today.

In summary, most studies published so far have not found a link between cell phone use and the development of tumors. However, these studies have had

some important limitations that make them unlikely to end the controversy about whether cell phone use affects cancer risk.

First, studies have not yet been able to follow people for very long periods of time. When tumors form after a known cancer-causing exposure, it usually takes decades for them to develop. Because cell phones have been in widespread use for less than 20 years in most countries, it is not possible to rule out future health effects that have not yet appeared.

Second, cell phone usage has been and is constantly changing. People are using cell phones much more than they were even 10 years ago, and the phones themselves are very different from what was used in the past. This makes it hard to know if the results of studies looking at cell phone use in years past would still apply today.

Third, the studies published so far have focused on adults, rather than children. Cell phone use is now widespread even among young children. It is possible that if there are health effects, they might be more pronounced in children because their nervous systems are still developing and their lifetime exposure will be greater than adults, who started at a later age.

Finally, the measurement of cell phone use in most studies has been crude. Most have been case-control studies, which have relied on people's memories about their past cell phone use. In these types of studies, it can be hard to interpret any possible link between cancer and an exposure. People with cancer are often looking for a possible reason for it, so they may sometimes (even subconsciously) recall their phone usage differently than people without cancer.

With these limitations in mind, it is important that the possible risk of cell phone exposure continue to be researched using strong study methods, especially with regard to use by children and longer term use.

---

## **What does the laboratory evidence suggest?**

As noted above, the RF waves given off by cell phones don't have enough energy to damage DNA directly. Because of this, many scientists believe that cell phones aren't able to cause cancer. Most studies done in the lab have supported this theory, finding that RF waves do not cause DNA damage.

A number of scientists have reported that the RF waves from cell phones produce effects in human cells (in lab dishes) that might possibly help tumors grow. However, several studies in rats and mice have looked at whether RF energy might promote the development of tumors caused by other known carcinogens (cancer-causing agents). These studies did not find evidence of tumor promotion.

A large study now being done by the US National Toxicology Program should help address some of the questions about whether exposure to RF energy could potentially lead to health issues. The study will expose a large group of laboratory mice and rats to RF energy for several hours a day for up to 2 years and follow the animals from birth to old age.

---

## What do expert agencies say?

Several agencies (national and international) study different substances in the environment to determine if they can cause cancer. The American Cancer Society looks to these organizations to evaluate the risks based on evidence from laboratory, animal, and human research studies.

Based on the available evidence, some of these expert agencies have evaluated the cancer-causing potential of cell phones and RF waves. In general, they agree that more research is needed to look at possible long-term effects.

The **International Agency for Research on Cancer (IARC)** is part of the World Health Organization (WHO). Its major goal is to identify causes of cancer. The IARC has classified RF fields as "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. (For more information on the IARC classification system, see our document, *Known and Probable Human Carcinogens*.)

The other main agencies that classify cancer-causing exposures (carcinogens), including the US Environmental Protection Agency (EPA) and the National Toxicology Program (NTP), have not formally classified cell phones as to their cancer-causing potential. However, several other agencies have commented on the possible risks.

According to the **Food and Drug Administration (FDA)**, which regulates the safety of radiation-emitting devices such as cell phones in the United States:

The majority of studies published have failed to show an association between exposure to radiofrequency from a cell phone and health problems.

According to the **Federal Communications Commission (FCC)**:

There is no scientific evidence that proves that wireless phone usage can lead to cancer or a variety of other problems, including headaches, dizziness or memory loss. However, organizations in the United States and overseas are sponsoring research and investigating claims of possible health effects related to the use of wireless telephones.

According to the **Centers for Disease Control and Prevention (CDC)**:

Although some studies have raised concerns, the scientific research, when taken together, does not indicate a significant association between cell phone use and health effects.

According to the **National Institute of Environmental Health Sciences (NIEHS)**, which is currently conducting studies of the possible health effects of cell phones:

The weight of the current scientific evidence has not conclusively linked cell phones with any adverse health problems, but more research is needed.

According to the **National Cancer Institute (NCI)**:

Although research has not consistently demonstrated a link between cellular telephone use and cancer, scientists still caution that further surveillance is needed before conclusions can be drawn.

## **Do cell phones cause any other health problems?**

Few other health concerns have been raised about cell phone use. One has been whether the RF waves from cell phones might interfere with medical devices such as heart pacemakers. According to the FDA, cell phones should not pose a major risk for the vast majority of pacemaker wearers. Still, people with pacemakers may want to take some simple precautions to help ensure that their cell phones don't cause a problem, such as not putting the phone in a shirt pocket close to the pacemaker.

Several studies have found that people who use cell phones while driving are more likely to be in car accidents. It is not clear that hands-free phones are any safer than hand-held phones when it comes to driving.

## **Can I lower my exposure to RF waves from cell phones?**

Studies now under way should give a clearer picture of the possible health effects of cell phone use in the future. Until then, there are several things that people who are concerned about RF waves can do to limit their exposure.

Use a hands-free device such as a corded or cordless earpiece. Using an earpiece moves the antenna away from the user's head, which decreases the amount of RF waves that reach the head. Corded earpieces emit virtually 0 RF

waves (although the phone itself still emits small amounts of RF waves that can reach parts of the body if close enough, such as on the waist or in a pocket). Bluetooth® earpieces have an SAR value of around 0.001 watts/kg (less than one thousandth the SAR limit for cell phones as set by the FDA and FCC).

Choose a phone with a low SAR value. Different models of phones can give off different levels of RF waves. One way to get information on the SAR level for a specific phone model is to find the FCC identification (ID) number for that model. The FCC ID number is usually somewhere on the phone, sometimes under the battery pack. Once you have the ID number, go to the following Web address: [www.fcc.gov/oet/ea/fccid](http://www.fcc.gov/oet/ea/fccid). On this page, you will see instructions for entering the FCC ID number.

Limit your (and your children's) cell phone use. One of the most obvious ways to limit exposure to RF waves from cell phones is to limit how much you use them. You may want to use your cell phone only for shorter conversations, or use it only when a conventional phone is not available. Parents who are concerned about their children's exposure may limit how much time they spend on the phone.

For safety reasons, it is especially important to limit or avoid the use of cell phones while driving.

## What about cordless phones?

Cordless phones, commonly used in homes, have base units that are plugged into telephone jacks and wired to a local telephone service. They are not considered "cell" phones. The question of health risks from cordless phones, which operate at about 1/600 the power of cell phones, has not been raised.

## Additional resources

---

### National organizations and Web sites\*

In addition to the American Cancer Society, other sources of information and support include:

#### **Federal Communications Commission**

RF Safety Program, Office of Engineering and Technology

Web site: [www.fcc.gov/oet/rfsafety/](http://www.fcc.gov/oet/rfsafety/)

#### **Food and Drug Administration**

Radiation-Emitting Products: Cell Phones

Web site: [www.fda.gov/Radiation-](http://www.fda.gov/Radiation-)

[EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/default.htm](#)

### **National Cancer Institute**

Cellular Telephone Use and Cancer Risk

Web site: [www.cancer.gov/cancertopics/factsheet/Risk/cellphones](http://www.cancer.gov/cancertopics/factsheet/Risk/cellphones)

### **National Institute of Environmental Health Sciences**

Cell Phones

Web site: [www.niehs.nih.gov/health/topics/agents/cellphones/index.cfm](http://www.niehs.nih.gov/health/topics/agents/cellphones/index.cfm)

*\* Inclusion on this list does not imply endorsement by the American Cancer Society.*

The American Cancer Society is happy to address almost any cancer-related topic. If you have any more questions, please call us at **1-800-227-2345** at any time, 24 hours a day.

## **References**

Christensen HC, Schuz J, Kosteljanetz M, et al. Cellular telephone use and risk of acoustic neuroma. *Am J Epidemiol.* 2004;159:277-283.

Cellular Telecommunications & Internet Association. Wireless Quick Facts. 2008. Accessed at [www.ctia.org/media/industry\\_info/index.cfm/AID/10323](http://www.ctia.org/media/industry_info/index.cfm/AID/10323) on September 24, 2009.

Centers for Disease Control and Prevention. Frequently Asked Questions about Cell Phones and Your Health. 2005. Accessed at [www.cdc.gov/nceh/radiation/factsheets/cellphone\\_facts.pdf](http://www.cdc.gov/nceh/radiation/factsheets/cellphone_facts.pdf) on September 28, 2009.

Food and Drug Administration. Cell Phones: Health Issues. 2009. Accessed at [www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/ucm116282.htm](http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/ucm116282.htm) on September 28, 2009.

Federal Communications Commission (FCC). Wireless. 2008. Accessed at [www.fcc.gov/cgb/cellular.html](http://www.fcc.gov/cgb/cellular.html) on September 28, 2009.

Hardell L, Nasman A, Pahlson A, et al. Use of cellular telephones and the risk for brain tumors: A case-control study. *Int J Oncol.* 1999;15:113-116.

Hardell L, Hallquist A, Mild KH, et al. Cellular and cordless telephones and the risk of brain tumours. *Eur J Cancer Prev.* 2002;159:277-283.

Hardell L, Carlberg M, Mild K. Case-control study on cellular and cordless telephones and the risk for acoustic neuroma or meningioma in patients diagnosed 2000-2003. *Neuroepidemiology*. 2005;25:120-128.

Inskip PD, Tarone RE, Hatch EE, et al. Cellular telephone use and brain tumors. *N Engl J Med*. 2001;344:79-86.

International Agency for Research on Cancer. IARC Classifies Radiofrequency Electromagnetic Fields as Possibly Carcinogenic to Humans. (Press Release) Accessed at [www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208\\_E.pdf](http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf) on May 31, 2011.

INTERPHONE Study Group. Brain tumor risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol*. Epub ahead of print on May 17, 2010.

Johansen C, Boice JD Jr, McLaughlin JK, et al. Cellular telephones and cancer -- a nationwide cohort study in Denmark. *J Natl Cancer Inst*. 2001;93:203-207.

Lai H, Singh NP. Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics*. 1995;16:204-210.

Lonn S, Ahlbom A, Hall P, et al. Swedish Interphone Study Group. Long-term mobile phone use and brain tumor risk. *Am J Epidemiol*. 2005; 161:526-535.

Malyapa RS, Ahern EW, Straube WL, et al. DNA damage in rat brain cells after in vivo exposure to 2450 MHz electromagnetic radiation and various methods of euthanasia. *Radiat Res*. 1998;149:637-645.

Minn Y, Wrensch M, Bondy M. Epidemiology of primary brain tumors. In: Prados M, ed. *Brain Cancer*. Hamilton: BC Decker; 2002:1-15.

Muscat JE, Malkin MG, Thompson S, et al. Handheld cellular telephone use and risk of brain cancer. *JAMA*. 2000;284:3001-3007.

Muscat JE, Malkin MG, Shore RE, et al. Handheld cellular telephone use and risk of acoustic neuroma. *Neurology*. 2002;58:1304-1306.

National Cancer Institute. Cellular telephone use and cancer risk. 2009. Accessed at [www.cancer.gov/cancertopics/factsheet/Risk/cellphones](http://www.cancer.gov/cancertopics/factsheet/Risk/cellphones) on September 25, 2009.

National Highway Traffic Safety Administration (NHTSA). An Investigation of the Safety Implications of Wireless Communications in Vehicles. 1997. Accessed at [www.nhtsa.dot.gov/people/injury/research/wireless](http://www.nhtsa.dot.gov/people/injury/research/wireless) on September 28, 2009.

National Institute of Environmental Health Sciences. Cell Phones. 2011. Accessed at [www.niehs.nih.gov/health/topics/agents/cellphones/index.cfm](http://www.niehs.nih.gov/health/topics/agents/cellphones/index.cfm) on May 31, 2011.

Redelmeier DA, Tibshirani RJ. Association between cellular telephone calls and motor vehicle collisions. *N Engl J Med*. 1997;336:453-458.

Repacholi MH. Radiofrequency field exposure and cancer: What do the laboratory studies suggest? *Environ Health Perspect*. 1997;105:1565-1568.

Rothman KJ, Chou CK, Morgan R, et al. Assessment of cellular telephone and other radio frequency exposure for epidemiologic research. *Epidemiology*. 1996;7:291-298.

Savitz DA. Mixed signals on cell phones and cancer. *Epidemiology*. 2004;15:651-652.

Schoemaker M J, Swerdlow AJ, Ahlbom A, et al. Mobile phone use and risk of acoustic neuroma: results of the Interphone case-control study in five North European countries. *Br J Cancer*. 2005;93:842-848.

Schuz J, Jacobsen R, Olsen JH, et al. Cellular telephone use and cancer risk: Update of a nationwide Danish cohort. *J Natl Cancer Inst*. 2006;98:1707-1713.

Stang A, Anastassiou G, Ahrens W, et al. The possible role of radiofrequency radiation in the development of uveal melanoma. *Epidemiology*. 2001;12:7-12.

Last Medical Review: 01/05/2010

Last Revised: 05/31/2011