

Cell Phones and Children: Follow the Precautionary Road

Suzanne Rosenberg

With new technology, there are typically risks and benefits. Potential harm is often not realized until years later. At the end of 2011, there were almost 6 billion mobile subscriptions. That is a dramatic increase from 5.4 billion in 2010 and 4.7 billion mobile subscriptions in 2009 (International Telecommunications Union, 2011). Due to its relatively short-term consumer use, concerned citizens are still examining the consequences of its radio frequency (RF) (Walsh, 2010). Three out of every four children under 12 years of age use a cell phone (Fernandez, 2011).

Worldwide, many researchers have raised the issue of the possible harm considering the increased use and cumulative effect of RF (Hardell, Carlberg, & Hansson, 2009). This is of concern regarding children; because of their thinner skulls and developing brains, they may be more susceptible to cellular damage. Several countries have issued warnings about cell phone use for children, but the United States government has not. According to the U.S. Government Accountability Office (GAO), scientific research has not demonstrated adverse human health effects of exposure to RF energy from mobile phone use, but research is ongoing that may increase understanding of any possible effects. In addition, officials from the Food and Drug Administration (FDA) and the National Institutes of

Children are increasingly using cell phones. "Family package" deals make it easy for parents to obtain phones for their children, and the phones provide parents with the comfort of easy access to their children. However, cell phones emit radio frequency (RF) radiation (Bucher & the Committee on Appropriations, 2010). While the government has deemed RF radiation to be safe, there is no current significant research to make this claim. To determine the relationship between cell phone radiation and brain cancer requires long-term studies lasting decades and with inclusion of frequent users in the subject pool. Further, to extend the results of any study to children requires controlling for the differences between juveniles and adults regarding the composition of the head, and bone density and neural tissue. Dr. L. Hardell of the University Hospital of Sweden noted that "it is necessary to apply the precautionary principle in this situation," especially for long-term exposure that is likely to affect children (Hardell as cited in Mead, 2008, p. 1). There is cause for concern.

Health (NIH), as well as experts interviewed by GAO, have reached similar conclusions about the scientific research. Ongoing research examining the health effects of RF energy exposure is funded and supported by federal agencies, international organizations, and the mobile phone industry. NIH is the only federal agency GAO interviewed that is directly funding studies in this area, but other agencies support research under way by collaborating with NIH or other organizations to conduct studies and identify areas for additional research (GAO, 2012).

Evidence to support the concern about RF effects continues to emerge. A trial led by Dr. Nora Volkow, Director of the National Institute on Drug Abuse, raises further questions. Forty-seven volunteers were asked to undergo two position-emission tomography (PET) scans, which measures glucose consumption in the brain, an indication of how cells use energy. For both 50-minute scans, the volunteers had a cell phone fixed to each ear. During the first scan, the devices were turned off, but for the second scan, the phone on the right ear was switched on and received a recorded message call. The results of the second scan showed that the regions of the brain nearest the device's antenna had

higher rates of glucose consumption than the rest of the brain (Volkow et al., 2011).

Increase in glucose metabolism is normal and occurs as various parts of the brain are activated during speaking, thinking, or moving (amount varies with activity). What is unknown, however, is whether repeated spikes in activity due to exposure to electromagnetic radiation from cell phones can permanently alter brain function or result in harm (Park, 2011). In a Podcast interview, Dr. Volkow states this study showed that the human brain is indeed sensitive to the electromagnetic radiation emitted from cell phones. Because the brain uses glucose when it is activated, Dr. Volkow interpreted this to mean electromagnetic waves in the brain were activating the cells. The conclusions from the study state that while no harm was seen immediately, it further raises the question of possible damage if the brain is stimulated over many years. Concern is raised in regard to children and adolescents, whose brains are still developing, with many neurological connections being formed. Potential effects this type of radiation may have on the formation or the deletion of these synaptic connections remains unknown; thus, cell phone use by children and adolescents is an area of concern (Volkow, 2011).

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Additional statements of disclosure appear on page 69.

Figure 1.
Web Sites for Updated Information on Cell Phone Concerns

Organization	Web Site
Environmental Health Trust (EHT) Provides information about the concerns of radiation and cell phone usage and what people can do to protect themselves.	http://ehtrust.org/cell-phones-radiation-3/
Environmental Working Group (EWG) A search result within the EWG Web site that provides various resources about cell phone concerns, including radiation.	http://www.ewg.org/search/ewgsearch/cell+phones+radiation
Federal Communications Commission (FCC) Provides information on specific absorption rates for phone models.	http://transition.fcc.gov/cgb/consumerfacts/sar.pdf

The National Cancer Institute (NCI), an agency of the National Institutes of Health (NIH), claims more studies are needed to determine the risk of long-term use of cell phones for children and adolescents. NCI indicates that results from studies have been “inconsistent and have not addressed adequately many questions regarding cancer and other adverse health effects of cell phone use particularly among children or heavy or long-term users of cell phones” (NCI, 2010, p. 1). NIH is exploring this important exposure and continues to invest in research to further the understanding of the potential health effects of cell phone use.

The American Cancer Society also expresses qualms. There is a lack of data on the risk to children, many of whom start using cell phones early in life. The frequent use of cell phones by young children is of particular concern because the RF waves from cell phones reach more brain tissue in children than in adults (due to thinner cranium). “It is important that these issues continue to be studied in children, with longer term use, and through prospective studies” (Snowden, 2010, p. 1).

Electromagnetic Fields, Radio Frequency, and Specific Absorption Rates

As cell phones make and take calls, they emit low levels of RF radiation. Everyone is exposed to electromagnetic fields (EMFs) with cell phones or mobile devices and are also described as radio frequency (RF), which is a waveform found in the EMF spectrum. RF is one of several energy forms, all of which exhibit wave-like behavior but travel at different rates through space. EMF has both electrical

and magnetic field components that oscillate (move) as the energy travels. The EMF spectrum, in order of increasing frequency and decreasing wavelength, consists of radio frequency, microwaves, infrared radiation, visible light, ultraviolet radiation X-rays, and gamma rays. RF is a slow, low-energy moving wave of EMF and is believed to do little harm, unlike higher energy X-rays, which are also part of the EMF spectrum. RF is non-ionizing; thus, not causing the breakup of ionic molecular bonds. The concern is that wireless devices have increased in use in society, especially among children. RF standards set by the Federal Communications Commission (FCC) are set at levels too low to cause significant heating of tissue. “Cell signals are weak, invisible, and as fast as the speed of light. This low power radio frequency radiation cannot heat human tissue, so it is presumed to be safe” (Davis, 2010, p. 56).

The amount of RF absorbed if the cell phone is in contact with the head is measured in terms of specific absorption rate (SAR). The FCC has determined it is safe to set phones at RF emissions up to 1.6 watts per kilogram of body tissue. SAR determination combines information on signal strength and the type and amount of tissue exposed. The computation for SAR includes how thick the tissue closest to the antenna is and how much the tissue weighs; its mass determines the absorption (Davis, 2010). However, these determinations were made based on adults. In a study of SAR exposure to children, results show the locally induced fields for children can be significantly higher due to the close proximity of the phone to these tissues in the area of the head that is close to the antenna (Baan et al., 2011). Depending on the phone design, the antenna can be in

different positions on the phone, and thus, would affect the area of the brain closest to the antenna. This higher exposure is caused by differences in anatomical proportions. The exposed regions inside the brain (tested on children 3 years of age and 7 years of age) showed higher uptake in comparison to adults. Because of differences in position (affected by the anatomical proportions) with regard to the ear and brain, regions close to the surface can exhibit significant differences in exposure in children (Christ, Goesselin, Christopoulos, Kuhn, & Kuster, 2010). The permissible SAR level is based on the amount of absorption of a standard anthropomorphic man who weighs more than 200 pounds and has an 11-pound head; the level is not tailored for persons of smaller dimensions (Davis, 2010). “These advances in our understanding have not had any impact on the way that cell phones are tested and rated” (Davis, 2010, p. 82).

Phone companies are required by law to state the SAR on its packaging so RF exposure can be measured (Kohl & Sachdev, 2009). The highest at-ear rating for voice calls for the Apple iPhone 4™, one of the most popular phones available, is 1.17 watts per kilogram. The Apple iPhone 4 safety manual states exposure should not exceed FCC guidelines. When using the iPhone for voice call or for wireless data transmission over a cellular network, Dellorto (2011) recommends keeping the phone at least 15 millimeters (5/8 inch) away from the body. The FCC’s Web site (see Figure 1) provides information regarding SAR of cell phones. Nurses can help consumers become aware of and use this information when selecting cell phones.

What This Means For Children

Radiation exposures are higher for children than adults because children have thinner skulls, and their brains have higher water and higher ion (charged particle) content. All of these three factors enhance radiation penetration. Researchers in the United States, France, and Japan have reported that a child's brain absorbs twice the amount of radiation compared to that of an adult (Environmental Working Group, 2010). Higher exposure combined with sensitive, developing brain tissue leave children at a greater risk for cell phone radiation (Environmental Working Group, 2009).

NCI Director Robert N. Hoover, MD, in a statement before Congress on the effects of cell phone use, reported:

We know that cell phone use is increasing rapidly among children and adolescents. They are a potentially sensitive group because their small head size could result in higher RF exposure, and the young brain may be more sensitive. While there are many unanswered questions, the cost of doing nothing will result in many young people being at increased cancer risk (Hoover, as cited in Carpenter, 2010, p. 1).

Reliability of the Studies

Brain tumors from radiation can take a long time to develop, sometimes greater than 10 to 15 years, according to the American Cancer Society (Mead, 2008). A few studies have investigated the safety of cell phones by evaluating the overall health of individuals who have used cell phones for 10 years or more. Critics express concern that these studies are flawed because a) studies have relied on self-reporting or retrospective interviewing in determining use; b) radiation exposure varies with different phone models, how the phone is used, and where the phone is used; and c) it is nearly impossible to eliminate exposure to RF from other sources and study only the isolated effects of cell phones (Kohl & Sachdev, 2009).

In sum, studies that do not control for the different variables associated with cell phone use may be unreliable (Kohl & Sachdev, 2009). The evaluation of cancer risk factors is challenging because of cancer's long latency. Some studies of longer-term cell phone use found an increased risk

of cancer (Hardell et al., 2009). Designing studies using retrospective billing records that provide independent evaluations of exposure and incorporating data on other key potential risk factors (such as genetics) from questionnaires could markedly advance the effort to evaluate the role of cell phones in causing cancer (Han, Hideyuki, Davis, Nirajan, & Lunsford, 2009).

Dr. Henry Lai, a research professor in the bioengineering department at the University of Washington, began studying the effects of radiation in 1980. He found that rats exposed to RF radiation had damaged brain DNA. He maintains a database of 400 scientific papers on possible biological effects of radiation from wireless communications. When categorizing these papers according to funding source, he noted something of concern. Findings from 67% of those not funded by the wireless industry indicated possible biological effects of radiation from cell phone use, but when the funding source was the wireless industry, the percent of studies that linked cell phones and biologic effect was only 28% (Stross, 2010).

Ipsilateral Brain Tumor And Cell Phone Use

Findings from two studies that investigated the health of individuals following 10 years of cell phone use revealed some harmful effects of RF on the ipsilateral side (same side as the cell phone is held). Dr. L. Hardell of the University Hospital of Sweden and the study team interviewed persons with recent brain tumors. One question was, "Which side of the head is the mobile phone used?" During this time, Dr. Hardell oversaw several smaller studies on the question being conducted throughout Europe. He noted a consistent pattern of an increased risk for acoustic neuroma (benign tumors growing near auditory and vestibular portions of nerve VIII, but can grow and cause contact with the brain stem) and glioma (a malignant brain tumor) following 10 years of cell phone use. The mega-analysis yielded an odds ratio of 1.9 and a 95% confidence interval for ipsilateral exposure, whereas contralateral exposure still produced an increased risk, but it was insignificant (Hardell et al., 2009).

Dr. Khurana of Australia also found evidence of brain tumors with cell phone use. The study concluded that using a cell phone for more than 10 years doubled the risk of being

diagnosed with a brain tumor on the same side of the head as used for the cell phone. Data were gathered from the Interphone group studies, which included research from Sweden, Denmark, the United Kingdom, Germany, and Finland from 1995 to 2004. Though cell phones have decreased in size, their SAR remains essentially the same. Therefore, conclusions from this study state that in the absence of timely interventions and given the increased use of wireless technology globally, especially among the younger generation, it is likely that the incidence of primary brain tumors will increase (Khurana, Teo, Kundi, Hardell, & Carlberg, 2009).

Most Current Data on Children's Health Risks From Cell Phone Use

An international Swiss case-controlled study (including Denmark, Norway, Switzerland, and Sweden) examined medical records of children 7 to 19 years of age with brain tumors from 2004 to 2008 and interviewed these patients. Children with brain cancer ($n = 352$) were studied alongside a control group ($n = 634$). Results indicated that patients with brain cancer were not statistically significantly more likely to have been greater users of cell phones than their counterparts (Aydin et al., 2011).

This study was immediately critiqued. The children's study, based on self-reported data, has limitations. Participants with brain cancer may have compromised recall as to their use of cell phones, and the researchers were not able to use billing records precisely. Subjects had been using cell phones for an average of about four years, which might not be long enough to evaluate the cancer risk. Further, the time the children spent on voice calls where the phone was to the ear was small. Dr. Roosli, one of the Swiss study's researchers, acknowledged that there are limitations in the research, but because mobile phone usage continues to rise, any possible health effects in children should be monitored closely (Naik, 2011).

According to the International Agency for Research on Cancer, an agency for the World Health Organization (WHO), radiation from cell phones can possibly cause cancer. The agency now lists mobile phone use in the same carcinogenic hazard classification as lead, engine exhaust, and

chloroform. This announcement was made after researchers at WHO examined peer-reviewed studies on cell phone safety (Dellorto, 2011).

Research Continues on Brain Cancer in Children And Cell Phone Use

The Centre for Research in Environmental Epidemiology (CREAL) is investigating cell phone use and cancer risk in children and adolescents through the MobiKids program, funded by the European Union. Initiated in 2010, CREAL is a 16-centered collaboration to investigate the risk of brain cancer from exposure to RF fields in childhood and adolescence 10 to 24 years of age. Over a period of two-and-a-half to three years, nearly 200 young people with brain tumors will be invited to participate in this study. The study will use a detailed questionnaire covering demographic factors, residential history, and risk factors in the environment, including the use of cell phones (CREAL, 2010). Also underway is a 5 million dollar study sponsored by the U.S. National Toxicology Program to assess the risk to 3,000 rats and mice exposed to RF for 10 hours daily from birth to old age (Thun, 2010). The U.S. Food and Drug Administration requested this study because a) there is widespread human usage of cell phones, b) current exposure guidelines are based on protection from acute injury from thermal effects (not long-term), c) little is known about the potential for health effects of long-term exposure, and d) sufficient data from human studies to definitively answer these questions may not be available for many years.

Rats and mice will be exposed to radio frequency radiation from the technologies that are currently used in the United States. Cell phone radiation will be administered at various intervals during the day (Bucher & the Committee on Appropriations, 2010). Further, GAO (2012) requests that the Federal Communications Commission (FCC) should formally reassess and if appropriate change the current RF energy exposure limit, as well as mobile phone testing requirements, particularly when cell phones are held against the body.

Recommendations

Ten-year longitudinal studies that are not sponsored in any way by telecommunication services or manufacturers of cell phones need to be

Table 1.
Recommendations for Minimizing Radio Frequency Exposure

Intervention	Commentary
1. Use a wired headset or speakerphone.	The antenna is the major source of radiation frequency. Keep away from head.
2. Purchase a cell phone with a lower specific absorption rate (SAR).	Cell phone companies are required to post SARs on insert literature. Parents can find information from manufacturer on line.
3. Limit children's use of cell phones until they are 16 years of age.	Parents and schools can limit the time periods children may use cell phones by taking away cell phones when they return to the house and monitoring minutes used.
4. Teach children to switch ears daily and not to press close to the ear until connection is made.	Reduces exposure to the same side and reduces accumulation to tissue.
5. Parents might check areas where the signal is weak and not allow children to use cell phones in these areas.	Weak areas require increased energy from source to reach the antenna; thus, more radiation exposure.

Note: Interventions 1 and 2 are recommended by the American Cancer Society (Snowden, 2009). Interventions 3, 4, and 5 are recommended by the Environmental Working Group (2009).

conducted on adults and children to learn definitively the relationship between RF, cell phone use, and primary brain tumor. These studies have to be designed to obtain precise data that include radiation emission from the cell phone, amount of time (both call length and frequency) the phone is used, which side of the brain is exposed, age of the subject, and radiation exposure. The protocol should contain an ethically sensitive clause that if early results indicate a connection between RF and brain cancer, the subjects will be informed, and the study stopped to decrease risk to participants. A trial case study comparing patients who have cancer with healthy patients using phone log data in which only the subject is using the phone is needed (Mukherjee, 2011). Consumers need to be educated about the most recent findings.

Nurses are a particularly valuable resource for educating children and parents about health-related concerns. Nurses in clinics and hospitals attended by parents and children can create educational wall posters that display how RF exposure can be reduced. School nurses can also post information about RF on display boards and be available should parents and children request further information. As trusted professionals,

nurses are in a good position to communicate to older children, teens, and parents about RF emissions from cell phone antennae and what steps can be taken to reduce this exposure and still benefit from the technology. Using a Bluetooth or the earpiece reduces the amount of radiation to the brain; the radiation effect drops exponentially as the antenna moves away from the head. Even using a speakerphone several inches away from the head reduces exposure significantly. Text messaging is another option because the cell phone is held away from the head while in use. Nurses can become politically active and request their legislators to craft legislation that provides warnings and protects children from radiation exposure as France, Toronto, India, and Israel have done. Through their specialty nursing associations, nurses can create position statements and submit them for publication in professional journals and lay publications. Nurses can encourage their professional organizations to advocate for research on this topic and participate in research if the opportunity becomes available.

Specific recommendations by the American Cancer Society and the Environmental Working Group to reduce RF exposure are listed in Table 1.

Instructions For Continuing Nursing Education Contact Hours

Cell Phones and Children: Follow
the Precautionary Road

Deadline for Submission:
April 30, 2015

PED 1303

To Obtain CNE Contact Hours

1. For those wishing to obtain CNE contact hours, you must read the article and complete the evaluation through **Pediatric Nursing's Web site**. Complete your evaluation online and your CNE certificate will be mailed to you. Simply go to **www.pediatricnursing.net/ce**
2. Evaluations must be completed **online** by April 30, 2015. Upon completion of the evaluation, a certificate for **1.4** contact hour(s) b.

Fees – **Subscriber: Free Regular: \$20**

Objectives

This continuing nursing education (CNE) activity is designed for nurses and other health care professionals who care for and educate patients and their families regarding the implications of cell phone use in children and adolescents. For those wishing to obtain CNE credit, an evaluation follows. After studying the information presented in this article, the nurse will be able to:

1. Describe the concern of radio frequency and its specific absorption rate may have on long-term users of cell phones.
2. Explain why children who use cell phones may be at greater risk for radiation exposure than adults.
3. Discuss the need for additional research on radiation from cell phone usage based on current study findings.

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Nurses have the opportunity to post and promote these recommendations.

Conclusions

Several studies are in process that will give valuable information regarding the safety of exposure to radio frequency. When available, these data will contribute to the scientific database and guide governmental agencies to better determine public policy with regard to cell phones. Many noteworthy scientists and public safety agencies have requested additional research because at present, not enough information exists on which to base conclusions and make recommendations about long-term effects of cell phone radiation, especially with regard to children.

Clinical conditions caused by environmental exposure often develop over a prolonged period of time; the exposed person might not exhibit any symptoms. The dangers of asbestos and cigarettes were not known until after years of exposure and research. Given the new information on the possible dangers of RF and the limitations of previous studies, a precautionary principle should be implemented. Informing parents and children about the recommendation to reduce RF exposure through monitoring SARs, and using devices and strategies to decrease exposure may prevent damage to children. The wireless industry is unlikely to initiate this policy, but nurses are in a position to inform consumers of the findings. Safeguarding children can occur if nurses are facilitators in their workplace and can disseminate information, which would result in a "precautionary" approach until findings are conclusive.

Nurses can keep themselves and the public informed by monitoring various Web sites that update information on cell phones (see Figure 1). Nurses are health advocates, and thus, responsible to keep the public informed of scientists' concerns about the long-term effects of exposure to RF. By teaching parents and children how to minimize exposure, yet enjoy the benefits of wireless technology, nurses can promote the health and well-being of families.

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