Human Exposure to Radio Frequency, Microwave and Millimeter Wave Electromagnetic Radiation

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Current world population (total number of human beings living on Earth) is about 7.4 billion according to estimates by the United Nations Department of Economic and Social Affairs, Population Division [1].

Statistics and forecast suggest the total number of mobile phone users worldwide will reach 4.8 billion by 2017 and is expected to pass the 5 billion mark by 2019 [2]. In 2014, ownership of mobile phones reached 60% of earth’s population. Mobile phone penetration is likely to continue to grow to 67% by 2019.

Mobile phones and other wireless devices and systems rely on radio frequency (RF) or microwave radiation to function. They use RF or microwave radiation to send and receive message, voice and data.

In addition to RF and microwaves millimeter (mm) and terahertz (T) waves are increasingly enlisted to support the rally toward ubiquitous wireless connectivity, any time.

Wireless applications of RF and microwave radiation are found nearly everywhere including, in outdoor environment, on the street, inside public transportation, in and outside the home, in and around automobiles, and even on and inside human bodies.

Besides mobile phones, wireless devices and gadgets show up as intelligent sensors, smart meters, and security monitors and controllers in homes, offices, factories, healthcare facilities, during workouts, and sports activities, and supported by such platforms as internet of things (IoT), among the latest.

Today, many healthcare providers rely on mobile information access and messaging tools to improve communications, accessibility and enhance decision making capabilities associated with delivery of healthcare.

Handhelds and wearables are commonly used for mobile tracking of fitness activities, vital signs or sleep research. They also are found in healthcare environments along with implantable and ingestible medical devices with integrated RF antennas for wireless communication (telemetry) supported by remote monitoring and control.
functions in many diagnostic and therapeutic procedures to help improve healthcare delivery.

These applications and other uses are enabled by wireless technologies such as Wi-Fi, Bluetooth and ZigBee and underpinned by networks, routers, base-stations, repeaters and satellite systems operating in the RF and microwave range.

RF and microwave electromagnetic radiation is the lifeblood of wireless systems. Once primarily an urban phenomenon in industrialized countries, the world in recent years has seen rapid growth in demand for wireless access, which is projected to continue for years to come. Meeting the demand would translate into greater human exposure to RF and microwave radiation.

Not only for the first time in its history an ubiquitous source of RF radiation is placed right next to the head (and body) of a large fraction of the human race, the percentage of all humanity exposed to RF electromagnetic radiation is approaching polluted air. (In 2013, 87% of the world's population lived in areas with pollution exceeding the World Health Organization Air Quality Guidelines [3]).

Scientific research on biological effects and health risks of RF radiation began in the 1940s and guidelines for limiting exposure to RF electromagnetic fields were published in the 1960s with the objective of providing protection against known adverse health effects. In the interim, guidelines were periodically revised and updated.

Current guidelines in RF range, for example, impose basic restrictions on specific absorption rate (SAR) limits on general public and occupational exposures to avoid whole-body heat stress and excessive localized tissue heating, specifically to prevent biological and health effects in responses to a body temperature rise of 1°C or more for an averaging time of 6 min [4, 5]. This level of temperature increase results from exposure of individuals under moderate environmental conditions to a whole-body SAR of approximately 4 W/kg for about 30 min. A whole-body average SAR of 0.4 W/kg was chosen as the restriction that provides adequate protection for occupational exposure. An additional reduction factor of 5 was introduced for public exposure, giving an average whole-body SAR limit of 0.08 W/kg.

However, a waxing question persists on guidelines for safe long-term exposure to low-level RF radiation. There is a general sense about lack of scientific knowledge regarding long-term human exposure below existing basic restrictions lower than those for which there is abundance of reliable data or evidence.

Since the initial research investigations, there have been thousands of published scientific studies on RF biological effects and health risks. Many of them followed the introduction of mobile telephony and are associated with it. A fair summary, regardless of their experimental design, quality, merits, limitations, flaws or methodological weakness, would suggest that there are more reported studies showing no effect than effect. However, few studies have been subjected to extant independent replication of results. Thus, the subject remains controversial and there still is a lot of uncertainty in
part, due to constraints on research funding, as government-funded RF biological effect science dwindled, especially in the U.S.

That said, since the late 2000s, a “secretive” 5-year project was sole sourced through a contract to IITRI in Chicago to investigate whether long-term exposure to cell-phone type wireless RF radiation can cause cancer in rats and mice [6]. This project is the largest animal cancer study ever undertaken by the National Toxicology Program (NTP) and National Institute of Environmental Health Sciences (NIEHS), with a price tag of $25 million or more of U.S. taxpayer money [7]. Although years overdue with huge budget overruns, the project appears to have not yet been completed. (Note that the life spans of rats and mice are about 2 years.) Staff members at IITRI are mum about it. To date, in contrast to scientific norm, they have not discussed any results or made any presentations of their findings at scientific meetings. NIEHS has refused to release any progress reports or project documents.

An international panel of experts convened by the World Health Organization’s International Agency for Research on Cancer (IARC) concluded in 2011 that exposure to RF electromagnetic fields including those used by mobile phones as “possibly carcinogenic” to humans [8]. The panel assessed available scientific papers and concluded that while evidence was incomplete and limited, published epidemiological studies reporting increased risks of 40 to 200% for gliomas (a type of malignant brain cancer) and acoustic neuromas (a non-malignant tumor of the auditory nerve on the side of the brain) among heavy or long-term users of mobile phones, are sufficiently strong to support a classification of possibly carcinogenic to humans for exposure to RF electromagnetic fields [9,10].

Note that other scientific groups such as the International Commission on Non-Ionizing Radiation Protection’s (ICNIRP) Standing Committee on Epidemiology [9], evaluating the same data or evidence concluded that increased risk was entirely explicable by various biases or errors, believing that there is little possibility that mobile-phone use could increase risk of glioma or acoustic neuroma in users.

Nevertheless, Belgium responded by adopting new regulations to promote mobile phone RF radiation safety and banned the sale of mobile phones to children [11]. The French Health Agency recommended that children and vulnerable groups should take measures to reduce their mobile phone RF exposure [12].

The U.S. Federal Communications Commission (FCC) states that no scientific evidence currently establishes a definite link between wireless device use and cancer or other illnesses, and that some parties have recommend taking measures to reduce exposure to RF energy from mobile phones [13]. While FCC does not endorse the need for these practices, it provides information on some simple steps that can be taken to reduce personal exposure to RF radiation from mobile phones. For example, it notes wireless devices only emit RF energy when they are in use and, the closer the device is to user, the more RF energy is absorbed by the individual.
The U.S. Federal Food and Drug Administration (FDA) advises, "if there is a risk from being exposed to RF radiation from mobile phones--and at this point FDA does not know that there is--it is probably very small." But if an individual is concerned about avoiding even potential risks, one can take a few simple steps to minimize RF exposure, such as reduce the amount of time spent using mobile phone and use speaker mode or a headset to place more distance between the head and the mobile phone [14].

Full recognition of a public health risk takes time. The paradigms of “An ounce of prevention is far better than a pound of cure” seems to have gone by the wayside years ago. And it now often evokes strong responses, with momentous resistance from those who have profited from mass marketing.

Antibiotics save lives and remain a vital tool in the fight against bacterial infection in modern medicine. However, antimicrobial resistance has become a major challenge. The number of bacterial pathogens that have become resistant to antibiotics is increasing as a result of wide spread and inappropriate use of antibiotics in health care and food production. Today, some 70 years since Alexander Fleming's Nobel Prize for discovery of penicillin and its curative effects in various infectious diseases in 1945 [15], too many of the hundreds of thousands of people who gets infected worldwide with pathogens die each year, and much more needs to be done to curb inappropriate use of antibiotics.

Fleming had cautioned about antimicrobial resistance in his acceptance lecture by telling a story (and I paraphrase), “a Mr. X who suffers from a sore throat takes some penicillin. The dose is not sufficient to eradicate the streptococci but enough to make them resistant to penicillin. His wife picks up the bug and she comes down with pneumonia. Mrs. X is treated then with this wonder drug, penicillin. As the streptococci are now resistant to penicillin, the treatment fails and unfortunately Mrs. X dies.”

In 1986, IARC classified active tobacco smoking as carcinogenic in humans, and announced that there was sufficient evidence to conclude that tobacco smoking caused cancers not only of the lung, but also of the upper digestive tract including oral cavity, pharynx, larynx, and esophagus; pancreas; and lower urinary tract including the bladder and renal pelvis [16].

However, evidence of the harm done by tobacco smoking had been accumulating for more than 200 years prior--at first with regard to cancers of the lip and mouth and then to vascular disease and cancer of the lung [17]. The evidence was generally ignored until several epidemiological studies linking smoking to the development of lung cancer were published in 1950. These studies stimulated more research which, by the 1950s, was beginning to show that smoking was associated with lung cancer. That smoking was connected with lung cancer and various diseases was vigorously debated for many years and general acceptance for lung cancer came only about by the late 1950s and eventually for other diseases in the subsequent decades.

Given their growing ubiquity, is the premise of an “ounce of prevention” for mobile devices so far out of the question?
References:


