Health Effects of Mobile Telephones

Kenneth J. Rothman

The safety of mobile telephones is a pressing question, now that the brains of nearly half the humans on the planet have become exposed within a short span of time to a physical agent to which their ancestors’ genes could not have adapted. It is no surprise then that epidemiologists have taken an interest in possible health effects of microwave exposure from mobile telephony. Few had experienced this novel exposure until 25 years ago, but nonionizing radiation from mobile telephones now regularly bathes the cerebral cortex of billions of people. This radiation has been demonstrated to affect communication channels across cell membranes by inhibiting or closing gap junctions, lending some plausibility to the idea that use of mobile telephones might have consequential biologic effects.

Conducting epidemiologic research of microwave exposure from mobile telephones, however, has proven to be problematic. The diseases of greatest concern that might be related to microwave exposure are malignancies of the brain and of other tissues that are in close proximity to the mobile telephone antenna when the telephone is placed against the ear. These malignancies include glioma, meningioma, acoustic neuroma, and tumors of the salivary gland. All are rare, thus posing the first challenge to epidemiologists. The second challenge is a low prevalence of relevant exposure. Although mobile telephony is fast becoming ubiquitous, most theories about the carcinogenicity of microwave exposure posit long induction times, perhaps even decades, between an exposure sufficient to induce a cancer and the appearance of the cancer. If using mobile telephones causes cancer with a long induction time, use of today’s mobile telephone may be inducing many future cancers but relatively few of today’s cancers, given the comparatively small number of users until recent years.

Unfortunately, rare disease and rare relevant exposure barely begin to describe the difficulties of studying the effects of using mobile telephones. By far the greatest obstacle is exposure assessment. Biologic exposure from using a mobile telephone extends just a few centimeters from the telephone, but people use telephones in myriad ways. They are sometimes held to the left ear, sometimes held to the right ear, and sometimes placed away from the head while used in speakerphone mode or with headsets. They are carried by some who seldom make or receive calls, and used by others as a nearly continuous channel of communication. All these factors strongly influence the biologic exposure to microwaves of susceptible tissues. Adding to the difficulty is the problem that the technology itself has been changing rapidly. Most users today employ telephones with “third-generation” technology, and “fourth-generation” is on the way, but the study of tumors occurring now might reflect the effects, if any, of first- and second-generation telephones that are no longer used. Finally, the transmission output of telephones is constantly changing, waxing and waning as it adjusts to the distance from cell towers or to shielding materials such as building walls. Thus, without an elaborate metering effort that would be impractical for any but a small subsample of users, a person’s actual tissue exposure to microwaves can only be vaguely estimated, even from telephone call records.

Even if metering were possible to sample some periods of exposure, it would hardly be possible over the length of time that a cohort is being followed. Furthermore, because the outcomes of primary interest are rare, nearly all of the studies conducted to date have
been case-control studies, in which metering of relevant exposure is impossible even for a subsample. Case-control studies have relied primarily on interview responses rather than recorded information to assess exposure, and thus have been vulnerable to recall bias. The widespread publicity about the hypothesis that mobile telephony is related to brain cancer has only exacerbated concern about recall bias.

Given these methodologic problems, especially the rarity of disease and relevant exposure, one can predict that the key inferences in this area will come from careful reviews or meta-analyses of the accumulating literature, rather than from any single study. We therefore welcome the comprehensive review of existing studies on use of mobile telephones and tumors published in this issue. This review, authored by a team led by Anders Ahlbom, is a work product of the International Commission for Non-Ionizing Radiation Protection, an international, nonprofit scientific body that was founded in 1977 to provide advice on the hazards of nonionizing radiation through careful evaluations of the scientific literature. The methodologic problems described above posed a challenge for the reviewers. Despite these problems, the reviewers were confident enough to conclude that “Overall the studies published to date do not demonstrate an increased risk within approximately 10 years of use for any tumor of the brain or any other head tumor.” Skeptics might rightly take this as only mild reassurance, because induction times for radiation-caused tumors often exceed 10 years. Nevertheless, as Ahlbom et al point out, even for carcinogens that induce cancer with very long average induction times, a causal effect should produce some increase in risk much earlier than the average induction time. Therefore, the absence of an effect for the first 10 years after exposure should have implications that extend beyond that time. The authors' conclusions were more tentative with respect to slow-growing tumors such as meningioma and acoustic neuroma, which in addition to a possible long induction time may have a long latent period before an existing tumor would be detected.

One notable feature of the literature to date is that authorship by Lennart Hardell is associated with finding an adverse effect of mobile telephone use for several different endpoints. The discrepancy between the findings of Hardell and those of other scientists was striking enough that Ahlbom et al presented some of their summary findings in 2 forms, including and excluding the studies by Hardell and colleagues. Treating the work of one research group in such a fashion is usually reserved for cases where fraud or other serious problems have been discovered, but that is not the case with Hardell. Ahlbom et al identified no single methodologic problem that could explain the difference between the studies by Hardell and the results from the other studies. In their words, “... the series of decisions in methods, analysis, and presentation provide the most plausible explanation for the deviation of the findings of the Hardell studies from those of other investigators.” It cannot be an easy task to review and summarize a body of studies that exhibits this kind of irregularity. It seems reasonable for Ahlbom et al to have reported this discrepancy, and their discussion of it seems even-handed. Still, we should keep in mind that even if methodologic subtleties could explain the difference between the studies of Hardell and the other studies in the literature, without more information we cannot know whether to exclude the studies from Hardell or to exclude the other studies and retain Hardell's. Therefore, a reasonable priority for future literature reviews might be to explore these methodologic differences more intensively.

The review by Ahlbom et al deals only with studies about tumors, and thus does not mention what is possibly the most important public health consequence of mobile telephone use traumatic injury caused by automobile crashes. This effect is of course not a result of nonionizing radiation, but a result of the distraction of automobile operators caused by using mobile telephones. Because this effect does not involve radiation exposure, there is no concern about which side of the head was exposed. For that reason, and because they have zero induction time, it has been easier to study. The zero induction time, for example, allows case-crossover methods to be applied. The effect appears to be strong enough to show up even in cohort studies that rely on rudimentary exposure metrics such as those based on billing records. Even these studies offer interpretation challenges, however. One is the confounding effect of risk-taking behavior, which might be associated with speaking on a mobile telephone while driving and with an increased risk of automobile crashes. Case-crossover studies, which are self-matched, should avert this problem, but they could be biased from other factors. For example, cases are known to have been driving their vehicle at the time of the crash, but may not have been driving during time windows chosen for comparison, a disparity that could introduce considerable bias that would exaggerate the effect estimate. Overall, the potentially lethal effect of distraction caused by using mobile telephones while driving seems hard to explain away. Debate continues on the role of other distractions such as hands-free telephony, listening to the radio, or conversing while driving. Whatever the eventual verdict regarding the effect of nonionizing radiation from mobile telephones on tumor occurrence, we would do well to consider that the most important health effect of using mobile telephones is likely to be the result of behavioral change related to attention span.
REFERENCES