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Comments on RF exposure simulation in NTP study

While the NTP study was intended to address possible health risks from using cell phones, the exposures in that study, in biologically significant terms, are far higher than those encountered with use of cell phones. Consequently, its relevance to possible health risks of using cell phones is difficult to establish. The exposures in the NTP study (1.5-6 W/kg whole body exposures in rats and 2.5-10 W/kg in mice) are far higher than limits for whole body exposure in humans (0.08 W/kg for the general public). The NTP exposures are at comparable levels to those known to produce behavioral responses and undoubtedly had considerable thermal effects on the animals. Comparison of the NTP exposures to FCC regulatory limits for local body exposure from cell phones (peak SAR of 1.6 W/kg averaged over 1 g tissue) is misleading. The following comments provide more detailed explanation.

The use of laboratory animal studies to investigate potential human health effects is a well-established practice. In such studies, it is important that exposure of the animals simulates realistic human exposures. When extrapolating animal observations to humans, physical and physiological scaling must be considered [Michaelson, 1990] (the degree of simulation similarity varies widely in the literature). Based on the draft NTP reports, the study simulates whole-body exposure of humans to the RF fields from cellphone base stations (at much higher intensities for toxicology study)—not localized exposures to part of the human head from hand-held cellphones. The following two examples of my previous studies illustrate the comparison.

In response to a request from officials of the United States Air Force in the late 1970's, the University of Washington carried out research to provide data for the assessment of the environmental impact of present and planned Air Force radar systems. Although the initial impetus for the study was to address the environmental impact of an Air Force missile warning and space surveillance radar (PAVE PAWS), it was decided to create a generalized exposure system that could provide whole-body averaged specific absorption rates (SAR) of 0.4 W/kg, the maximum permissible value at the resonant frequency of human beings recommended by ANSI C95.1-1982 and later by NCRP in 1986, but scaled to the proportions of the experimental animal of choice. The study consisted of 100 male rats in circularly polarized waveguides continuously exposed to pulsed microwave fields for 21 hours per day for 25 months, plus 100 sham exposed animals. A total of 155 parameters were measured to monitor the effects on general health and longevity of the animals. In this case, the life-long whole-body exposure study of animals was designed to simulate whole body exposure of humans chronically exposed to a radar system. Results are published in Bioelectromagnetics (Chou et al. 1992).

In the mid 1990's, supported by Wireless Technology Research L.L.C. (WTR), a head only exposure system was designed at the City of Hope National Medical Center. The purpose this system was to study the biological effects of localized exposure of the head associated with operating hand-held cellphones operating in the cellular frequency and personal communication service (PCS) frequency bands, 800–900 MHz and 1.8–2 GHz, respectively (Chou et al. 1999). The goal was to develop an exposure system, utilizing appropriate antennas operating at cellular or PCS frequencies, for conducting rat head only exposures. It was desirable to produce energy absorption in a rat brain comparable to that in a human

brain and, in addition, an order of magnitude higher than those experienced by cellphone users. Multiple SAR levels provide a means to study dose–response relationships, provided that the higher exposure levels do not cause thermal stress in the exposed animals.

In the NTP study, the whole-body exposure levels were chosen such that the core temperature rise will be less than 1 ^{o}C. Due to the 10 minutes on and 10 minutes off cycle, animals were able to thermally regulate their core temperature to tolerate 6 W/kg (rats) and 10 W/kg (mice) in a 72^{o} F/50% humidity environment. It has been shown that whole body exposures of rats or monkeys to 4 W/kg and higher can cause behavioral disruption; this value has been used by groups that develop standards and guidelines as the adverse health effect threshold value. Factors of 10 (0.4 W/kg) or 50 (0.08 W/kg) are incorporated to establish exposure limits for workers or the general public, e.g., see NCRP Report 86, IEEE C95.1-1991, ICNIRP 1998, and IEEE C95.1-2005. For localized exposures, both IEEE C95.1-2005 and ICNIRP 1998 have a separate set of limits—10 W/kg or 2 W/kg averaged over 10 g tissue for the two tiers. In the US, the FCC continues to use 1.6 W/kg averaged over 1 g tissue as adopted from IEEE C95.1-1991, as a limit for the general public. According to numerical computations, e.g., Gandhi et al. (2001), have shown that the 1.6 W/kg limit in one gram of internal tissue, such as the brain and eye, will result in temperatures that are no more than 0.1 - 0.2 ^{o}C higher than the basal values. Other studies, e.g., Gati et al. 2009, have shown that due to the adaptive power control of cellphones, the actual power transmitted from the phone is less than 1 mW (90% of the time) and most commonly at 0.1 mW, which is 100 to 1000 times below the maximum power of the phone. Therefore, under realistic cellphone use conditions, the maximum steady state temperature rise in 1 gram of brain tissue is negligible.

In summary, the comparison of the whole-body heating SAR with the SAR associated with localized exposure of the head of cellphone users is problematic. Whole body high intensity exposure above the SAR threshold can generate physiological changes in animals, but a localized small temperature rise cannot be expected to generate the same effect. The NTP study is a better simulation of the whole body exposure to the RF fields from base stations (but at a much higher value than the 0.08 W/kg permitted by the FCC for the general public) than exposure from the use of cellphones.

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