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Response

Epidemiologic Data and Standards: Response to Kundi

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While we welcome a scientific discourse on developing policy for electromagnetic fields (EMF) and on setting guideline limits, the letter by Kundi has a number of inaccuracies. The author appears not to understand the basis for the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998), EMF guidelines, or the use of precautionary measures suggested by the World Health Organization (WHO). Two of our authors (MR and LK) were instrumental in the development of the draft WHO framework and our views are "not at odds," but rather consistent, with it.

First, the ICNIRP low-frequency EMF guideline limits are based on established adverse health consequences, namely, acute short-term effects on excitable tissues (nerve and muscle cells). The scientific evidence on the association between childhood leukemia and ELF magnetic fields is noted by ICNIRP, but is considered insufficient for guideline formulation.

Second, the author's assertion on relationships between EMF and "cardiovascular diseases, Alzheimer's disease, amyotrophic lateral sclerosis, childhood and adult brain cancer, male and female breast cancer, and adverse pregnancy outcomes" is not supported by current scientific knowledge. A recent comprehensive health risk assessment by the WHO ELF Task Group (for publication as an Environmental Health Criteria monograph) forms the basis for our understanding of the scientific literature. It found, for example, that the evidence "does not support an association between ELF exposure and cardiovascular disease" (WHO, in press). The evidence for breast cancer was also considered to be effectively negative, while for other diseases it was judged to be inadequate.

Third, the author claims that "the pooled analyses of the relationship between power-frequency EMF and childhood leukemia give no indication of a threshold. Or more precisely, no empirical decision between a model with and without a threshold can be drawn. Therefore, as a conservative approach, a no-threshold model must be chosen." Assuming a no-threshold model would lend support for our suggestion of reducing exposures, rather than advocating for limiting "average exposure levels (say at 0.2 μT)." Furthermore, the author's claim that his "analysis takes imprecision of the exposure assessment into account" is unsubstantiated. For a detailed account of imprecision of the exposure assessment and discussion of other uncertainties, see Greenland and Kheifets (in press).

Fourth, it is incorrect that "practically, the only case of a systematic long-term environmental exposure above levels of about 0.2 μT occurs in the vicinity of high-voltage power-lines and transformer stations." Likely, 75% or more of such exposures are due to other sources such as ground currents in many homes and schools that are not in the vicinity of high-voltage power-lines and transformer stations. For example, von Winterfeldt *et al*. (2004) found that only about 16% of magnetic fields above 0.2 μT in California were due to transmission lines, and were much more commonly associated with home grounding. In the United Kingdom, only 23% of homes with exposures above 0.2 μT were in the vicinity of high-voltage power-lines; a higher percentage (35%) of such exposures were due to internal wiring and appliances, and the rest due to low-voltage lines (some underground) or a combination of sources (Maslanyj *et al*., 2005). Clearly, and contradictory to his claim, the author's

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call for an exposure limit of 0.2 μT for high-voltage power-lines is neither supported by the science nor will be an efficient strategy.

Finally, describing our reasoning as "based on the imperfections of exposure assessment and the arbitrary choice of cut-off points for the derivation of risk estimates within epidemiologic studies" is superficial and ignores numerous other details of the EMF science discussed in our paper, such as biophysical plausibility, lack of support from animal and cellular studies, and cost-benefit considerations, to mention a few.

Contrary to the assertion of the author, our approach would result in more comprehensive, effective, and ultimately efficient public health policies with respect to the EMF issue. Our proposal is driven by two considerations: (1) consensus of the scientific community is that magnetic fields are "possibly carcinogenic" (i.e., "2B" based on the epidemiologic literature using the IARC classification system) and (2) taken as a whole, the scientific literature does not allow any conclusions to be drawn with respect to the causal factor, if any, associated with exposures to magnetic fields below, say, 100 μT. Therefore, it is clear that policy setting cannot rely on a formal risk assessment to derive a "numeric standard." The policy decision, therefore, is whether interim, precaution-based approaches are justified given the lack of established health impacts. We believe that they are, but not as a "back door" to create quasi-scientific numeric exposure criteria.

Precaution-based approaches can be particularly effective for the EMF issue, since there are no-cost and low-cost options to lower magnetic field exposures for new construction of electric utility distribution and transmission systems, occupied structures, and appliances. These policies should be evaluated and adopted at the national level to maintain a consistent technical basis, avoid adverse unintended consequences from overly restrictive policies, and to ensure the consistent application for national products and services. Decision making at the national level is more likely to result in a sound policy that recognizes the limits of available scientific knowledge and protects the clearly established benefits of reliable, safe, and economic electric power.

Similarly, instead of advocating for low-level guidelines as does the author of the commentary, WHO has suggested a rational approach to the use of precautionary measures through the development of a policy framework. This framework is currently being reviewed to accommodate the comments received, and should be published in the next two to three months. In the case of ELF, precautionary measures that lead to a reduction in exposure to people will be suggested to take into account the uncertainty in the science, particularly for long-term, low-level effects. The revised WHO framework for EMF will follow recommendations of a recent WHO Task Group described above. The group concluded that in recommending precautionary approaches, an overriding principle is that any action taken should not compromise on the essential health, social, and economic benefits of electric power. In light of the current scientific evidence, and given the important remaining scientific uncertainties, an assessment should be conducted, prior to any policy recommendation, of the impact of any precautionary approach on the health, social, and economic benefits of electric power. Provided there is no compromise to these benefits, implementing precautionary procedures to reduce exposures is reasonable and warranted. Given the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukemia and the limited impact on public health, the benefits of exposure reduction on health are unclear and thus the costs to reduce exposure should be very low. We concur with this Task Group recommendation and advocate it in our paper.

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