

Epidemiologic Assessment of Cancer Risk from Mobile Phone Use: Where Are We?

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Abstract—More than a dozen epidemiological studies have addressed the possible risk of cancer associated with mobile phone use. Overall, the evidence is reassuring, as risk estimates are close to unity and confidence interval relatively narrow. However, most studies have been based on relatively small number of long-term users. When the analysis was restricted to long-term use of mobile phones, some indication of increased risk was found for acoustic neurinomas. Also, effect related to use on the same side as where the tumor was diagnosed could not be excluded. Despite the substantial volume of research some increase in risk cannot be ruled out at the moment. Knowledge could be further advanced by improving exposure assessment rather than increasing the number of case-control studies. Prospective cohort study is a gold standard in epidemiology and would substantially advance our understanding of the possible health effects of radiofrequency electromagnetic fields emitted by mobile phones.

1. Introduction

When new factors (exposures) are introduced or identified that have the potential to affect human health, multidisciplinary evaluation of possible health impact is required. Risk assessment involves hazard identification, exposure assessment and risk estimation. Hazard identification entails discovery of harmful potential, with its possible target for toxicity. Exposure assessment includes describing the occurrence of the agent, pathways and distribution in the population. Risk estimation comprises identification of mechanism of effect and evaluation of dose-response.

In this review, we summarize the findings from epidemiological studies. In addition, weaknesses in published studies are considered and some suggestions for improved assessment given.

2. Methods

We review the epidemiological evidence regarding cancer risk from mobile phone use. The evidence from studies conducted at individual level is summarized by means of meta-analysis, i.e., quantitative synthesis of results by obtaining a pooled estimate from published results. The pooled results is obtained by weighting the individual estimates with the inverse of the variance (obtained from confidence intervals), which is a measure of precision (amount of information). Consistency of results is evaluated by tests for heterogeneity. When heterogeneity is present, a random effects model is used. If no heterogeneity is found, a fixed effects model is used, assuming that all results represent the same global distribution of values. No such assumption is involved in random effects model.

3. Results

In ecological studies, brain tumor incidence and mortality have been related to mobile phone use at population level, without being able to assess if tumors have occurred in mobile phone users or not. Analyses regarding four Nordic countries showed no obvious increase in benign [1] or malignant intracranial tumors [2] parallel with increasing mobile phone coverage. However, in some subgroups including the oldest age groups and incidence of glioblastoma increase during the late 1990's was reported.

A total of 14 epidemiological studies on mobile phone use and cancer have been published by late 2005. Twelve have been case-control studies and they have included a total of more than 5000 cases with intracranial tumors. The total number of exposed cases is more than 1800 (corresponding to exposure prevalence of 1/3). In the two cohort studies the total number of brain tumor cases is much smaller, only 160. A further limitation of the latter has been relatively short follow-up, only one year in the US cohort and three years on average in the Danish study. This review will therefore focus on case-control studies, which also have an additional strength in more detailed exposure assessment.

Overall, there is substantial evidence indicating that (ever or regular) mobile phone use is not associated with the risk of intracranial tumors. The pooled overall OR from all studies is 1.09, 95% CI 0.86–1.38. For

all malignant tumors, consisting mainly of glioma/astrocytoma, the pooled odds ratio from nine studies is very close to unity, with a narrow confidence interval (OR=1.02, 95% CI 0.77–1.37). Pooled odds ratio for benign brain tumors, mainly meningiomas, from eight studies is actually below unity (OR=0.89, 95% CI 0.75–1.06). For acoustic neurinoma (vestibular schwannoma) little indication of risk overall is found based on seven studies.

Eight studies have compared analog (NMT) and digital (GSM) network. Both showed some increase (OR 1.2–1.3), but neither was statistically significant.

Among subjects who have used a mobile phone for at least five years, a slightly elevated risk of borderline significance is found (OR=1.11, 95% CI 0.99–1.26). This was mainly due to acoustic neurinoma (OR=1.5, 95% CI 1.2–2.0). No clear indication of increased risk was found for malignant tumors (OR=1.1, 95% CI 0.9–1.3) or meningioma (OR=0.9, 0.8–1.1).

Ipsilateral use (mobile phone on the same side where the tumor was diagnosed) was associated with some indication of a slightly increased risk (OR=1.4, 95% CI 0.9–2.0)

When the groups with longest cumulative calling time were combined from different studies (using various cut-points), an odds ratio below one was obtained (OR=0.91, 95% CI 0.74–0.60).

4. Discussion

The number of studies conducted and number of subjects included in epidemiologic studies are relatively large. However, quality of evidence should also be considered. Most studies so far have relied on self-reported extent of mobile phone use as principal exposure measure of exposure. However, the limitations of such approach are evident. Whether or not a person is a regular mobile phone user can probably be reliably assessed. Yet, for construction of quantitative exposure-effect relationship, much more detailed information is required. Validation studies carried out indicate that the precision of self-reported use in terms of number of calls or cumulative call duration is only adequate (correlation coefficients between reported and recorded use 0.5–0.7 for both number and duration of calls) [3–5]. Furthermore, there is tendency to systematically overestimate amount of use (reported call duration up to 2–3 times the recorded value). Additional uncertainty arises from the fact that cumulative calling duration is only a proxy measure for the exposure of interest, energy absorbed in the target tissue from the radiofrequency electromagnetic field.

Random error, if non-differential, i.e., similar among cases and controls, is likely to attenuate any effect of exposure and therefore hinder detection of possible association. In addition to random error, systematic error (bias) is likely to affect the results of epidemiologic studies.

No studies have been published addressing possible information bias, i.e., differential error among cases and controls. Typically, recall bias, based on less complete reporting of exposure among controls, tends to overestimate any effect on outcome. In brain tumors, it is possible that the disease or its treatment, or anxiety following diagnosis may affect the recall and cognitive function of cases, diminishing accuracy of reporting. Also, proxy respondents are used more commonly for cases with malignant tumors than controls, which is likely to affect the quality of information.

The results of a recent study conducted in Finland [6] showed that non-participants were less likely to use mobile phone than study participants. This applied to both cases and controls. Selection bias resulted in apparent protective effect of mobile phone use. It may also distort the shape of dose-response.

These methodological weaknesses are inherent for retrospective exposure assessment. Epidemiological risk assessment is unlikely to improve from simply increasing the volume of research. A cohort study where concurrent mobile phone use is assessed would likely achieve substantially improved accuracy. Another advantage would be the possibility to risk of several health outcomes such as disease incidence and mortality (not only cancer, but also neurological, cerebrovascular and psychiatric disease), as well as ‘soft’ end-points, including symptoms and well-being. However, such study would require resources as recruitment of a very large number of subjects (probably > 100,000) is needed with follow-up for at least 10 years.

5. Conclusion

Currently, the factor limiting our knowledge of possible carcinogenic effect of mobile phone use is no longer the volume of evidence, but quality of epidemiological studies conducted. Improved knowledge could be gained by conducting prospective cohort studies, rather than increasing the number of case-control studies.

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