Types of Scientific Studies

There are two basic types of scientific studies that are used to determine the limits of safe exposure to electromagnetic energy. Laboratory studies use either isolated cells or animals to test for effects of highly controlled exposures. Epidemiological studies focus on the incidence of adverse effects or diseases in the population to look for trends that may be related to some type of exposure. All scientific studies must deal with the biological variations between various people. Natural variations are separated from the effects of the stimulus under examination by examining large populations of subjects that have been exposed to the stimulus (study population) and those that have not (control population). If the number of subjects studied is large enough and all variables and stimuli except the stimulus under study are identical between the study and control populations, statistical analysis will point to any effects that are associated with the stimulus in question.

Neither type of study can be conclusive as to the formation of a disease or production of some form of adverse reaction. An epidemiological study can indicate an association between a given stimulus and disease. Laboratory experimentation may shed light on the mechanisms that may cause disease, but neither type of study on its own is capable of proving a causal link between RF exposure and human disease.

Scientific studies are made public through the process of peer review. The results of a study are written as a scientific article, which briefly reviews previous work on that subject, specifies the methods that were used to obtain the reported results, presents the results, and then includes an interpretation of the results. The written report of the study is submitted to a scientific journal, generally which specializes in the topic of the current study. The journal sends copies of the report to a number of peer reviewers, who use their expertise in the subject to critique the study and, after it is acceptable to the peer experts, it is then published in the journal. The process of peer review has been widely accepted as an acceptable gate keeper that separates good from bad science.

In recent years, there has been evidence that the peer review process is not infallible. Many scientific publications that clearly do not have the scientific basis to make the claims that they do have been published as having been peer reviewed but appear to have bypassed the process. There are several ways that this has been done. For instance, papers that are not accepted by journals in their field are sometimes resubmitted to journals in other fields where the peers are not experts in the topic of the paper.

The scientific publication process also includes the ability for other peers, who were not asked to review a paper, to comment on science that they do not agree with. The comments are published in future editions of the journal and the original authors are given the opportunity to reply. Often, the comment and reply process is not followed with the original paper that is being challenged.

As weaknesses in the peer review process have become more evident, one tool that the scientific community has come to rely on is independent replication of results. If a scientific study provides results that contradict what has been seen in the past, it is important that the new results be confirmed by an independent laboratory that follows that first study's procedures. Often independent replication is able to identify errors in the original study that led to the unique results.

Laboratory Studies

The best way to test for an effect of a given stimulus is to perform experiments under tightly controlled conditions in a laboratory. Biological organisms are affected by many things, so to determine if a single stimulus is causing an effect, it is important to control all other variables. A well-designed laboratory study can identify a mechanism for a disease process. Even though most studies are not performed on humans, the extrapolation of effects found in other mammals to effects or diseases found in humans is often used. One of the reasons that RF exposure limits include appropriate safety factors is to account for uncertainty in the extrapolation process.

One important sign of a properly performed laboratory study is the presence of a dose-response relationship. An observed reaction of a biological organism to a given level of exposure should be seen to increase when the exposure level is also increased. That relationship should be present in a majority of the experimental subjects over several different exposure levels. If a reasonable dose-response relationship cannot be demonstrated then the investigators should be looking for errors in the experimental procedure.

Epidemiological Studies

Epidemiology is a valuable tool to help scientists recognize harmful stimuli. It is also a very difficult science to perform because of the inability to control all stimuli to which individuals are exposed. An epidemiological study typically looks for differences in rates of diseases in population groups that are, to the greatest extent possible, identical except for exposure to the stimulus of interest. If the rate of a disease is significantly higher in the exposed population than in the unexposed population, then the likelihood that the stimulus under test contributes to that disease development is increased.

The simplest epidemiological studies involve basic and mainly publicly available information about the subjects, and are often called preliminary studies. A preliminary epidemiological study can be performed with much less expense and effort and provides an indication that a problem may exist. If the results in the preliminary study show a large expectation of an association between a stimulus and disease, a common next step would be to gather more information about the subjects so that the results can be tied more definitely to the stimulus.

A common result of an epidemiological study is a factor called the risk ratio, which tries to quantify the increased risk of the stimulus being studied. Some epidemiological studies express their results as standardized mortality ratio, SMR, which compares the number of deaths in the study due to a given cause to standardized population deaths. SMR is similar to risk ratio and is often presented with a number scale of 100 when number of deaths in a study exactly matches the number of deaths expected from an age corrected population. For instance, a risk ratio of 2, or an SMR of 200, means that someone exposed to the given stimulus is twice as likely to die from the disease as someone who is not exposed. Conversely, a risk ratio of 0.5, or an SMR of 50, means that someone exposed to the given stimulus is half as likely to die from the disease as someone who is not exposed.

Risk ratios and SMRs can be misleading, however. An epidemiological study compares people exposed to a given stimulus with those who are not exposed. However, usually it is not possible to account for other variables and stimuli that may affect the results. Epidemiologists are often not able to account for eating habits, smoking habits, underlying diseases, exposure to chemicals not being studied and any other exposures that occur in a person's daily life. All of these things could affect the results of the study of a given stimulus and introduce a level of uncertainty in the results. This is accounted for by using very large numbers of people in a study and by looking for very high risk ratios. Risk ratios of 4 (SMR of 400) or greater are often used by epidemiologists to indicate that more study should be performed, with more detailed epidemiology and laboratory investigation. As a point of reference, epidemiological studies of cigarette smokers have yielded risk ratios of 17 (SMR of 1700) and higher.

Amateur Radio and Epidemiological Studies of Disease

Amateur Radio operators might be a useful subgroup of the population that can help uncover whether there are any diseases caused by exposure to electromagnetic energy. Radio amateurs have been exposed to the RF signals that they transmit for over 100 years. There have been two epidemiological studies performed on radio amateurs in the United States. Both have indicated very weak associations between having an amateur radio license and any disease. There has been no evidence presented that indicates causality between exposure to electromagnetic energy and any disease.

The most quoted study, by Samuel Milham, Jr. in 1988[1] was a preliminary study that compared all amateurs from Washington State and California listed in the FCC license database with those states' death records. In a study of 67,829 radio amateurs there were 2,485 deaths in the years 1979-1984 in those two states. The results of this study implied a weak association between having an amateur radio license and dying of acute myeloid leukemia, with an SMR of 176. The same analysis, however, yielded an SMR of 71 for all deaths, meaning radio amateurs listed in the FCC license database lived longer than expected. The radio amateurs that were studied also had favorable results for death from malignant cancer overall (SMR = 89), death from circulatory diseases (SMR = 70), death from respiratory diseases (SMR = 50), and death from accidents (SMR = 64). Since an SMR of 100 indicates that the number of deaths equals what is expected from the general population, the possession of an FCC amateur radio license appears to be associated with living longer, based on this study. The amount of information about the subjects was very sparse, since it did not include any information about how long a subject had been an amateur radio operator, how much the subjects used their radios, what levels of exposure the subjects received, what the subjects did for a living, what chemicals the subjects were exposed to in their occupations, if the subjects had family histories of diseases and many other factors that could affect how they died.

In 2003, Kenneth Cantor, a researcher at the National Cancer Institute, performed a similar preliminary study on FCC licensed amateur radio operators[2]. The NCI felt that many of the inconsistencies in the Milham study were due to the limited data that were available, which they could improve by using the National Death Index and the mortality listings of the Social Security Administration. The NCI database consisted of 108,586 subjects (94,610 males and 13,976 females) over the period of 1966-1995. Unlike Milham, the NCI data distinguished between men and women and also permitted determining if there were effects of license class. Similar to Milham's results, there were slight associations to chronic myelogenous leukemia (SMR = 120), ALS (SMR = 121), and Hodgkin's disease (SMR = 131). Also, similar to Milham's results, any form of death, death from any cancer, and death from most other causes were better than the general population. The results were so unremarkable that the NCI decided no additional benefit would be attained by continuing the study, so it was terminated in the preliminary stage without obtaining more information about the subjects.

Considering the very weak associations that these two preliminary epidemiological studies found between being an FCC amateur radio licensee and death from leukemia, ALS and Hodgkin's disease, and the fact that there has never been a laboratory study showing that these diseases can occur due to exposure to electromagnetic energy in animals in controlled environments, no causal link has been found between having an amateur radio license and death from any disease. Similarly, the weakness of the data in both studies did not provide a causal link between amateur radio and living longer.

References

1. Milham, Samuel, Jr, "Increased Mortality in Amateur Radio Operators Due to Lymphatic and Hematopoietic Malignancies," *Am J Epidemiology*, **127**:1, pp. 50 – 54, 1988.
2. Cantor, Kenneth P. PhD, Dalsu Baris, MD, PhD, Peter Inskip, ScD, "Mortality among Radio Amateur Operators," *Submitted to the 15th Annual Meeting of the International Society of Environmental Epidemiology in Perth, Australia, September 24-26, 2003, Not Presented.*