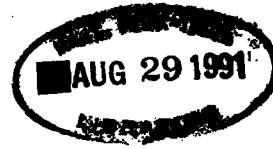


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**"Electromagnetic Fields: Health Effects and Policy Issues"**

**March 21, 1991**

**Seminar Notes**

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
COMMUNICATIONS FORUM**

**"Electromagnetic Fields: Health Effects and Policy Issues"**

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**Seminar Notes**

**Prof. Harvey Sapolsky, M.I.T., Moderator**

**Mr. Robert Pool, News Editor, *Nature***

**Prof. William Thilly, M.I.T. Center for Health Sciences**

**Dr. Louis Slesin, Editor and Publisher, *Microwave News***

**Elizabeth H. Prodromou, M.I.T., Rapporteur**

This session of the M.I.T. Communications Forum brought together three panelists to discuss the subject of electromagnetic fields (EMFs) and the health effects and policy issues related to EMFs.

The first speaker was Dr. Robert Pool, News Editor for *Nature Magazine*. Pool, as a former reporter at *Science Magazine*, had prepared a series on EMFs. When he announced to his colleagues at *Science* that he wanted to do an article on EMFs and their possible health effects, their reaction was to discourage him and to argue that the field of study on EMFs is a morass. Nonetheless, Pool did the articles. He observed, however, that they took far longer for him to research and develop than the other pieces he had written, because the area of study on the possible health effects of EMFs is, in fact, a mess, full of suggestive and inconclusive data. Pool noted that there is no biological mechanism that we know of which can explain why EMFs could cause cancer, birth defects, or any other negative health effect, but he pointed out that the analysis will differ from scientist to scientist.

In Pool's view, the majority of the worries about the possible health effects of EMFs are basically generated by epidemiological data. There are two types of studies - residential studies and occupational studies - which indicate that there may be health risks. The residential studies find an increased cancer risk, usually in terms of lymphomas and leukemias in children who live close to power lines. There are several problems, however, with these studies. First, they are based on extremely low risk ratios (1.5 to 2), meaning that children living close to power lines with high levels of EMFs are maybe 1.5 to 2.0 times as likely to get certain types of cancers versus children living in areas where they are not exposed to such levels of EMFs. Pool observed that, any time epidemiologists work with such low levels, they find it very difficult to separate fact from "noise." The second and more difficult problem with the studies is the difficulty of determining the exact correlation between the risk ratio and the EMF levels that are in the home. Most of the epidemiological studies which have argued that there is increased risk have depended on something called wire coating. Pool explained wire coating: you look at the types of power lines which are close to the home, determine how much current is going through those lines and how close the lines are to the home, and you rate the homes (low, medium, high); the rating is based on what you think you are going to see, based on the visual inspection. This method has shown risk ratios of 1.5, 2.0 and, sometimes, 3.0, but with actual measuring of EMFs inside the home, the effect seems to get smaller and sometimes vanish completely. Pool observed that the variation in the study results remains unexplained.

Turning to the occupational studies, Pool argued that these seem to be a bit sharper than the residential studies. A number of studies of those people in occupations (e.g. electricians or telephone linemen) where the level of EMF exposure would be expected to be high have shown increased cancer risk, especially with brain and nervous system cancers. These risk ratios are usually much higher than in the residential studies, sometimes ranging as high as 6.0. But Pool pointed out problems with these studies as well. No one has really gone and done a study which measures EMF exposures in these different occupations. Instead, what has been done thus far for the most part is to say that these workers would be expected to be exposed to higher levels of EMFs than workers in other occupations, and the studies then proceed on that assumption. In some cases where researchers have gone and done the measurements, the results are less consistent. In his view, the variability in the results suggests that the electricians, etc. might have developed cancer as a result of other factors. So although the occupational studies indeed have shown that there are health hazards associated with certain occupations, the studies have not conclusively proven that it is the EMFs that cause the hazards.

According to Pool, the problem with both types of epidemiological studies is lack of solid laboratory evidence pointing to the possibility that EMFs can cause cancer. There are no studies of lab animals which indicate these results, nor are there any good studies of cell cultures which support the hypothesis. Pool noted, however, that this is not to say that there are no biological effects of EMFs - a fact which further confuses the issue. Pool stated there are approximately 250,000 people in the world who can testify that EMFs indeed do have very strong biological effects - these are the people who have benefitted from magnetic fields which have been used to heal bones. For about ten years now, doctors have been using magnetic fields to promote the healing of very bad fractures. As a result, we know that magnetic fields do have a biological effect on how bones grow inside the body. There are also other laboratory studies which show that EMFs have various effects of cells or on whole animals, in terms of

hormone levels and on the binding of ions to cell membranes. Pool commented, however, that most of the observed effects from electric and magnetic fields are from EMFs that are much higher than anything that we would ever be exposed to in a particular environment - for example, sitting next to a VDT terminal or under an electric blanket. Most of the things which have been observed in laboratory experiments are from much higher exposure to EMFs than would occur in the environment. Pool pointed out that there are few laboratory effects which have been observed repeatedly from EMFs of about the level which you would get in the environment. For instance, it is pretty well accepted now that EMFs at environmental levels can affect the level of the hormone melatonin, as is the fact that EMFs can do something to affect RNA replication. Pool reiterated, however, that what these effects have to do with causing cancer or miscarriages or other negative health effects is not at all clear. Pool emphasized that there is no solid connection.

Pool suggested that what is very much needed is a comprehensive laboratory study on mice or rats, where a number of the subjects is exposed to EMFs and a comparison is done of the health effects (e.g. cancer rates) on this group versus the control group. There is one such study underway now, but the results probably will not be ready for at least a couple of years.

Pool summarized some of the pitfalls and difficulties associated with reporting on EMFs. First, and perhaps most frustrating, is the fact that readers want a yes or no answer - are EMFs dangerous or aren't they. It is inaccurate to draw such yes or no conclusions and it is impossible, at this juncture of the research, to offer a yes or no answer. Any articles which pretend to offer a pat answer should be taken with a grain of salt. In Pool's opinion, there is no pat answer.

Another difficulty he cited is the complexity of the subject. A reporter needs to learn a lot of science in order to do a credible job of reporting the subject and, according to Pool, many reporters do not have the necessary background for understanding the epidemiological and subtle biological questions associated with the subject. It is almost impossible to do a good story on the subject without a working knowledge of the subject, but most reporters don't have enough time to do the proper homework.

Moreover, even in those cases where the reporter has done the homework and understands the science, the reader may not understand the subtleties. Pool commented that the reader oftentimes reads only the first few paragraphs of a story, in which he might see the words cancer and EMFs in the same sentence. The reader then takes away this connections. The only way for a reporter to deal with this problem is to make certain to include all the ifs, ands or buts in the article.

Pool also commented that another negative aspect of reporting about the issue is that the articles scare people. The reaction depends very much on the particular individual. While the answer is not to stop reporting on the subject, it is unclear how to deal with the fear which the reporting tends to engender. Oftentimes, a more costly result of the reporting is that it leads to policy decisions on the basis of people's fears. Pool cited as an example the fact that Florida and New York state have been pushing to limit the EMF exposure from power lines.

Despite the fears caused by reporting on EMF, Pool maintained that reporters must continue to report the information. The general public is a better public if it is educated on a variety of subjects. People will become better citizens, in one way or another, if they are better educated about an important scientific issue. In Pool's perspective, the second reason to continue reporting on the subject is the real possibility that research down the line may prove the real existence of hazards associated with EMFs. As a result, reporting constitutes a public service. Pool cited the asbestos issue as an analogous case.

The final point mentioned by Pool is the need to keep in mind that whatever is done about EMFs (now or in the future) must be a societal decision. Decisions can not be made only by scientists or by the scientific community, because this is a societal issue (which policies to implement, what sort of resources to commit) which affects everyone.

In conclusion, Pool emphasized that his bottom line at this point is that we don't know, that we should stay tuned and, that when scientists do finally figure things out, we probably will find out about it first in the newspapers rather than in the scientific journals.

The next speaker was Dr. William Thilly, an expert on research methodology and a Professor of Toxicology at M.I.T. and Director of the M.I.T. Center for Environmental Health Sciences. Thilly stated that he would pick up where Pool left off, noting that he comes to the lecture as an agnostic and therefore can't take issue with Pool's statements. Thilly explained that his introduction to the issue of problems associated with EMF exposure came via the Director of the M.I.T. Energy Laboratory, who was very concerned about power line transmission and its longterm potential effects. He noted that he understands the problem of great uncertainty which we as a society face. With regard to the means of discovering whether something which may or may not increase the probability of leukemia in the 0 to 18 age group, Thilly's opinion was that society in general actually recoils from the idea of creating conditions which would increase rates of such dread childhood diseases.

Thilly parted ways with Pool over the issue of the possibility of a 10% risk that there's a positive effect. Thilly wondered how it would be possible to determine such a percentage, and considered how we can find out if anything is causing cancer in people. Although the lecture subject is EMFs, Thilly pointed out that people are doing research on low level radiation, toxins in peanut butter, direct radiation from sunlight, etc. According to Thilly, there are methodological problems with answering any of those questions.

From his perspective as a genetic toxicologist, Thilly viewed EMFs as part of the larger question of what mutates people and, specifically, what causes the mutations which we now know are necessary for cancer in humans. Thilly attempted to summarize the dilemma (slides here), discussing an experiment which considered what would happen if otherwise normal human cells were grown in the presence of a bit more oxygen than what we are normally exposed to in the environment. It had been extremely difficult to formulate the methodology for examining such a question but a group of researchers at MIT had developed such a methodology, whose results show the following: by exposing human cells to certain things (e.g. those things which are normally part of human experience - diesel exhaust, microtoxins, etc.), mutations in the cells result. Thilly pointed out that the kinds of changes which occur are very specific, with the particular set of mutations depending on what the cells were exposed to. In the initial experiment Thilly had mentioned, the results were much different from what radiation biologists had thought up until that point; the results showed that the kinds of mutations caused by x-rays were quite different from the kinds of mutations caused by oxygen and were totally different from the kinds of mutations which occur when human cells are allowed to grow under pristine conditions in the laboratory. According to Thilly, these results forced radiation biologists to begin looking at the problem of EMFs in different ways than had previously been conceived.

Like Pool, Thilly discussed the literature. A recent article in *Mutation Research* discusses human cells exposed for one, two, or three days to pulsating magnetic fields. The experimenters used 60-cycle at a tenth of a mill-tesla. Thilly remarked that the work reminded him of research done about thirty years ago by a cytogeneticist who exposed human and mouse cells to caffeine, and discovered that upwards of 10 millimolar of caffeine shattered the chromosome. However, there had to be very specific conditions for such levels of exposure to occur and, further, additional research contradicted the supposed effects of the exposure. Such divergent results in the research on EMFs is occurring, and it is difficult to go from the amount of broken chromosomes in the real environment and to make a link with very low levels of exposure to anything (whether EMF, microtoxins, or ionizing radiation).

In his opinion, the best that researchers can do is to develop the tools to reduce the uncertainty so that society can make decisions. He went on to discuss the development of frequency distributions for mutations, which are a function of position on the DNA. The frequency distribution is called a mutational spectra, and was worked out by people working with bacterial viruses in the 1950s. Contemporary research has facilitated the means of getting this kind of information on mutational spectra relating to microtoxins. Thilly's emphasis was that the mutational spectra research shows that there does seem to be a way to go into human cells and to start looking for and measuring the specific

genetic fingerprints that are harming us. A hypothesis can be set up relating to exposure to certain EMFs and resultant genetic mutations, and the technology for researching such DNA mutations, their causes and their measure, is improving. Thilly pointed out that, even before the emergence of EMFs as an issue, toxicologists were stuck with having to extrapolate from high dose to low dose and from non-humans to humans; but this was unsatisfactory - it was mathematically indeterminate - so that development of the technology needed to research genetic mutations from exposure to toxins became a priority in this field. Such technology should be useful in researching the EMF issue and in discussing the issue with the public. Thilly called himself a rabid agnostic at this point, since it is still not possible to know what is responsible for the specific set of mutations (EMF or otherwise) known to be on the pathway to human cancer.

The final speaker was Dr. Louis Slesin, an MIT alumnus and the Editor and Publisher of *Microwave News*. Slesin introduced his remarks by noting that, despite his general agreement with most of the speakers' remarks thus far, he had some reservations. Slesin explained that he has been following the EMF issue for about a dozen years, reporting regularly on it for about ten years. Slesin remarked that, while Pool had stated that we should stay tuned because we will find out more on the EMF issue, he would say that we may not find out. In his opinion, we are not really on the road to finding out the answers, and public action is essential for us to find out the kind of research answers we need. Slesin maintained that the research which needs to be done is not getting done, characterizing the EMF issue as one which is driven by the public and which, therefore, is relatively unique. There aren't organizations, interest groups, or institutions which deal with the issue insofar as having earmarked funds to research EMFs. Slesin also emphasized that there is no Congressional leadership in this area, nor is there federal agency leadership in this area. His view was that none of the major medical groups has really spearheaded a movement for trying to get some answers to these questions.

Slesin turned to considering three groups and their relationship to the EMF question: the scientific community, the press, and the government, (slides here). According to Slesin, the EPRI (Electric Power Research Institute), which is the research arm of the Electrical Utilities, has about six to seven million dollars a year for research on exposure at the extremely low frequency (ELF) level. The Department of Energy (DOE) has the lion's share of the federal government's EMF research budget, but it is approximately half of the size of the EPRI's.

Slesin emphasized that the key point about the people who are doing the research is that they are interested parties - that is, they are interested in the outcome of the research. Previous debates, over issues such as exposure to asbestos, chemicals, ionizing radiation, have shown that there must be a separation of user and researchers. The person who has something to gain or lose from the research should not be actively doing the research. He pointed out that 90% of all research is being done by the DOE and EPRI, whose mission is not health but the provision of energy. Slesin noted that the DOE has stalled in releasing research on exposure to ionizing radiation at nuclear plants, so that this is not a model of how health research should be conducted.

Reiterating that the state of research on the EMF issue is extremely limited, Slesin emphasized that there is more research being done outside of this country than inside the country and that part of the problem is who is doing the research. For example, the electrical utility industry state at recent Congressional hearings that they can't afford the appearance of being an interested party in the outcome; Slesin noted that they are now trying to put some distance between themselves and the research. In Slesin's perspective, the research is being centrally controlled by the interested parties, with the biggest user of all technology along the whole electromagnetic spectrum being the military. He emphasized that, clearly, they are interested in the outcome.

In terms of the scientific community, Slesin noted that while one normally thinks of a new issue (such as EMF) as spawning open debate in the scientific community, there is definitely an unequal playing field where EMF is concerned. On one end are the industry experts and, because of the people who are funding the research, the other experts are very hesitant to go on the record. In his efforts to conduct interviews on the subject, Slesin has been struck by the number of experts who refuse to go on record because they fear the subsequent loss of their research funding. At an EPA hearing on cancer

and EMFs attended by Slesin, leading academic experts on the subject had been called to testify. However, when panelists began questioning the testifiers (e.g. Dr. Korn, Dean of Stanford Medical School), it became clear that these experts had not read the literature. According to Slesin, such experts are willing to get up in public and trash a scientific idea that they haven't read the literature on. Slesin observed that they are willing to do this because the subject is arcane and they don't expect the results of their testimony to become part of a public debate and because they are extremely well compensated in financial terms for their testimony.

Turning to the press, Slesin quoted from a recent review in the *New York Times*. He remarked that whatever one thinks of the EMF issue, it is extraordinary that the health effects of EMFs are being compared in the press to UFO discussions. There are over thirty-five different studies which show some link between EMF exposure and cancer, and four of the studies link childhood exposure at home to power lines. Slesin emphasized that this is not UFO talk, and he questioned how a prestigious science writer at a prestigious newspaper could be making such a comparison. A quote from the Science Editor at the *Washington Post*, claimed that the whole issue has been hyped and "...doesn't deserve coverage at all."

In a brief synopsis of the data, Slesin pointed out that after three years of work, the EPA classified EMF's as 'probably human carcinogens'. The most controversial part of the report, in which a direct linkage was made between EMF exposure and cancer, was deleted from the report following meetings at the White House. Still, even in its final release, the report said that there was a consistent pattern of response from EMFs in the biological system. As an aside, Slesin observed that the *Washington Post* headline on the report shows that reporters still don't understand the issue. He also emphasized that, nearly a year after the EPA report first surface, there is still not a plan at EPA to spend any funds on EMF research. There is no public policy on the EMF issue and, instead, that there is a consistent passing of responsibility. Slesin disagreed with Pool's claim that there is no laboratory evidence. While he agreed that there is not enough of it, there is some to suggest that what we see in the epidemiological studies can also be seen in the cellular studies.

Slesin pointed out the studies, particularly the occupational studies, showing risk factors associating brain tumors and exposure to EMFs. In his view, these risks are potentially very serious, particularly since we don't yet have good measurement techniques and therefore the risk factors actually could be much higher than originally thought. He understood the studies as supporting the fact that independent research leads to much different results than in those studies conducted by interested parties.

In closing, Slesin remarked that what we are seeing in the power line debates is just the tip of the iceberg. We are not even yet talking about all of the technologies of the information age, such as car phones, VDT's, microwaves, all of which emit the same stuff - electromagnetic fields and electromagnetic radiation. He suggested that it is just an accident of history that we are focusing only on the low frequencies, although there are a lot of people who are interested in researching the effects of high frequencies. His view is there are some very basic answers that remain outstanding and that those answers will not be obtained without public movement on the issue.

#### Question & Answer

The first questioner commented on a correction necessary for one of the speaker's comments. He noted that the EPA, in fact, has committed funds to research for EMFs, and that the agency is expecting nearly half a million dollars in the near future (to be matched by private sector funds). Next year, the EPA budget for this research will be between eight hundred thousand and one million dollars. He also pointed out that the Health Effects Institute is now undergoing a feasibility study to determine what might be an appropriate niche for them, as an independent agency, vis-a-vis the EMF research. The Health Effects Institute is a non-profit corporation set up about ten years ago, to look at the question of health effects of motor vehicle emissions. The Institute was set up with equal funding from the private sector (which was being regulated) and from the public sector (the EPA, which was doing the regulation). It was also set up with a very strong, independent scientific contingency, so that the review

and direction of the work could be done by the best scientists, who were not beholden either to the regulators or to the regulated. The questioner observed that there are "scoundrels in each camp"; he commented that research on EMFs, in order to have integrity, must be conducted without being beholden to either camp, and he stated his view that the Institute is just such a place.

The same questioner also asked about the slides that were shown about the dramatic increases in cancer, remarking that there is serious debate and lack of uniform agreement about the correlations between EMFs and cancer rates. He noted that although the cancer incidence studies for the United States are the best data base anywhere in the world, these studies, with the exception of increasing lung cancer rates among women, show most of the rest of the cancer rates to be flat or decreasing. With respect to the brain tumor rates, the ability to find cancers with the new technologies we use may account for the higher levels; that is, it's just that we are now able to discover more cancers, rather than that there is a higher rate of cancers.

Slesin responded to the point on the cancer trends. He commented that he was not saying that the data about rising cancer rates is unequivocal, but that you can't use the argument that cancer rates have not gone up as a reason for forgiving the other data suggesting the dangers of the EMFs. He also remarked that his publication has been regularly calling the Institute's office in order to find out if the EPA has actually come up with the EMF funds, and asked if they had.

The speaker responded that, at the moment, the Institute still does not have the funds in hand.

The next questioner introduced herself as an employee at an environmental consulting firm. Although she did not disagree with Slesin's general thrust that we are not doing nearly enough research and not on the right wave lengths, she commented that Slesin's tone and, particularly, his lumping together all of the consultants who appeared at the Science Advisory Board meeting in Washington (which she attended) was a bit irresponsible - although she agreed that Dr. Korn had been completely unprepared and that this was appalling. However, she cited Dr. Trichopoulos, at the Harvard School of Public Health, as someone who had been extremely well prepared and who had contributed immensely to the understanding of the epidemiological studies. She noted that he had addressed, in particular, the problems of confounding and the problems of attempting to correct for confounding. Trichopoulos had pointed out that the problems associated with doing an epidemiological study when you don't know what the actual dose is and with establishing correlation levels that would have to exist in order to produce the kinds of risk factors being cited in the studies. She reiterated that she resented Slesin's having lumped all of the people together who had been testifying, since it was clear that some of them had given the problem much thought and were very competent to testify.

Slesin responded that it was extraordinary to call him irresponsible, when two of those experts had been shockingly unprepared at a public forum where they accepted public monies for their testimonies. He also noted that he had interviewed all of the epidemiologists on the panel in Washington. Trichopoulos had used one model, according to which one would expect a much higher relative risk if the EMFs were a real issue. The epidemiologists he had spoken to viewed Trichopoulos' assumptions as extreme.

The speaker responded that she did not disagree with Slesin's central points, but she reiterated that it bothered her that he had lumped all of the consultants together and assigned equal blame. She went on to comment about Thilly's remarks on the genetic issues, and questioned whether, even if EMFs do have a genetic effect, it could be possible that the effect wouldn't be a direct mutation effect. In that case, Thilly's approach would not be valid. She observed that, at this point, most people think that the most probable effect at the organ level might be in an emotional sense. So, if EMFs do promote cancer, Thilly's approach would turn up nothing and would give EMFs a clean bill of health.

Thilly responded that her points were well taken. He noted that the word "promotion" is, as yet, undefined in the field, but that the increased frequency of cancer as a result of treatment is defined. There are, in fact, a number of ways in which things can work synergistically in increasing the observed frequency of cancer in animal studies. When something is able to cause cancer all by itself but will do



so after a previous small dose of a known carcinogen markedly increases the frequency of observed tumors, Thilly explained that this is called a promoter. The basic mechanisms of these synergistic effects is, either they are causing genetic changes which are not previously detected and complement the mutations caused in the first round of exposure to carcinogen (which is another model or way of thinking about it) or, according to the questioner's observation, cell proliferation is induced. If the latter case is true, then researchers can follow up this development. Cell proliferation naturally must bring more spontaneous mutation and, since the technology is both quantitative as well as qualitative, those kinds of effects will be measurable. If in fact promotion has nothing to do with genetic change (Thilly noted that he disagrees with this notion, because there must be a testable hypothesis before one can reach such a conclusion), then we will not be able to use our existing methods to detect neurotoxicologic effects. He described his talk today as an effort to address the issue of how one designs a methodology which is specific for the thing which one is trying to measure; the genetic spectrum method is an example of the kind of thinking and the kind of technology which must be developed.

The same questioner then commented that she appreciated what Thilly had just said. She agreed with the majority of Pool's remarks, but had a problem with his analogy between EMFs and asbestos. Calling the analogy a dangerous one that provokes people to immediately associate asbestos with carcinogens, she cited the difference in the histories of asbestos and EMFs. She commented that there was a tremendous amount of work which was being done by the principal, responsible parties, and this work was suppressed. They knew clearly that asbestos was a human carcinogen and that in such a case, the role of the press in bringing the issue to public attention was vital. EMFs are not in that league at all, and she emphasized that there is not any known cover up of known major carcinogenic effects of EMFs. Therefore, there is a danger in making analogies between EMFs and asbestos, given the big distinction.

Pool responded by agreeing with her remarks. He clarified that he had been speaking more in a general sense intended to show that it is helpful for the press to write about such things because they sometimes uncover things. The point is that, if there were something that was obviously dangerous about EMFs (on the same level as asbestos), we would see a lot more response than we have seen up until now. The fact that we are not seeing a huge response is an indication partly that it's not as dangerous as asbestos. Pool also commented that there are certainly a lot of people who testify for a lot of money on behalf of industry. However, we sometimes forget that there are some people testifying on the other side, who are just as locked into their positions and just as blind to any possibilities other than what they believe. He noted that they don't get paid as much, since the other side usually doesn't have as much money as industry does. It is important to keep in mind that it runs both ways.

Slesin followed up by noting that there is an asymmetry. That is, the people who testify on behalf of industry don't do the research, whereas those who testify on the other side have experience and have been doing research. He commented, though, that industry has enough money to lure people to testify, even in those cases where they haven't read the literature.

The next questioner remarked that he views EMF journalistic reporting as lacking for several definite reasons, pointing first to a 1976 report from MIT which concluded that there would be a need in the future to work with oncologists if we are to look at what happens to brain cells in the presence of EMF. The questioner then explained that the Coalition for Workplace Technology is a lobbying effort in Washington, which was characterized in a Columbia Journalism Review article as part of all of the associations in this country that are trying to make sure that no EMF literature comes out in the press. He termed the article "very illuminating" because it doesn't mince words, and remarked that he has not seen any press refutations of the conclusions reached in the article. The questioner also mentioned that, when the Peter's Study came out recently from the University of Southern California, the Boston Globe carried it. The paper carried two and a half inches of kids getting leukemia because they lived next to power lines, on Saturday in the obit page, so that people would understand what they are living with in terms of environmental factors. He asked about the state of EMF research funding during the last ten years during Reagan-Bush and Reagan-Sununu, and questioned the lack of occupational studies in the face of the fact that all the conditions for study have been there for quite some time.

Pool commented that there have been a number of occupational studies, which go back to the 1970's, that these studies have made clear that a number of occupations have an increased risk of cancer associated with them, and that those occupations seem to be connected with some type of exposure to EMFs. However, what is missing is a causal effect; it is unknown that it is indeed the EMFs which is causing the increased cancer. The breast cancer issue is a very interesting case, because male breast cancer, which has shown up in a number of cases, stands out because it is rare. It is a lot harder to know what to make of female breast cancer, but a number of studies have been started now. Pool suggested that there should be the possibility of some good occupational studies looking at female breast cancer.

Commenting that the EMF research during the Reagan years was decimated, Slesin remarked that EPA could be chastized for not spending any money, since ten years ago they had both the leading laboratory in the world and a group of researchers who were very committed to the work. But they were disbanded in 1985. There are occupational studies going on in this country, most of which are funded by NIEHS. One of these (yet to be published) is showing high rates of increases of cancer among telephone workers, and may show the breast cancer link as the possible fingerprint cancer promoter. While there is no disagreement that breast cancer rates are increasing, it is impossible to extrapolate from male to female breast cancer. But the results found to date should prompt studies of EMFs and female breast cancer. It is easier to identify a link between an agent and a rare form of cancer than a common one. Therefore, the EMF-male breast cancer association may be a breakthrough that would not have been apparent with female breast cancer.