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After Chernobyl—How U.S. Physicians Respond to Radioactive Fallout

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Synopsis

On April 26, 1986, a reactor unit at the Soviet Union's Chernobyl Power Station exploded, and substantial amounts of radioactive material were released. Fallout from this incident was deposited in the United States and elsewhere.

Radioactive fallout is a major concern for obstetricians and pediatricians; their patients are the most vulnerable to the adverse effects of radiation. This study addresses the question: What are these physicians' perceptions and beliefs about fallout and its effects on their patients?

A questionnaire was developed to measure these perceptions and beliefs. This instrument was mailed in November 1986 to all obstetricians and pediatricians listed in the telephone directory for western Massachusetts. A factor analysis of the physicians' responses yielded five factors: concern for patients, management of risk, effect of fallout, physicians' role in prevention, and guidance on advising patients. The physicians' responses to patients' inquiries were categorized as giving information, reassurance, and prescription.

The authors recommend that the study be replicated with a more representative sample, that professional medical groups provide reliable information to members, and that physicians ask their professional organizations to address the issue of physician participation in the national planning process relevant to their concerns about radioactive fallout.

A REACTOR UNIT of the RBMK type ignited following an explosion at the Chernobyl Power Station, April 26, 1986. Soviet authorities officially announced that the reactor fire had ended on May 5 and the reaction had stopped.

During the episode, substantial amounts of radioactive materials, basically fission products, were released into the atmosphere. Because air temperatures were high during the release, a great plume rose and radioactive materials reached high

altitudes. The released materials then were dispersed by diffusion and transported many hundreds of miles by the winds that prevailed at the different atmospheric heights.

On May 7, 1986, a report issued by an Environmental Protection Agency (EPA) Task Force noted (*1*):

> Patches of contaminated air continue to move across the U.S. from west to northeast at upper air levels (above about 20,000 feet). . . . If additional radioactivity moves into the Gulf of Alaska or off the northeast coast of the U.S., it will be carried southeast into a large storm system in the western U.S. Rainwater from high-reaching rainstorms in the west and in New England may contain detectable radioactivity from the Chernobyl accident.

This forecast became a reality on May 11 when Montpelier, VT, reported a reading for ^{131}Iodine (^{131}I) of 12,300 picocuries per square meter (pCi/m^2). That was the highest reading ever recorded in the United States in a single day (*2*). This reading and readings for major U.S. cities that were reported in early May 1986 represent a sudden and substantial increase in the presence of ^{131}I. Furthermore, the appearance of these readings immediately after the Chernobyl incident, although not proof, seems to add weight to the prediciton made by the EPA Task Force on May 7. Although the measurable amount of ^{131}I was substantially lower than the FDA-EPA permissible level of 130,000 pCi/m^2, it points to a significant increase in the amount of low level radiation present in the atmosphere.

Members of the scientific and medical communities differ in their assessment of the health effects of low levels of ionizing radiation (*3–6*). However, possible biological effects leading to cancers and genetic and teratogenic effects should be considered. There remains a real possibility that small doses will cause a proportionally small probability that an exposed population will incur some effect. According to the 1981 report of the National Academy of Sciences' Committee on Biological Effects of Ionizing Radiation, exposure to ionizing radiation can induce cancer in virtually any tissue (*7*). The findings in that report are further supported by a study published in 1984 of cancer incidence in an area of radioactive fallout downwind from the Nevada test site (*8*). The ambient doses in air, soil, and water may be further enhanced by bio-magnifications. Bio-magnification

'Members of the scientific and medical communities differ in their assessment of the health effects of low levels of ionizing radiation. However, possible biological effects leading to cancers and genetic and teratogenic effects should be considered.'

is a process that concentrates the intensity of the radioenergy, a process that can occur as the radioactivity from fallout travels through the food chain (*9*).

The radioactive fallout from the Chernobyl incident presented a major concern for physicians, namely, what are the potential health effects and to whom? The evidence points to pregnant women, infants, and young children as being the most vulnerable groups. Several studies have confirmed the increased incidence of benign and malignant thyroid nodules occurring in children exposed to radioactive particles from nuclear fallout (*11–13*). The difficulty of establishing vulnerability in infants and children is due to the variable time interval between exposure to radiation of the fetus or child and the presence of a diagnosable condition. Some effects that appear at birth or shortly thereafter are low birth weight, fetal or neonatal mortality, aborted pregnancy, and microcephaly. Leukemia appears in 3 to 8 years; cancers (solid tumors) are not likely to appear until 10 to 35 years after exposure (according to D.W. Boardman, President, Center for Atomic Radiation Studies, Acton, MA, in personal correspondence dated September 11, 1987).

This study addresses the following question: How well do the perceptions and beliefs of the two most concerned medical groups, obstetricians and pediatricians, prepare them to meet the medical responsibilities precipitated by this kind of catastrophe? This research has three objectives: (*a*) to determine the bases for the beliefs of those two groups of medical specialists concerning the potential danger of fallout from the Chernobyl incident, (*b*) to survey physicians about their beliefs concerning low level ionizing radiation, their responses to patients' questions, their sharing of concerns with colleagues, and their seeking further information, and (*c*) to determine if there are significant differences between the two groups with respect to their beliefs and actions.

Questionnaire items for response by physicians concerning their perceptions and beliefs about the hazards of radioactive fallout

1. If pregnant women and infants drink milk contaminated by radioactive fallout, a significant increase in cancer should be expected.

2. I am unlikely to discuss the effects of radioactive fallout with patients unless my medical specialty association were to issue a statement that there is a creditable risk.

3. Teaching preventive measures regarding food and water will reduce health risks of radioactive fallout to my patient.

4. I will advise my patients about precautions to protect their health from radioactive fallout when the appropriate State or Federal agency declares it a problem.

5. Any radiation beyond normal background levels is undesirable for pregnant women and young children.

6. The only credible source about the effects of radioactive fallout that would affect my medical practice would be communication from my professional medical association.

7. The health of the public is enhanced when physicians take leadership in providing information about potential health risks of radioactive fallout.

8. Physician's response to effects of radioactive fallout is beyond the scope of medical practice.

9. I am concerned that my patients are vulnerable to the effects of radioactive fallout.

10. Unless there is a domestic nuclear accident like that at Chernobyl, physicians need not be concerned about health risks of radioactive fallout.

11. It is difficult to advise patients about what health actions reduce risk from radioactive fallout.

12. Medical reports of health conditions in Hiroshima, Nagasaki, and the Marshall Islands indicate the serious consequences of radioactive fallout.

13. The effects of radioactive fallout are exaggerated.

14. Informed physicians can act to reduce significantly the risk from radioactive fallout to their patients.

15. Teaching patients about the effects of radioactive fallout to their health may create unncessary anxiety.

16. Do you agree with the statement made by the U.S. Public Health Service that there is no creditable risk to the American population from Chernobyl fallout?
    Yes☐ No☐ Undecided☐

17. In your opinion, is there a threshold level below which background level radiation exposure is safe?
    Yes☐ No☐ Undecided☐

18a. Have patients asked about radioactive fallout since the Chernobyl incident?
    Yes☐ No☐

b. Have you provided advice to patients about radioactive fallout since the incident?
    Yes☐ No☐ If yes, what advice?

19. Have you discussed with colleagues the health risks from radioactive fallout?
    Yes☐ No☐

20. Have you sought information about health consequences or medical treatment related to radioactive fallout since the incident?
    Yes☐ No☐

Conceptual Framework

In designing this study, two health models were considered in the selection and inclusion of survey items: the Health Belief Model (HBM) and the Knowledge, Attitude, and Practice Model (KAP). The most widely used model developed in the health field is the HBM (*14*). The theory that underlies the HBM is that a belief system provides a framework of beliefs from which persons define health and make health judgments. Furthermore, although a belief system does not cause action, it does organize and orient action. The HBM postulates that the likelihood of undertaking health

action is a function of a person's beliefs along four subjective dimensions: perceived level of personal susceptibility to a particular condition, perceived degree of severity of the consequences that might result from the condition occurring, estimation of the recommended health action's potential benefits or efficacy in preventing or reducing susceptibility and severity, and views of possible psychological and other costs barriers related to the proposed action. In addition, the HBM stipulates that a stimulus or "cue to action" is necessary to trigger the appropriate health behavior by making people aware of their feelings about the condition.

Health educators frequently use the KAP, a model that indicates the likelihood of a person's engaging in risk reducing behavior. This model provides for the development of questions that test knowledge about a given health risk, attitudes toward that risk, and health practice designed to reduce health risk behavior (*15*). Both the KAP and HBM models served as guides for constructing the questionnaire and were adapted to meet the needs of the specific objectives of the study.

Although the individual survey items are of some interest and some responses are reported separately, the principal concern of the study is with the underlying dimensions to which the items are related. Factor analysis was used to explore the relationships among the first 15 items to develop constructs that would provide an understanding of the physicians' perceptions and beliefs.

Methods

Fifteen items were constructed based on the two models considered. In the box on page 130, the items are listed in the order they appear in the questionnaire. Each of the items 1–15 was scaled on a 5-point Likert-type scale. This is an ordinal scale of 5 points ranging from "strongly agree" to "strongly disagree." The scale was coded so that strongly agree received a score of 4 and strongly disagree was equal to 0. The 15 items were randomly numbered for inclusion in the questionnaire and assigned to the research instrument.

Additional questions (16 and 17) addressed an assessment of the credibility of information (see box). Two questions (18a and 18b) addressed patients' inquiries about fallout and physicians' responses. Questions 19 and 20 asked about actions taken by physicians with patients and colleagues in response to the Chernobyl incident.

Questionnaires were mailed to 125 pediatricians and obstetricians in western Massachusetts who were identified from telephone directories of Hampshire, Berkshire, and Hampden Counties. Initial and second mailings of the questionnaire, along with followup telephone calls, resulted in a sample of 52 usable returns and a response rate of 42 percent. (We recognize that by selecting the survey population from the telephone directory, we excluded those practitioners whose names were not listed.)

The research items were separated into two groups for analyzing. Questions 1 to 15 were subjected to a study of means and standard deviations and factor analysis, and questions 16 to 20 to content analysis, the chi-square test of independence, categorization, and the two-sample *t*-test.

The method of factor analysis permits the researchers to explore, without formulating a hypothesis, the bases of the respondents' beliefs. Generally there are several factors at work, and the response to each question is influenced to some degree by each factor. The resulting factor coefficients, the loadings, indicate the relative effect of each factor on the response to each question. Once the factors have been extracted, a rotation of the axes helps to bring the relationship between factors and responses into focus. The varimax rotation has the effect of producing large or small loadings; that is, it produces factors with either a strong association with the responses or with no association (*16*).

Based on the results of factor analysis, five scale variables were computed to correspond to the five factors extracted. Each scale variable was the unweighted sum of the questions that loaded most heavily in the corresponding factor. The mean scores on the scale variables of the two physician groups were then statistically compared with the use of the *t*-test (*17*).

Results

The means and standard deviations of the responses of the 52 physicians to the 15 attitude and belief items are presented in table 1. On average, they agreed with seven items, disagreed with three items, and were undecided about the remaining five.

The responses to the five negatively phrased items 2, 8, 10, 13, and 15 were reversed, and the responses to all 15 items were entered into the principal factor analysis. Five factors were extracted. The rotated factor loadings are presented in table 2.

Table 1. Mean and standard deviation of 52 physicians' responses to items 1–15

Item number	Mean	Standard deviation
1	2.7	1.1
2	2.1	1.4
3	2.5	1.0
4	3.2	0.6
5	3.2	0.8
6	1.7	1.2
7	3.2	0.6
8	1.0	0.9
9	2.8	1.0
10	1.0	1.0
11	2.3	1.0
12	3.5	0.7
13	1.1	0.9
14	2.4	1.0
15	1.7	0.9

Table 2. Loadings for the 5 factors based on 52 physicians' responses to items 1–15

	Factor				
Item number	1 Concern	2 Management	3 Fallout	4 Role	5 Guidance
10	0.79	...	0.37	...	...
9	0.72	...	...	...	...
2	0.66	...	...	...	...
15	0.55	0.32	...	...	...
3	...	0.77	...	...	...
1	...	0.65	0.25	...	0.31
14	...	0.62	...	...	...
6	−0.38	0.59	...	−0.26	...
5	...	...	0.90	...	...
4	−0.34	...	0.67	0.32	...
13	0.45	...	0.61	...	0.39
7	...	0.26	...	0.78	...
8	...	...	...	0.74	...
11	...	...	...	...	0.84
12	...	...	...	0.34	0.64

NOTE: ... = loadings less than 0.25.

The first factor loaded most heavily in items that demonstrate concern for patients' welfare in terms of both the risk of radiation as well as anxiety that might be produced by discussion of the risk. We named this factor "concern." The second factor loaded most heavily in the items that relate to the physicians' beliefs about the assessment and management of the effects of radiation health risks on patients. This factor was designated "management." Factor 3, "fallout," contained items relating specifically to the physicians' beliefs concerning the health risks of radioactive fallout. Factor 4 loaded heavily in items describing how physicians perceive the effects of radioactive fallout affecting their role as medical practitioners; this factor was named "role." Factor 5 contained the items that indicate the physicians' perceived need for guidance and information if they are to incorporate the health effects of radioactive fallout into their medical practice; this factor was termed "guidance."

In response to question 16, 49 percent of the physicians agreed with the Public Health Service's statement (see box), 10 percent disagreed, and 41 percent were undecided. Question 17 asked for an opinion on whether there is a safe threshold level of radiation. In response, 45 percent of all physicians said yes, 20 percent said no, and 35 percent were undecided. Questions 18a, 18b, 19, and 20 dealt with actions taken by physicians in advising patients, discussing the incident with colleagues, and seeking information (box). In response to questions 18a and 18b, 31 percent of the physicians said that patients asked about the effects of fallout; 69 percent said they did not. All physicians who were asked for fallout-related information by patients reported a response; however, no physicians who were not asked volunteered any information on this subject. Fifty-three percent of the physicians answered question 19 by saying that they had discussed the health risks from the Chernobyl incident with their colleagues; 47 percent had not discussed these risks. Only 15 percent of the respondents to question 20 had actively sought information about the health consequences; 85 percent stated they had not.

There were no statistically significant differences in response to items 16–20 between obstetricians and pediatricians with the use of the chi-square test of independence. It is interesting to note, however, that in answering question 16, 67 percent of obstetricians but only 40 percent of the pediatricians believed the Public Health Service's statement.

Sixteen physicians responded to patient inquiries (questions 18a and 18b). The physicians' responses were assigned to three categories: information, reassurance, and prescription. The first category, information, is characterized by this statement: "Thus far there is no evidence that fallout from Chernobyl represents a significant health risk to this area." The second category, reassurance, is illustrated by these comments; "Keep calm" and "Don't worry about this particular incident." The third category, prescription, can be further divided. The first subcategory recommends that the patient seek information to better assess the health risk, for example: "Keep tuned to the news media and call me if specific problems arise." The

second subcategory prescribes protective health behavior: "Substitute canned or powdered milk and packaged vegetables in the diet."

In an attempt to see whether the five dimensions identified by the factor analysis were related to the reported activities of the physicians, we created a scale variable corresponding to each factor. Each scale was the unweighted sum of the individual items that loaded most heavily (factor loading greater than 0.49) in the factor corresponding to that scale. Then, for each scale, we compared, with the use of the two-sample *t*-test, the mean score for physicians who responded yes to items 19 and 20 with that for physicians who responded no. There appeared to be no statistically significant relationship between any of the scales thus defined and the physicians' responses to items 19 and 20.

Discussion

The five factors obtained from the physicians' responses to the questions representing the dimensions of the HBM suggest that there is an underlying structure to the beliefs of the two specialty groups with respect to the fallout from the Chernobyl accident. Each of the factors reflects a different dimension of that belief structure.

The first factor, concern, reflects the physicians' regard for the welfare of their patients. They are concerned that they do not have reliable information, they are concerned that their patients may be vulnerable to radioactive fallout, they are concerned about the health risks associated with a nuclear accident, and they are apprehensive that the information they impart may stimulate unnecessary anxiety. Additionally, the physicians are not reassured by public statements. For example, only 49 percent believe the Public Health Service's statement that there is no creditable risk. When patients ask for information, a number of physicians tend to respond with reassurances.

The second factor, management, suggests that physicians are concerned with both the assessment of possible health risks to patients from fallout and the means to manage those risks. The assessment of risk is problematic in the absence of some official medical communication that can be trusted. Once properly informed, physicians believe they can act to reduce health risks through appropriate action. The category of physician's response to patient's inquiry illustrates that physicians will advise and prescribe if they understand both that there is a health risk and the nature of the presumed risk posed by low level radiation.

Factor three, fallout, relates to the physician's concern about the health risks associated with radioactive fallout. Physicians' responses reveal a great deal of uncertainty about the dangers of low level radiation to their patient population. In their answers to question 17, which is concerned with a safe threshold level of radiation, slightly more than half of the respondents are either undecided or disagree with the belief that there is a safe level of radiation.

The fourth factor, role, questions the physician's role in responding to the effects of radioactive fallout. This factor specifically addresses the issue of whether physicians should actively take leadership in providing information and education to their patients about the potential dangers of radioactive fallout. How does the sample of physicians in this study respond to this issue? Sixteen of the physicians reported that they answered their patients' questions; however, none of the physicians volunteered to educate, advise, or prescribe in the absence of a patient's inquiry. This finding suggests that at the time this study was completed, these physicians did not appear to be pro-active. Although factor five, guidance, is statistically independent of factor four, it appears, nevertheless, to have a shared meaning. The guidance factor indicates that a belief in the serious health consequences of radioactive fallout is associated with physicians' concern about the difficulty in advising patients about actions to reduce health risks. The name "guidance" was chosen because it appeared that physicians need some direction about how to proceed. Factors four and five, when considered together, may be interpreted as referring to the belief that unless physicians believe that they have adequate information and direction, they are not likely to volunteer to inform, advise, or prescribe to patients about radioactive fallout.

The second objective of the study was to survey physicians' beliefs and actions related to radioactive fallout and its potential demands on a physician's practice. We authors were impressed by the uncertainty reflected in the responses to all questions dealing with this issue except for question 20, where the responses indicate a majority of the sample have not actively sought additional information.

The uncertainty among physicians about the reliability of available information on the extent of fallout and its effects on their patients is supported by the observations of Dr. Michael McCally, a physician who traveled in Europe for Physicians

for Social Responsibility in May 1986. Dr. McCally reports that in Germany, for example, physicians generally obtained their information on the fallout from Chernobyl from newspapers and television. He stated, "There are no channels of medical communication that operate more rapidly then the public media." He further noted, "We could create them but they aren't in place now" (*18*). Some efforts, however, are currently being made to remedy this situation. The International Atomic Energy Agency has recently published a guide outlining what physicians should know about the treatment of persons exposed to radiation (*19*). A reference manual is also being compiled by the American Medical Association (AMA) with the aim of readying physicians for the next nuclear accident (*20*).

The third objective of the study posed the question, are there any significant differences between the two medical specialty groups? The similarity in responses of both groups to items 16–20 may be explained by physicians' uncertainty about the dangers of low level radiation to their patients. Additionally, there was an absence of detailed public information about the fallout from Chernobyl. This lack of information plus the relative inaccessibility of medical literature available to clinicians about the effects of low levels of ionizing radiation might have helped to account for the uncertainty that characterized both groups' responses.

Limitations

The major limitations of this study are the small sample size, the lack of information about the nonrespondents, and the small geographic area from which the sample was selected. These limitations raise the question, how representative is the sample and therefore how generalizable are the results? The sample selection excluded those physicians not listed in the telephone directory; however, we believe that the majority of practitioners in the area are listed. This research did not make a systematic attempt to gain information about nonrespondents. Inquiry was made, however, to determine why many physicians did not respond. The major reasons given were busy schedules and the difficulties in responding to large amounts of mail. The authors do not know if the nonrespondents represent a different population from the respondents. Finally, limiting the population studies to physicians in western Massachusetts makes any generalization to larger regions of the country or to the entire United States extremely risky.

Based on the results of this study, we recommend that

- a greater number of physicians be surveyed to yield a greater response rate so that credible generalizations may be drawn from the data;
- professional associations such as the AMA, the American College of Obstetricians and Gynecologists, and the American Academy of Pediatrics assume responsibility for ensuring that (*a*) timely and reliable information about nuclear disasters is made available to their members, and (*b*) relevant literature on ionizing radiation is made readily accessible to clinicians;
- the medical community lobby politically, through its representative associations, to see that physicians engage in planning the prevention of fallout-related injuries and the medical care and evacuation of injured persons to hospitals should a nuclear disaster occur. We note that at the time we prepared this manuscript, the AMA's advisory panel on radiation emergencies had recommended that physicians increase their participation in planning for national emergencies and in the development of radiation-related educational activities for professionals and the public (*21*).

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Economic Status Differences in Infant Mortality by Cause of Death

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Synopsis

Infant mortality differentials in a metropolitan aggregate of eight Ohio cities were examined for the years 1979-81. The primary analytical unit was the census tract of mother's usual residence. The independent variable was defined as the percentage of low-income families in each tract at the 1980 census.

Results of the analysis revealed that in spite of some very substantial declines in the overall level of infant mortality in recent decades, there continues to be a pronounced inverse association between the aggregate economic status of an area and the probability that a newborn infant will not survive the first year of life. This inverse association characterizes both males and females, whites as well as nonwhites, and it is observed during both the neonatal and postneonatal age intervals. Moreover, it is apparent that the adverse influence of a low economic status is reflected in the incidence of mortality from all major exogenous and endogenous causes. Since these two cause groups have such different underlying determinants, this finding has important implications for the development and implementation of specific maternal and child health care policies and programs.

ONE OF THE TRULY OUTSTANDING achievements of the 20th century has been the remarkable progress that has been made in reducing death rates. This progress has been most keenly reflected in a profound reduction in the risk of dying during infancy. At the same time, however, all of the available evidence makes it abundantly clear that the fruits of this progress are not being shared equally by all segments of the population. Rather, the findings of a wide variety of studies dealing with this decrease in mortality have consistently shown that the lower income groups in all societies