

THREE MILE ISLAND: AN ENVIRONMENTAL AND PUBLIC HEALTH EMERGENCY*

by

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The accident at the Three Mile Island (TMI) nuclear plant began on March 28, 1979, as a result of a series of what is termed in nuclear regulatory language as an "unlikely event" due to minor plumbing problems that occurred in the cooling system which eventually led to the shutdown of the Unit 2 nuclear reactor. Many thousands of gallons of radioactive water spilled within the plant containment building and the reactor core excessively overheated. An estimated 2.5 to 10 million curies of radioactivity escaped into the atmosphere in the form of xenon, cesium and some iodine gases. Chemical reactions which took place within the nuclear core produced potentially explosive hydrogen bubble, which was to become a major source of concern for plant safety and public health of the surrounding population.

Voluntary evacuation in the vicinity of TMI began almost immediately after the discovery of the nuclear accident was broadcast to the public. During the first two days after the accident, the evacuation was minimum with only 5 to 6 percent of the population within the 5-mile radius actually leaving the area. On the third day, however, nearly 50 percent of the population within the 5-mile radius evacuated. This was largely precipitated by the Governor of Pennsylvania's advisory for voluntary evacuation of all pregnant women and pre-school children in the area. Compounded by the increasingly confusing and sometimes alarming stories being reported by news media, the extent of evacuation further increased as days passed: 60% of the population within 5 miles, 44% in the 5-10 mile ring, and 32% in the 10-15 mile ring left the area during the crisis. The total number of those who evacuated was estimated to be approximately 150,000. The median distance

traveled by evacuees was 100 miles and the average period of evacuation was 5 days. Fortunately, there were no signs of mass panic and evacuation was fairly orderly. Although Red Cross sponsored shelters were provided, 85% of all evacuees stayed with family or friends with the remaining 15% using hotel or motel accommodations.

Evacuation behavior, assessed through surveys of the population after the crisis, showed that the older the head of the household, the less likely that the household evacuated. Families with pregnant women and/or small children, those with higher than average education or higher than average income were more likely to evacuate. In general, women were more prone to evacuate than men. Younger persons were more likely to evacuate than older persons. Contrary to the usual expectation, health care providers, including doctors, nurses, and other related personnel evacuated as did the general public.

During the early days of the accident, it was not possible to ascertain accurate and detailed information regarding radioactive emissions from the damaged nuclear reactor into the environment. However, the presence of diffuse and growing psychological disturbance in the area was apparent. As a public health agency, the Pennsylvania Department of Health immediately recognized the importance and need for documentation of potential health effects of this unique emergency event.

Within a short period of days following the accident, the Bureau of Health Research was able to conceptualize and develop a comprehensive plan for a variety of epidemiological and other health studies designed to assess the impact of the accident.

However, additional resources, both fiscal and personnel, needed to carry out such studies were not immediately available within the Department.

Through intense and urgent negotiations with the White House and various federal agencies, we were able to secure emergency funding from the Centers for Disease Control, National Institutes of Health, and U.S. Maternal and Child Health Services. We were also pleased to have received a substantial financial support from the Electric Power Research Institute to conduct certain short-term studies.

Specific studies and projects conceived during the critical period of the accident reflected mostly the existing epidemiological knowledge regarding biological effect of low level ionizing radiation and health effects of severe emotional stress and anxiety. Now, I would like to briefly outline some of the major studies conducted and our plans for long-term followup of the accident-exposed local population as well as for the development of a new and unique epidemiologic surveillance system around nuclear power plants in Pennsylvania.

The first and most urgent need recognized at the time of the accident was to determine the number, identity and certain essential characteristics of the local population whose health effects are to be evaluated in the future. To this end, we conducted a special census of those who were residing within a 5-mile radius from the damaged nuclear plant. This project, which took approximately two months to prepare, was mostly financed by the Centers for Disease Control and technically supported by both CDC and the U.S. Bureau of the Census. In addition to usual demographic data, such as age, sex and race, the census questionnaire included such items as marital status, smoking habits, medical history (particularly cancer and thyroid disease), recent pregnancy experience, medical-occupational radiation exposure, and detailed whereabouts during the 10-day crisis when abnormal radioactive releases were reported.

Included in the TMI Census were approximately 37,000 individuals in some 14,000 household units which now comprise a TMI Population Registry. This Registry is being updated annually as to living status, current address and telephone number, and names and addresses of informants for future followup inquiries. From this data base, we have conducted several short-term studies including spontaneous abortions, population mobility and crisis evacuation. An automated data linkage system is now being developed between the TMI Population Registry file and the mortality files (Pennsylvania as well as National Death Index) on the one hand and with the cancer registry files (Pennsylvania as well as other states) on the other. The TMI Population Registry cohort will be followed at least for a 15-year period since the accident, during which random sample morbidity surveys will be conducted every 5th year in order to evaluate possible health effects of the 1979 accident.

One of the most important short-term studies conducted was directly related to pregnancy outcome which covered an area of 10-mile radius. As we are aware, both ionizing radiation and maternal stress can affect the human reproductive process because of the fetal sensitivity to such environmental insults. The accident-exposed maternal population consisted of approximately 4,000 women who gave births during the one year period immediately following the accident. These infants were compared with another cohort of 4,000 births given by control mothers also living in the same 10-mile area communities one year later, but not exposed to the accident radiation. Pregnancy outcome measures evaluated were: fetal death, neonatal death, prematurity, low birthweight, congenital anomalies, and low Apgar scores.

For each pregnancy case under study, the extent of the accident radiation exposure to the mother and the fetus as well as the level of maternal psycho-

logical stress related to TMI were estimated. In addition to these two major independent factors, data on many confounding/intervening variables were collected which are likely to influence the outcome of pregnancy. These included maternal demographic, socioeconomic, behavioral characteristics, and medical-obstetric histories including x-ray exposures, prenatal care, provider attributes as well as birth order of the index child.

All mother-infant pairs included in the pregnancy outcome study have now been incorporated into a special TMI Mother/Child Registry for future followup studies. Living status, current address and telephone number of each registrant are being updated annually while causes of death and new cancer diagnosis are ascertained by record linkage with the Pennsylvania Cancer Registry file, and cancer registries of other states. This cohort will be followed at least for a period of 15 years after the accident in order to conduct random sample morbidity surveys every 5th year. I am pleased to acknowledge the excellent cooperation and technical support being provided for the long-term followup studies by a number of federal agencies including CDC, National Center for Health Statistics, National Institute of Mental Health, and National Institute of Child Health and Human Development.

Other studies we have conducted under the aegis of the TMI Program include, (a) psychological stress studies with emphasis on psychosomatic symptoms, behavioral adjustments to cope with the crisis situation and attitudes toward nuclear energy, (b) incidence and distribution of neonatal hypothyroidism, (c) sex ratio of newborn infants, (d) fetal mortality, (e) infant mortality, (f) congenital anomalies, and (g) health economics designed to assess the cost of the accident to the society in terms of both direct expenditures and industrial production losses.

In conjunction with the various health effects studies initiated, we have also conducted a series of studies designed to determine best estimates of radiation doses exposed to individual residents living within a 5-mile radius and to individual pregnant women residing within a 10-mile radius. Under contracts with the Department of Radiation Health of the University of Pittsburgh, both maximum possible and most likely doses were estimated for whole-body gamma, thyroid tissue, including fetal doses and total skin doses, which included both beta and gamma rays. According to our studies, the maximum possible whole-body gamma radiation dose to anyone off site was no more than 175 mrem, slightly more than the prevailing annual natural background radiation in the area. From these low doses, no major physical health effects can be expected. So far, the results of the various epidemiologic studies have been consistent with this expectation.

As indicated earlier, certain amount of radioactive iodines, particularly I^{131} , was released from the damaged nuclear reactor into the environment during the accident. This led to two important health considerations: (a) potential damage to the thyroid gland, both adults and children including pregnant women and fetus; and (b) development of emergency plans regarding thyroid-blocking agent in the event of accidental releases of radioactive iodines. The TMI accident emphasized the need for consideration of the potential use of potassium iodide to reduce uptake of radioiodines by the thyroid gland, thereby mitigating the possible adverse effects of such exposure. Understanding the mechanism of action of potassium iodide is essential to its appropriate use as a radiation protection measure. To be most effective, potassium iodide would have to be administered promptly - either before, simultaneous with, or within 2 hours of the onset of exposure.

Also important is an understanding of the rationale for the recommended dosage and the possible side effects. Furthermore, radiation emergency planners must also consider methods of storage and distribution of potassium iodide along with population at risk and pathways of radiation exposure.

As an important offshoot of the TMI nuclear accident, we are developing a new, automated Epidemiologic Surveillance System Around Nuclear Power Plants in Pennsylvania. Several important characteristics of this Epidemiologic Surveillance System should be emphasized. First, the primary intent is to establish an automated method of compiling baseline health data for specific geographic areas which can be updated and monitored routinely. Second, the System is designed as a "screening" rather than "diagnostic" device; that is, significant changes or differences in health status based on the data analyzed will be regarded only as "potential warning signals." If and when such signals are detected in a population, further "diagnostic" study would be necessary to substantiate the magnitude of the problem and to identify specific cause(s). Third, the Surveillance System, of itself, is not intended to test any specific hypotheses or to determine health effects of radiation as such or any other specific health hazards, but rather to detect significant changes within or differences from norms in any health indicators under consideration that can be determined with the available data. Fourth, the System would provide comparative data which would be useful in the continuing effort to assess the potential health effects of the TMI accident. The public demand for health information in the TMI area is beginning to rise again as the length of time since the accident approaches the lower limits of the estimated latency periods of certain cancers. Many local residents still believe that they have been

exposed to much larger doses of radiation than have been reported officially. Furthermore, the System would provide health information which would be invaluable in the event of another nuclear accident or any other health threatening event.

Apart from the substantial psychological effects described earlier and adverse effects upon low birthweight of excess medications taken by pregnant women to cope with their anxiety and stress, to date, we have not found any short-term evidence for significant physical health effects from the 1979 nuclear accident at the Three Mile Island; nor do we expect such major health effects from the officially-reported low doses of radiation.

However, because of the confusion and uncertainty surrounding the TMI accident from the beginning, particularly with respect to the extent of radiation exposure as disputed by some nuclear scientists, the uniqueness of this accident in a historical context, possible long-term effects of psychological stress, and the scientific need to document potential health effects of very low dose radiation in humans, we feel that the rare opportunity presented by the TMI accident should not be lost in the pursuit of these important epidemiologic studies. Regardless of the results, positive or negative, the exposed population should be followed and its health status evaluated. Our TMI Health Effects Research Program is dedicated to address these scientific and sociological issues as well as to satisfy the need of concerned local citizens of the affected area.