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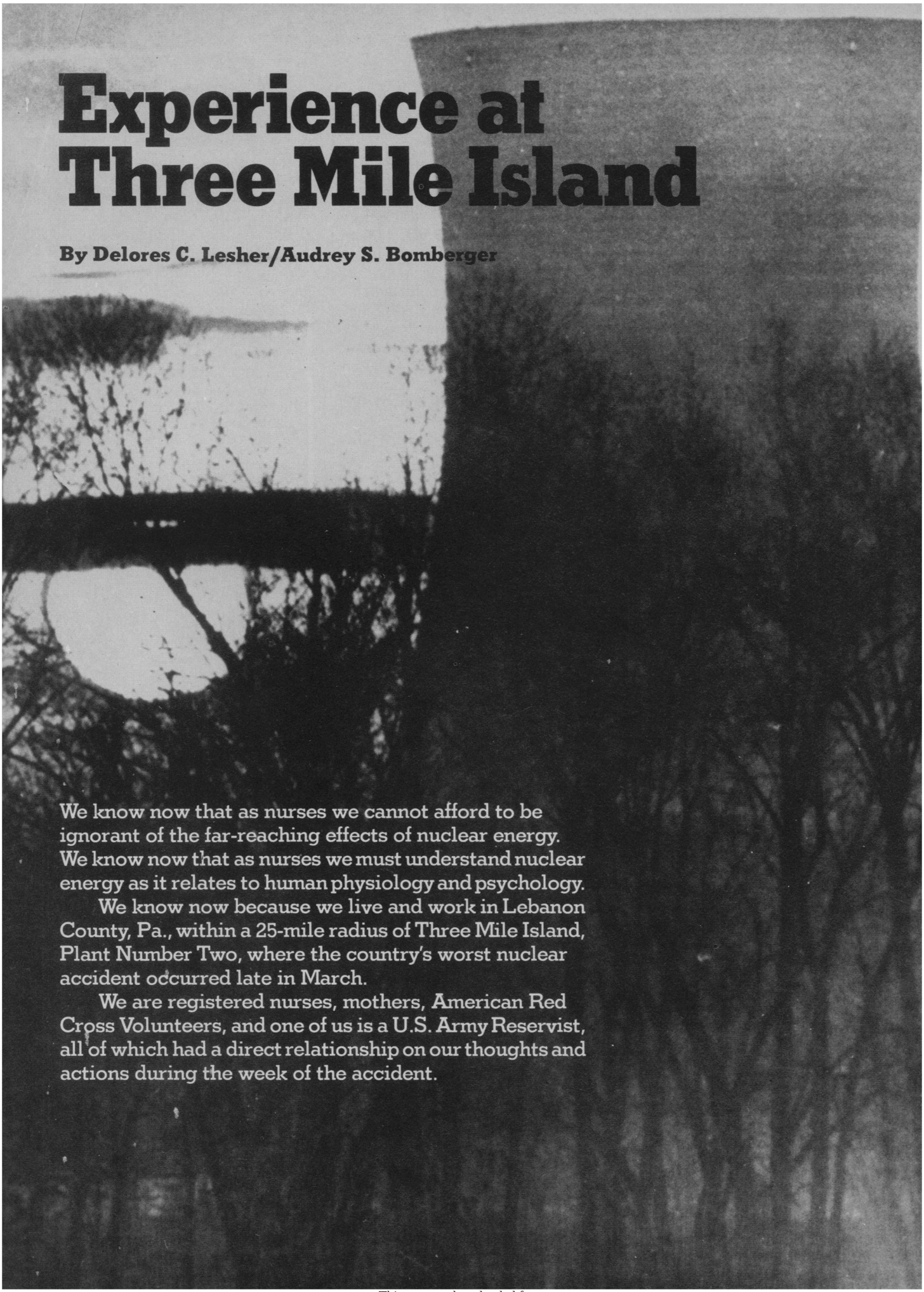
Source: *The American Journal of Nursing*, Aug., 1979, Vol. 79, No. 8 (Aug., 1979), pp. 1402-1408

Published by: Lippincott Williams & Wilkins

Stable URL: https://www.jstor.org/stable/3424609



Experience at Three Mile Island

By Delores C. Lesher/Audrey S. Bomberger

We know now that as nurses we cannot afford to be ignorant of the far-reaching effects of nuclear energy. We know now that as nurses we must understand nuclear energy as it relates to human physiology and psychology.

We know now because we live and work in Lebanon County, Pa., within a 25-mile radius of Three Mile Island, Plant Number Two, where the country's worst nuclear accident occurred late in March.

We are registered nurses, mothers, American Red Cross Volunteers, and one of us is a U.S. Army Reservist, all of which had a direct relationship on our thoughts and actions during the week of the accident.

Diary of Events

Wednesday, March 28, 1979

At 10:00 A.M. the news media report a radiation leak in one of the reactors at TMI. A general site emergency is declared at 7:00 A.M. and all TMI employees, except emergency crews, have been sent home.

Air samples at 7:14 A.M. by state police and civil defense personnel give readings of 8 millirems per hour. Government officials at a 10:45 A.M. news conference announce, "There is and was no danger to public health and safety from radiation." A full-scale investigation is to be conducted by the Federal Nuclear Regulatory Committee (NRC).

Reaction—We are at work at Lebanon Valley General Hospital but not "as usual." We are uncertain and confused. Reports are contradicting, reassuring, frightening. It is difficult to determine just how bad things are. We do not understand the nuclear terminology.

Thursday, March 29

The reactor mysteriously will not cool down. There are periodic releases of radiation. Low levels of radiation have been measured 16 miles from the plant. The NRC inspector states, "The danger is over for people off site."

Antinuclear groups are demanding a shutdown of TMI. Lack of safety, human error, and sabotage are cited as possible causes of the accident. The possibility of a meltdown is mentioned, and we learn what that means and that if it happens, there will be widespread release of radioactive contamination.

Reaction—One of us is totally unconcerned. The other is worried about possible consequences to her family and herself. Who of all authorities being quoted is speaking the truth? Is the food, water, and milk safe to consume?

Friday, March 30

Uncontrolled releases of radioactive gas occur at 8:40 A.M. A hydrogen bubble has been discovered and this could result in a hydrogen explosion or a nuclear explosion! Governor Richard Thornburg has urged preschool children and pregnant women living within five miles of the plant to leave the area. Twenty-three schools are closed. The Hershey Sports Arena, about 15 miles from TMI, is set up as an evacuation shelter. Residents living within a 10-mile radius are urged to stay indoors and keep windows closed. York, Dauphin, Lancaster, and Cumberland Counties have been alerted for possible mass evacuation of approximately 950,000 people living within a 20-mile radius.

Harold Denton, spokesman for the NRC says, "A catastrophic meltdown is very remote. This is easily the most serious accident in the licensed reactor program." The public is assured of a 4- to 5-hour evacuation notice. Radiation readings have increased to 20, 30, and 80 millirems per hour in the TMI area.

Reaction—We are now both concerned and somewhat fearful. Nuclear terminology and consequences are becoming more meaningful. We know a millirem is the term used to measure absorption of radiation by humans and that the average American is exposed to 100 to 200 millirems a year (from x-rays and cosmic rays).

One of us, in Harrisburg in the morning for a previously scheduled meeting, sees terror in the faces of people, office workers intently listening to radios, barren streets, and heavy traffic exiting from the city.

We are now questioning what we will do in the event of an evacuation. We make choices feeling accountable to our families, the hospital, the Red Cross, and the Army Reserve. We make provisional arrangements for our families to leave the state. Professionally, we feel obligated to stay in the area because nurses will be needed.

The American Red Cross makes its first contact with us to help staff the Hershey Arena evacuation shelter.

Saturday, March 31

A hydrogen bubble in the reactor is now a major problem; 10 to 12 millirems per hour of radiation are being released into the atmosphere. The experts don't seem to know what to make of the dangerous build-up. We learn that the bubble might grow and cause separation from the coolant and the reactor's core, triggering events leading to a meltdown. If anything happens to the reactor containment building, lethal radioactive fallout could be released over an area of 60 to 70 miles depending on wind and weather conditions. These are being monitored by the weather bureau.

People are leaving—not only the five-mile area surrounding TMI, said to be the danger zone—but from as far as 25 miles away. Where 600 people live, 100 now remain. Curfews are imposed.

Reaction—We are now fully aware of the seriousness of the situation. We don't really understand the rationale behind differentiation of 5, 10, 15 miles from the plant site. We feel vulnerable 25 miles away.

Tentative evacuation plans seem in direct opposition to the reassurances being voiced by various officials. We seek information from reference books we have at hand. We are off from work for the weekend but contact the hospital to offer assistance.

Sunday, April 1

Harold Denton is named spokesperson for the nuclear accident. Atomic experts are trying to eliminate a hydrogen bubble that they don't understand. The President visits Middletown, Pa. Governor Thornburg appeals for calm and patience. Evacuation has not

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been ordered, but estimates are that 50,000 to 200,000 people have already left.

Sunday night Denton reports that the bubble is shrinking. A toll-free phone line has been set up to answer questions from the public. Questions range from "What is radiation?" to "Where can I buy a Geiger counter?"

Reaction—The American Red Cross calls requesting volunteer help to expedite evacuation plans in Lebanon County; a briefing meeting is to be held tomorrow evening.

At the hospital, all but emergency surgery is being cancelled. Patients who can be discharged are, so that beds will be available for evacuees. Arrangements are made to handle possible irradiation victims. Many physicians and nurses reportedly have left the area with their families. We realize staffing problems are imminent.

We feel relief when we hear the bubble is decreasing in size. Plans for a total evacuation of patients are being made. After many phone calls a hospital is located that can accommodate our patients if an evacuation order is issued for our county. That hospital is 100 miles away.

How are we going to transport our patients to the evacuation point? This detail is to be addressed, when relevant, later.

Monday, April 2

A dramatic decrease in the bubble's size is confirmed. Core temperatures are falling, and contamination is being confined to the plant site. Tension eases. People start moving back home, but children and pregnant women still are being urged to stay away. There is still danger that radiation can leak during the shutdown process.

Reaction—We prepare for the possible entry into our hospital of nursing home evacuees from within a 20-mile radius of the Three Mile Island. Details on relocation of our patients to a hospital 100 miles away are still to be dealt with. Also unsettled is how we will cope in the hospital if entrenchment—staying inside with what food and water is available—becomes necessary.

We have mixed reactions of frustration and anger. We realize the emergency plans we have are inadequate to cope with the evacuation of enormous numbers of people. Medical complications that could have occurred during the disaster and which can still occur have barely been thought about or publicized. Local evacuation plans are only now being shared with those of us who are expected to implement them. We attend the Red Cross meeting.

April 3 and 4

We are told the worst is over! The reactor core is badly damaged. There are no indications as to how long it will take for a complete cold shutdown. There has been no new major release of radiation since Friday. Emissions of radiation in a 2-mile radius of TMI measure 1 millirem. The reactor containment building has shown radiation levels of 30,000 rems. Environmental monitoring of radioactive iodine within an 18-mile radius indicates that milk and water are safe to drink.

Six counties remain on advanced evacuation alert. Schools reopen and residents continue to drift back. The evacuation center for preschool children and pregnant women remains open. The National Weather Service continues a close watch on weather conditions and wind direction in the event of additional radiation leakage so officials will know which area needs priority if evacuation is ordered.

Reaction—We discuss our roles as nurse educators. Having experienced a nuclear accident with fatal possibilities, we know how deficient we are in understanding the technical, physiological, and psychological aspects of such a catastrophe. Is anyone anywhere prepared to cope with this kind of a disaster? Obviously, we as nurses need to learn and prepare.

Psychological Effects

It is difficult to estimate the numbers of people who were acutely affected psychologically by the TMI crisis. Children had little understanding except what was told to them by parents and playmates. As one child stated while playing with another, "Do you smell something strange? I think it's radiation." A preschool child at a Middletown School tearfully explained to a newsman that there was something in the air "that could kill me." Many persons in the shelter were fearful and after several days showed signs of depression.

The primary psychological abnormality that develops in severe stress is a transient, fluid state of emotional disruption(1). The individual cannot cope with the danger and is unable to make meaningful decisions or initiate purposeful actions. Fear increases when combined with inaction. The fight or flight instinct is activated, but flight with direction and purpose is not panic and is considered a useful response.

Panic in disaster situations usually is short-lived and not chronic but it does occur.

Characteristic clinical signs are stunned mute behavior, uncontrolled flight, tearful helpfulness, apathetic depressed states, inappropriate activity, and increased tension lasting minutes, hours, or days.

The severity of symptoms varies with the intensity and severity of the stress, degree of personal involvement, degree of training, degree of warning, presence or absence of leadership, and group identification.

Treatment is best when it is simple and direct. Victims of a disaster need reassurance that the situation will improve. During extreme fatigue they need a short period of rest in a safe area but should not be isolated from group and family relationships. They should be encouraged to express their feelings to avoid retention of fear and anxiety.

The most important preventive treatment is advanced preparation. This relieves tension, and fear is less likely to be incapacitating.

Throughout the events of the week of the disaster, efforts were made to reassure mothers and children in the shelter area. The evacuees were entertained by volunteer groups, TV was available, and a PA system was set up for communications.

Biological Effects of Radiation

The biological effects of radiation are influenced by many variables: the type and energy of the

Acute Radiation Syndrome

Disease Classification Based on Dose Uniformly Received

CLASSIFICATION	DOSE RANGE	DURATION	CLINICAL SYMPTOMS
no obvious disease	0-100 rad		no apparent clinical symptomatology or disability; may have vomiting due to preconditioning by public
hematopoietic syndrome	100-1000 rad		
1. exposure phase and delay time	100-300 rad	a few hours from exposure to onset of initial symptoms	asymptomatic
2. prodromal phase (initial phase)	300-350 rad	2-3 days with mild cyclic fatigue post third day	nausea, vomiting, fatigue, headache, anorexia
3. latent phase	300 + rad	3rd day to 21st day	benign period with some mild fatigue until 12th to 18th day when epilation of all body and head hair occurs with exception of eyebrows and eyelashes, marked lymphopenia
4. symptomatic phase (bone marrow depression phase or secondary phase of overt hypoplastic anemia)	300 + rad	3-6 weeks (symptoms may be self-limiting)	chills, fever, malaise, increased fatigue, pharyngitis progressive to ulceration of oropharynx, gingiva and tonsillar areas, petechiae and ecchymosis, acute aplastic anemia
5. recovery phase	300 + rad	3 to 6 months	continued improvement; however, major complications such as pneumonia, multiple abscess formation, bacterial resistance to available antibiotics can be expected to occur in a significant percentage of patients
gastrointestinal syndrome	1000-5000 rad	abrupt onset	
1. prodomal phase	1000 + rad	0-2 days	diarrhea
2. latent phase	1000 + rad	2-4 days	benign, asymptomatic
3. final phase	1000 + rad	post 4th day	nausea, vomiting, diarrhea, fever, death due to gross electrolyte and fluid imbalance within 2 weeks
central nervous system syndrome	over 5000 rad	within minutes after total dose received	explosive vomiting and diarrhea; mortal insult to brain and spinal cord, irrational behavior, circulatory collapse and neuromuscular discoordination

Sources: Academy of Health Sciences. *Medical Aspects of Nuclear Weapons and Their Effects on Medical Operations.* Texas, U. S. Army, Jan. 1976, pp. 48-50. U. S. Army Department, Defense Department. *Nuclear Handbook for Medical Service Personnel.* Washington, D. C., U. S. Government Printing Office, Apr. 1969, pp. 26-28.

radiation, the length of time it was received, part or parts of the body irradiated, the presence of associated injuries, individual biological susceptibility, and total dose received.

Little is known about the long-term effects of low-level exposure, but much has been learned from studies of Hiroshima survivors, the Marshall Islands fallout radiation victims, laboratory and industrial accidents which involved approximately 30 victims, and those exposed to clinical radiotherapy(2,3).

The biological effect of radiation is largely determined by the rate at which a radiation dose is received. It is possible for tissue healing to keep up with the damage incurred when radiation is delivered over a long period of time. If the dose was received all at once, a noticeable reaction results.

An individual's sensitivity to radiation will be greatly affected by his age. Fetal organs are highly sensitive due to the rate of differentiation of cells. Between birth and puberty further differentiation and high rates of cell division make children highly sensitive to radiation. The mature adult is more resistant to its effects.

In order to appreciate clinical responses to varying doses of radiation, one must understand that not all cells and tissues are equally sensitive to radiation injury (see list below).

Generally the biological effects of radiation are classified as genetic or somatic. Heredity genes normally change gradually over many generations; a mutation is produced when alteration of the hereditary material is sudden. Radiation-induced mutations are divided into two classes, chromosomal abnormalities and gene mutations.

Chromosomal abnormalities occur less frequently than gene mutations, are more severe, and usually result in embryo death.

Genetic damage anticipated from radiation is often discussed in terms of doubling dose. This is the radiation absorbed dose (rad) that would ultimately cause a doubling in the rate of spontaneous gene mutations which occur.

In a report by the National Academy of Sciences entitled, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," the doubling dose is estimated to be 40 rads per generation. If the average dose to the reproductive cells from conception to age 30 were a total of 40 rads, after approximately 10 generations the rate of impaired mutations would gradually increase so as to ultimately double(4).

Radiosensitivity of Organs

ORGANS	*RELATIVE RADIOSENSITIVITY*
muscle brain spinal cord	low
mature bone or cartilage lung, kidney, pancreas, liver pituitary and adrenal glands	fairly low
growing cartilage fine vasculature growing bone	medium
skin, cornea and lens of eyes gastrointestinal organs, cavity, esophagus, stomach and rectum	fairly high
lymphoid organs bone marrow testes and ovaries small intestines	high

Source: U. S. Army, Navy, and Air Force Departments. *NATO Handbook on the Medical Aspects of NBC Defensive Operations AMedP-6.* Washington, D. C., The Departments, Aug. 1973, pp. 5-8.

Systemic Effects of Whole-Body Irradiation

The effects of a large sudden whole body dose of radiation are designated as the acute radiation sickness syndrome. Acute radiation syndrome follows total body irradiation by neutron or gamma rays, or both. The physiological response in man is especially dose dependent.

Early signs and symptoms include nausea, vomiting, loss of appetite, weakness, fatigue and headache. Later the irradiated individual may have a sore mouth, bleeding gums, diarrhea, alopecia and petechiae. Some of these symptoms may not be noticed for several days(5).

There is no known medication or specific treatment to cure radiation sickness. Therefore, irradiated victims are given palliative treatment to ensure maximum comfort. Radiation sickness is not contagious and requires no isolation precautions unless the victim has open wounds, in which case reverse isolation may be desirable to protect them(6).

Aftermath

The nuclear accident at TMI ended with a cold shutdown 30 days after the original accident. After the immediate crisis was over the safety committee at Lebanon Valley General Hospital met to see what had happened. At that meeting were some staff who seriously didn't believe a nuclear catastrophe could have or ever had occurred. We observed a denial response in many hospital employees similar to that one frequently observes in heart attack victims.

Major concerns were expressed in relation to better nuclear disaster preparation for the hospital. Who would have the authority to give the hospital a directive for evacuation? Who would monitor hospital radiation levels? How would we control anxiety and hysteria of staff?

There was much discussion about the conflict of our dual obligation: to families and to patients. Many staff members said it was realistic to anticipate that the majority of staff would consider the safety of their families first.

The need for reorganization of the existing disaster plan was obvious. The current disaster plan had been developed to accommodate mass injuries. We now needed guidelines for the total evacuation of all hospital patients. We were prepared to be "receivers" but not to be "receivees." An ad hoc committee was established to address the problem.

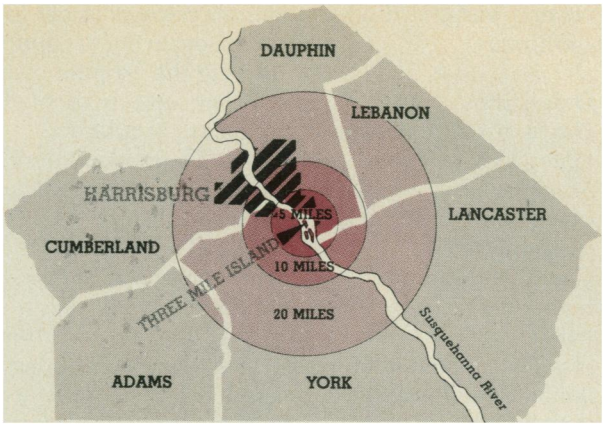
Issues discussed at subsequent meetings have included the following: staff responsibility in the event off duty administrative personnel are unable to report because of hysteria, congested traffic conditions, or entrenchment; emergency discharge criteria; a patient coding system and identification guidelines; problems of food, water, and transportation; and the need for coordination between community hospitals, nursing homes, and voluntary and emergency medical services.

Nurses are participating in the formation of disaster guidelines at our hospital. In addition, we are developing guidelines for the nursing staff based on what we have learned.

Nursing Management of Patients in a Nuclear Accident

The successful nursing management of the irradiated victim is contingent upon sound judgment in triage, decontamination, utilization of personnel, hospital flexibility, evacuation of casualties, advance planning, and training.

If large numbers of casualties have to be cared for, efficient sorting and classification become increasingly important to ensure the best use of the available resources.



How York County Prepared for Evacuation

The Three Mile Island accident required purposeful planning for mass transportation of area residents. June Snyder, R.N., public health director of the York office of the Pennsylvania Department of Health, helped to formulate a plan to evacuate 200,000 residents from York County. Rapid communication was the key to the venture's success.

"Until I received the summons, 'Come to the Courthouse,' two days after TMI malfunctioned, I gave little thought to danger," said Ms. Snyder. "Like all York County residents, I was lulled by Metropolitan-Edison's continued assurances. Joining other members of the Civil Defense Committee at an emergency meeting was the beginning of an experience so encompassing, it is hard to separate the time sequence of events.

"I knew that the only evacuation plan that had ever existed was for a five-mile radius. Was that a safe distance? Nobody knew."

Minute by minute, the intensity of the situation grew. Members of the Pennsylvania Emergency Management Agency joined the group, followed shortly by federal agents. As more groups became involved, telephones were added. At the final count, 72 telephones were in use, including a "white one," a direct line to the governor. Federal agents talked by short wave radio. Police relayed information, and local professionals worked by beeper.

Ms. Snyder spent Friday night in the high school gymnasium with the first evacuees, pregnant women and preschool children from the five-mile radius.

At 7:30 A.M. in the Courthouse, renamed "Emergency Operations Center," the committee reassembled to plan evacuation for a 10-mile radius; an hour later, 20 miles, to be completed that afternoon.

"The 'feds' were skilled in evacuation planning. They coordinated information that we supplied," Ms. Synder explained. " 'Czars' were appointed for Traffic Control, Fire Support, Mass Care Shelters, Transportation, and so on," Ms. Snyder explained. "I was named 'Czar' of Health, Medical and Human Services."

The first destination for evacuees requiring hospitalization, west to Hanover, Pa., was discarded when the patient lists from the area's two hospitals were examined. Dr. Benjamin White of the Maryland Department of Health coordinated an alternate plan, accepting the evacuees in Baltimore. Area ambulances and the two emergency rooms were to care for health crises related to the move, such as auto accidents or heart attacks. Evacuation was to be managed by military personnel, with members of hospital staffs traveling with their patients. Nursing home residents, the handicapped, patients on methadone, geriatric residents, and the mentally retarded were assigned to centers in Hanover. School buses would deliver them to the Red Cross Shelters.

On Monday night Ms. Snyder first thought of the magnitude of the operation she had set in motion.

"We mobilized in 40 hours," she said, looking back on the most intense experience of her nursing career. "Fortunately, the evacuation plan was not put to the test, but I believe it would have worked."

Triage classifications are defined in our current hospital disaster manual as follows:

Classes	Definitions
I	Has a life-threatening emergency problem.
IA	Must be seen by the emergency department physician.
IB	Can safely wait up to 2 hours for emergency treatment.
II	Has an urgent problem, although not life-threatening, but has the potential for becoming so if not treated expeditiously.
IIA	Must be seen on the same day of presentation, but not necessarily in the emergency department.
IIB	Must be seen within five days in the appropriate outpatient department.
III	Has chronic, minor or psychosomatic complaints. Should receive a clinic referral.

At Lebanon Valley General Hospital, emergency department staff have, in the past, had training in the handling of radiation accident victims. That training included the differentiation between contamination and exposure, internal and external contamination, types of exposure, and the treatment of an irradiated patient according to safety standards. We also have procedures for the handling of such cases as part of our disaster planning.

Upon arrival at the hospital, radiation victims are met at the emergency department entrance where they are assessed. These victims may have been exposed to radiation with or without contamination. The contaminated patient is one who is carrying the radiation source on his person. When in doubt about exposure versus contamination, victims are treated as contaminated.

Exposure occurs at the initial accident site and cannot be transferred. Therefore, they present no danger to those providing treatment.

At Lebanon Valley General, victims are decontaminated in the morgue room adjacent to the emergency department ramp prior to entering the hospital complex.

The objectives of decontamination are as follows:

1. To prevent injury caused by the presence of radioactive substance on the body
2. To prevent the spread of contamination over and into the patient
3. To protect attending personnel from becoming contaminated or, in extreme cases, from being exposed to a source of radiation(7).

Whenever victims of radiation contamination are not injured or sick, decontamination should be accomplished at the accident site. If injury has occurred, hospitalization becomes more complicated, since the fallout contamination can be hazardous to both the patient and attending personnel.

After life-saving measures are instituted, the decontamination procedure follows. Radiology personnel monitor victims for radiation contamination. The contaminated victim may have fallout residues, in the form of dust, ashes, dirt, or mud, loosely adhering to his clothing and skin. Removal of outer clothing and shoes usually accomplishes 90 to 95 percent of the decontamination.

The contaminated clothing is placed in bags, tagged, and removed to a remote section of the area to be decontaminated or disposed of later by qualified personnel. The exposed skin is washed, leaving the patient 98 percent decontaminated. The remaining decontamination consists of washing or clipping the hair and washing the scalp(8). This is done only if monitoring indicates the hair is contaminated. After the victim is rechecked with radiologic monitoring equipment, he is then moved into an emergency room or main floor solarium for further treatment.

Care must be taken to avoid accumulation of contaminated waste material in the area where decontamination is carried out. These wastes must be properly controlled and monitored.

Protective clothing such as lab coats, rubber gloves, shoe covers, and a cap usually give adequate protection to attending personnel, but they should be monitored themselves periodically during all of the decontamination procedures.

All equipment used is washed thoroughly with soap and water after decontamination of the victims. Contaminated excreta is placed in lead-lined boxes and removed after radioactivity has decreased.

When handling radiation victims, it is important to have a history of the nature of the accident, the number of persons involved, the type of radiation exposure, the areas of the body affected, and a gross measurement of the amount of radiation as a result of the accident(9). This should be sent from the accident site with the patient.

Recommendations from the ad hoc committee will give our hospital direction for the improvement of our disaster plans, policies, and procedures. Disaster drills and critiques will help keep us prepared. In addition the ad hoc committee is presently involved in preparing a communitywide nuclear disaster drill.

Our institution represents any typical community hospital. What happened to us could happen to you. Are you prepared to handle nuclear accident victims in your institution? Or, if you are located near a nuclear plant, are you prepared for evacuation?

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