Conference of Radiological Health Specialists

Protection Against I-131 in Utah

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THE CONTROL of human exposure to radiation has been attained, primarily, by protective measures applied at the radiation source. When public health officials have been confronted with radiation health problems, such as fallout, for which source control measures have not been applicable, they have been forced to look for other approaches directed toward control of appropriate segments of the environment. As with any health protection program which may be required for temporary use to meet an unusual situation, a predetermined plan of action is indicated.

The developmental aspects of such a program warrant serious consideration by all responsible public health agencies because of the novelty or lack of experience with such situations. Furthermore, the selection of specific measures is highly dependent upon local resources and capabilities as well as the particular circumstances associated with a given incident. Conjointly with the need to develop a plan for protective measures is the need to establish criteria for the time and place to implement such a program.

The implementation of protective measures in Utah during the summer of 1962 provided a unique experience which has been helpful in formulating an approach to this problem. In July 1962, as a result of one major and several minor fallout events, several areas in the State were subjected to fallout contamination. Within a few days fallout contributed some 25,000 picocuries to the cumulative radioiodine level in the Salt Lake City milkshed. Higher levels were measured in milk from a number of individual ranches, one ranch reaching a cumulative total of about 800,000 picocuries.

The key factors in determining the course of action taken during this episode are emphasized in this discussion. Primary emphasis is directed toward the special problem of contamination of milk by iodine 131. Of course, other radioactive isotopes from fallout can also contaminate milk, other foods, and public water supplies. Furthermore, radiation hazards from accidents with reactors or radioactive materials can develop. However, many of these could be controlled by using principles similar to those applied in the Utah incident.

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Public Relations and Information

State and local health agencies, traditionally, are expected to provide reliable information to the public and to various groups on potential or existing hazards associated with environmental contamination. Such contamination may be from nuclear detonations, nuclear reactor accidents, or other situations when radiation-source control techniques become inoperative.

Public confidence is essential not only to prevent intake of harmful material but also to avoid unnecessary, potentially damaging changes in food habits, such as decreased use of milk. The ultimate success of any radiation control program in public health is based upon the confidence the public has in the integrity and capability of the controlling agency.

To merit confidence, health agencies need to recognize that the public is interested in radioactive contamination. The agencies must become knowledgeable and capable in these matters. They need to take appropriate action and to cooperate and communicate with others. As a corollary these agencies are expected to comment intelligently upon a large variety of suggestions for possible protective actions from various sources, informed and uninformed.

Of equal importance is the confidence of the industry involved in control. For example, the milk producer and processor will cooperate willingly and effectively only if they are convinced the controlling agency is competent, the controlling action is necessary, and their interests are being fully considered in the process of providing the public the protection that is indicated. Reluctant application of control measures by industry can seriously complicate an already difficult situation and necessitate instituting enforcement action. An otherwise reasonably successful control program could approach complete failure, with unnecessary controversy or even litigation.

It is of utmost importance that persons governing policies for the news media in a given area appreciate their responsibility in maintaining public confidence in the surveillance and control agency. This requires responsible reporting as well as the confidence of the news personnel in the capability of the surveillance and control agency.

Since knowledge is limited in the field of radiation health protection, honest differences of opinion and of interpretation arise even among those most knowledgeable in the field. Within any given sphere of activity, differences need to be resolved or successfully negotiated in such a manner that for each incident a unified approach to the public is made with the best knowledge available.

The complexity of radiation control makes it mandatory that public information regarding the State's surveillance and countermeasure effort be focused in one agency. In Utah the dairy industry requested that only the State department of health issue statements to the public. This does not imply that the State health department should be solely responsible for all countermeasure activity. On the contrary, many State, local, and Federal agencies, as well as universities and other institutions, will be needed to meet the task ahead and, indeed, already are engaged in a cooperative effort.

Radiological Health Advisory Committee

To obtain maximum use of scientific talent, a radiological health advisory committee is considered necessary. A committee representing the best knowledge on radiation in a State can be invaluable not only in dealing with fallout problems but also with other effects of radiation. Such a committee, composed of well-known and highly respected experts, was appointed in Utah after the 1962 incident. The committee's recommendations provide the health department with a solid, factual, and effective base for action. The group acts as a clearinghouse for technical radiological health information and is responsible for recommending standards and criteria, as well as surveillance and control programs.

In 1963 the committee recommended, and the State board of health adopted, the Radiation Protection Guides established by the Federal Radiation Council as the basis but not the sole criteria for determining the need for control action in fallout situations. This action formally confirmed the practice followed throughout the 1962 incident of using these criteria. The philosophy in Utah was then, as it is now, that until better guides are available there remains no choice but to use those of the Federal Radiation Council.

Industry

Fallout vitally concerns the dairy industry, whose aid is indispensable in planning and implementing any control program.

The State department of agriculture and the management personnel representing the entire dairy industry in Utah have constituted a Dairy Industry Advisory Committee since early in the July 1962 incident. Information supplied by this group made effective voluntary control actions possible. The group also provided the basis for a practical plan of surveillance and of action in case controls should again be necessary.

The dairy processor knows intimately his producers' farm practices; he has, or can quickly obtain, information on stored hay capacity, milk-flow patterns, and transportation facilities, and inventories on and capacities for concentrated milk, cheese, and the like. All of these facts are essential for devising and implementing control activities.

In addition, dairy processors routinely collect milk samples of each tanker coming into the plant for their own quality control program. They are thus ideally suited to assist in collecting milk samples, under direction, for radiological surveillance and control purposes.

Dairy personnel also constitute a direct and effective means of communication with the producer. Any surveillance or control program hinges upon the active participation of either the producer or processor, or both. Effective participation is possible only if the participants have a clear understanding of the potential hazard, the procedures needed to avert it, and their respective roles. An industry educational program is being initiated in Utah.

Surveillance

Any control program is dependent upon sufficient and accurate data for assessing the situation and following the progress of a control action. For this purpose, a surveillance program and a permanent laboratory are essential. A laboratory on standby basis only is inadequate, since proficiency in radiochemical analysis requires constant practice. However, a laboratory for a continuous monitoring program, with standby capacity for emergencies, should assure the capability of the laboratory staff and the accuracy of analyses.

The rapidity with which fresh milk reaches the consumer creates a major difficulty in control. Data are not always obtained in time to permit action, if needed, to benefit the consumer. When milk samples are collected from tankers as they arrive at the processing plant, or from the plant itself, the sampled milk may reach the consumer within 24 hours or less, allowing insufficient time for action. While several days can elapse before milk sampled on the farm reaches the commercial consumer, this sampling may not be practical for control purposes unless the contaminated area is small. The time lapse between sample collection and the reporting of analytical data can be reduced by (*a*) locating the laboratory as close as possible to sample sources, (*b*) providing rapid transport of samples, and (*c*) using rapid analytical procedures.

Even under the best of circumstances, however, today's control action must usually be decided on the basis of yesterday's milk samples. Improved methods of collecting, processing, and evaluating samples are needed. We are now initiating a project in Utah in cooperation with the Public Health Service to develop such methods.

Legality

The responsibility for and authority to conduct a control program must be clearly established since mandatory control measures might be necessary. However, it is far better, and should be possible, to maintain control by voluntary means. Mandatory action, at least in Utah, would be covered under the present circumstances by the powers vested in the State board of health, in the State department of agriculture, and in local health ordinances. During the 1962 incident in Utah, all control was a joint effort by the Salt Lake City Health Department and the Utah State Health Department, in cooperation with the Utah State Department of Agriculture. Salt Lake City's standard milk ordinance relates to about 70 percent of Utah's grade A milk supply.

Cost

Although the cost of the 1962 incident in Utah was absorbed by milk producers and processors, State and local health departments, and the Public Health Service, such financing may not be possible in the future. Several other possibilities have been suggested:

1. An increase in the retail price of milk. This procedure may be applicable to widespread incidents, for example, affecting an entire State or entire milkshed areas, but it would be difficult to apply in incidents of localized contamination.

2. Federal Government reimbursement of producers under Public Law 87–703 through the mechanism of the U.S. Department of Agriculture supplying government-owned feed at a reduced price. This provides for producer costs only.

3. Making the cost of control procedures part and parcel of the cost of testing or using atomic devices, either domestic or foreign. It is presumed that such a cost would be a Federal obligation.

Type of Hazards

A number of situations can result in radiation hazards, each presenting demands for different control procedures.

1. Contamination can occur gradually over an extended period. This is more characteristic for longer-lived isotopes such as strontium but has also resulted from I-131, as for example in 1962 in the midwestern States. Prolonged contamination from fallout would almost certainly affect statewide areas.

2. Nuclear testing, particularly subsurface shots and those near the ground, can result in severe contamination of downwind areas, the deposition being completed for a given region in a very short time. This type of contamination is likely to affect an area of limited size. For example, a few square miles can be seriously contaminated by fallout that is carried to the ground by precipitation.

3. The season of the year in which I-131 fallout occurs is of prime importance. Contamination that would result in an acute emergency if it occurred during the grazing season would be of little significance were it to occur during the winter months. This, of course, is not necessarily true for radioactive strontium and other long-lived isotopes.

Basis for Action

It is not feasible to prescribe definite and precise actions or combinations of actions to take in a radioactive fallout situation until the extent of the actual or potential hazard is evaluated. Action will depend upon the size and nature of the affected area, the magnitude of previous radiation levels in the area, the rate of radiation buildup and the predictability of the occurrence of subsequent radiation exposure. The first consideration is whether the hazard or potential hazard is subject to source control, complete or partial. If environmental contamination arises from fallout or from an accident, source control, at best, is likely to be inadequate. Any type of action will require patterning for rapid adjustments to meet changing radiation situations as well as consideration of how long action should be sustained. In Utah, for example, making the decision to discontinue action was more difficult than deciding to undertake it.

Each contaminating incident and the associated protective measures selected must be individually evaluated and reevaluated as the situation changes. Thus, advance plans of action can be formulated only in general terms. For example, the question often arises as to what specific numbers will be used for initiating, continuing, and stopping action. In Utah attempts have been made, as yet with no marked success, to develop more useful guidelines than now exist in publications of the Federal Radiation Council or the Public Health Service. Experience has demonstrated that for any precise level of I-131 selected for the initiation of control action, an actual situation can be identified in which that level would be unacceptable or, in some cases, ridiculous.

Some may believe that the problem of fallout no longer exists because of the current ban on atmospheric testing, but they forget that the treaty permits underground testing. The uncertainties regarding the venting of underground tests and the fact that debris may be carried via the atmosphere beyond the test site constitute a basic reason for control preparation. The expected continuation of underground testing and the possibility of the resumption of atmospheric testing necessitate continued preparation for potentially hazardous situations from fallout. Therefore, study continues with the hope of developing better guidelines for taking action under circumstances like the July 1962 incident.

Practical Applications

Future radiation control action in Utah will be based on the following principles:

1. Statewide regional daily air monitoring.

2. Statewide milk monitoring at appropriate intervals for certain milk pools, selected dairies, and tanker routes, supplemented by monitoring, as part of special research studies, some 50 individual dairy herds scattered throughout the State.

3. Rapid identification of any localized fallout problems with immediate diversion of staff effort to the area to permit more precise monitoring.

4. Control actions that are tempered by the best technical judgment so as to prevent milk reaching the consumer with I-131 levels in excess of the Federal Radiation Council range II standards. Any action taken will be directed toward protecting the consumer against a hazardous intake of radioactive substance but also against the unsound curtailment of the use of milk as an important foodstuff. It will also seek to protect the dairy industry as much as possible from a substantial and unnecessary reduction in the use of milk products based only on an emotional public reaction. The dairy industry committee will meet with the State health department and be kept informed in each situation so that action, if and when needed, will be taken on a voluntary basis.

5. Possible control actions will include:

a) Exchange of milk sources between grade A pasteurized milk outlets and manufacturing outlets such as those supplying concentrated milk, cheese, and the like.

b) Diversion of grade A pasteurized milk to manufacturing outlets.

c) Shifting cattle from pasture to aged feed, cut and stored before fallout.

d) Use of concentrated milk for pregnant women and infants under 2 years of age.

Several assumed situations involving radiation might be discussed in terms of our principles for action:

1. Assume it is early in the growing season, and the 12-month I-131 intake level in the area is 4,000 picocuries. A sudden fallout occurs with gross beta atmospheric levels at a peak of 1,000 picocuries per cubic meter, followed within a week by a sudden milk contamination, producing an estimated 25,000 picocuries added to the 12-month level. There are no single spots in the area where the milk levels are exceptionally high, and intelligence indicates with definite assurance that no further tests causing a fallout problem will occur within 6 months. A quick calculation indicates that the I-131 level in milk would remain within the Federal Radiation Council criteria. Therefore, no control action would be indicated.

2. Assume the same circumstances except that the starting I-131 level of the 12-month milk pool is 13,000. On this basis one would estimate that for the subsequent 12-month period, the Federal Radiation Council criteria would be slightly exceeded during some portion of that time. Consideration could be given to measures which could prevent the 12-month total from exceeding the Federal Radiation Council range II upper limits. This would entail only a limited control measure, probably selected diversion of milk.

3. Assume an I-131 intake level of 30,000 picocuries for a 12-month period and a precipitous fallout situation of 1,000 picocuries per cubic meter of air. It is immediately foreseeable, assuming the existence of I-131 in the fallout, that within a week the milk pool I-131 levels will rise to a probable level that may soon exceed Federal Radiation Council range II criteria.

While further study is needed on the relationship between fallout air levels and milk I-131 levels, some early action can be taken to minimize the effect of radiation fallout on milk produced in the area. Intensified monitoring of pastures in the area immediately after fallout may identify dairy herds for early milk monitoring. An immediate change to uncontaminated feed for these cattle may avoid or minimize the need for subsequent diversion of milk.

4. Assume a gradual increase in the I-131 intake levels beyond 30,000 picocuries. The action planned would be the type used in Minnesota in 1962, requiring a change to uncontaminated feed, and would be initiated at a time when the Federal Radiation Council criteria were exceeded.

Predicting Radioactivity Levels

It is obvious that ability to predict the time, location, and magnitude of milk radioactivity would greatly enhance control capabilities. However, it is equally obvious that the acute type of radiation episode likely to occur in Utah is not really predictable in advance. The use of extensive and flexible monitoring techniques applied to air, forage, and milk may be useful in the early identification of affected milk sources. The continuing pattern of I-131 levels in milk resulting from fallout may be predicted from these early measurements.

On the basis of data on milk samples taken during 1962 from several Utah farms, Pendleton and associates (*1*) assume that a contaminating episode will result in linear buildup of I-131 concentration in milk during a period of 9 days, followed by an exponential decrease with a half-period of 5.8 days.

If each person ingests one liter per day of milk having this pattern of contamination, total accumulated I-131 resulting from the episode is shown to be 12.8 C_p picocuries where C_p is the peak concentration of I-131 in picocuries per liter. It can be shown also that the buildup phase contributes about 35 percent of the total accumulation, and the decreasing phase the remaining 65 percent.

The time of buildup and the half-period for the decreasing phase might be shown by additional data to have other values, but comparison of Pendleton's curve with the actual 1962 Salt Lake City milk pool curve suggests the proposed values have considerable validity. Slight variations in the value are not too critical from the standpoint of calculations made to aid in planning controls. For example, the Salt Lake City data suggest a slightly longer buildup period than 9 days. With 10 days for buildup and a half-period of 6.3 days during decline, the total accumulated I-131 is calculated as 14.1 C_p, divided about 35.5 percent and 64.5 percent between buildup and decreasing phases.

As a matter of fact, calculations and operations during the 1962 Utah incident were based on a value of 10 C_p. In retrospect this value was in the range of practicality.

Application of this type of analysis to a future incident might permit an estimate of C_p a few days before it is actually measured, permitting in turn a rough calculation of the I-131 accumulation for the entire incident. Even if a week elapses during a contamination incident while data are being gathered, the total I-131 accumulation by that time will be only about 20 percent of the total potential intake even though the daily milk analysis will be showing about 75 percent of the peak value. Thus, it might be possible for control action to be based on a reasonably accurate estimate while 80 percent of the potential I-131 accumulation is yet to come.

Summary and Conclusions

The foregoing discussion has stressed public health implications of radioactive fallout and has touched on other aspects of the environmental radiation problem. It seems important now, in view of the discussion, to record the conviction that modern health departments, Federal, State, and local, need to incorporate in their program planning a recognition of this new and burgeoning problem. Taking on additional responsibilities and staff in a new field is admittedly difficult in view of the usual and well-recognized deficiencies in some programs of long standing, but no department can escape, in coming years, deep involvement in radiation matters. It will be wise to start preparing for such involvement now by a planned and orderly improvement of capabilities, including an adequate active surveillance program.

The general principles underlying any successful program to control population exposures from environmental radioactive contamination include:

1. Control and coordinating authority should be vested in only one of the many agencies necessarily involved in a control program. This controlling agency must merit and maintain the confidence and cooperation of the public, the industry involved, the news media, and the cooperating agencies and experts.

2. A radiological health advisory committee and a dairy industry advisory committee are indispensable adjuncts to the controlling agency.

3. The legal responsibility and authority to conduct the control program must be clearly established.

4. A practical procedure for defraying the costs of the control program needs to be developed.

5. A large variety of complex problems can arise from a fallout contaminating incident. In

some incidents, there may be a slow, extended buildup of widespread contamination; in others, acute localized fallout and "rain-outs." In all, geographic and seasonal factors will need to be taken into account.

In general, future action in Utah will include:

1. Statewide milk monitoring and daily air monitoring.

2. Rapid delineation of any localized fallout problem, with immediate concentration of effort on it.

3. Preventing public use of milk with I-131 levels higher than those permissible under Federal Radiation Council standards.

4. Avoiding unsound curtailment of milk use.

5. Protecting the dairy industry.

Specific control action in Utah may include:

1. Exchange of grade A for process milk.

2. Diversion of grade A milk to processing.

3. Shifting dairy cattle to uncontaminated feed.

4. Use of concentrated milk for children under 2 years of age and pregnant women.

REFERENCE

(*1*) Pendleton, R. C., Lloyd, R. D., and Mays, C. W.: Iodine-131 in Utah during July and August 1962. Science 141: 640, Aug. 16, 1963.

PHS Study of Medical X-ray Exposure

To provide estimates of exposure of the U.S. population from various types of X-ray examinations and procedures, the Public Health Service is undertaking a nationwide study based on a household survey of approximately 10,000 households and 32,000 persons.

Many articles and reports have indicated that an important part of the total radiation to which the population is exposed derives from medical and dental X-rays. Thus, long-range efforts are being made by medical and dental organizations and public health agencies throughout the country toward elimination of unnecessary radiation exposure from the healing arts without loss of the diagnostic or therapeutic benefits which X-rays provide.

The current comprehensive study is the second in a series conducted jointly by the Division of Radiological Health and the National Health Survey of the Public Health Service. A report on the first study covering X-ray visits July 1960–June 1961 was published by the National Health Survey in October 1962. The current study will extend this information by providing radiographic, fluoroscopic, and therapeutic exposure estimates for a representative sample of the U.S. population. A third study is planned to translate these exposure data into dose estimates to specific body organs.

The current study was planned with the advice of a group of distinguished radiologists and physicists. These consultants had available a report on a field trial conducted in Berks County, Pa., during 1963 to determine the feasibility of the methodology to be used in the national study (summarized in the March 1964 issue of *Public Health Reports*).

The household interview survey is scheduled to begin April 1, 1964. From May through September 1964, followup questionnaires and film packs, designed to provide required exposure information, will be mailed to practitioners or facilities identified in the survey. In each case, authority for the X-ray facility to provide the requested information will have been obtained from the household respondent. It is estimated that approximately 6,000 X-ray facilities will have been named by respondents.