PANEL I DISCUSSION: SESSION III PROTECTIVE VALUE OF POTASSIUM IODIDE*

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DR. BECKER: Since Dr. Shleien spoke first, we ought to give him a chance to make his comments.

DR. SHLEIEN: We did use 3,000 rats, of course, in our whole group. Indeed, only 250 were in each dose group. But I am just amazed that the old animal studies which showed that radioiodine was only one tenth as effective as x rays and have been given a good deal of credence, started out with a total of 250 animals or so and lost sometimes 72% of them along the way. More than 90% of the animals in our study were entered into the final data base. So I stand behind our study; it is a good one.

Second, reporting of adverse reactions to potassium iodide is handled like any other drug. We have the same reporting requirements that we have for any drug sold over the counter. I do not know how we could establish a special one. Neither do I want to give the impression that the Food and Drug Administration has some vested interest in this drug. We have made recommendations. It is up to the state and local governments to incorporate or not to incorporate them into their emergency plans.

Last, as was already pointed out, we believe that there is a great difference between sensitivity to organic iodides and to potassium iodide.

DR. YALOW: The question to be addressed is: What is the probability that radioiodine intake is the sole radiation risk associated with a reactor accident? From most of the studies it seems rather clear that radioactive iodine is likely to escape only along with other particulate matter, perhaps in the form of cesium iodide. Rather than think that one is protected by potassium iodide, sheltering would probably give better protection, par-

*Presented as part of the *Symposium on the Health Aspects of Nuclear Power Plant Incidents* held by the Committee on Public Health of the New York Academy of Medicine April 7 and 8, 1983.

ticularly if air exchange with the outside is reduced. A number of studies showed that varying thicknesses of towelling or handkerchiefs will reduce ingestion to a very significant extent.

All the studies since Three Mile Island indicate that radioiodines will not come out alone as was previously thought. It will come out in other forms and in forms likely to be more lethal; therefore, one should consider other methods of protection in the unlikely event of a nuclear accident. American reactors differ from British reactors in that they contain water, and this affects the forms in which radioiodines would be released.

DR. ROBBINS: Judging from today's discussions, I think it is the relatively small accident that will lead to enough iodine release that we need to be concerned about.

DR. JOHN MATUSZEK (New York State Department of Health): Dr. Robbins was doing very well until he discussed reactor releases. He made a serious error when he described a small release as 1% of the iodine in the reactor. The data indicates that a release fraction of 10^{-6}, rather than 10^{-2}, is a small release (which can be expected). His 500 rad dose suddenly becomes 50 millirads, and all concern suddenly disappears. Physiologically he may be right, but from a physics standpoint I think he is wrong.

The way to avoid radiation consequences is to avoid radiation doses. The easiest way to prevent thyroid uptake of iodine is to recognize that the radioiodine released during an accident is mostly particulate, and that there are mechanisms to avoid particulate uptake. Organic iodine is a special case which occurs during routine releases and has nothing to do with accidents.

Let us consider accidental releases of particulates which need only to be filtered out of the air. Handkerchiefs, towels, or dust protectors are as effective as potassium iodide. They are cheaper because they have infinite shelf life and do not create new health consequences.

DR. SHLEIEN: In most but not all of the reactor accident scenarios the thyroid dose is 10 to 100 times greater than the whole body dose. Indeed, if the amount of radioiodine coming out of the reactor would be reduced, that would only reduce the distance from the reactor receiving 25 rem to the thyroid. It has been estimated that, under certain conditions, 1,000 curies of radioiodine released from a reactor would give doses of 25 rem at one mile. We are talking about millions of curies of radioiodine in a reactor, and even if only 1% came out, it still would have some effect.

DR. EUGENE SAENGER (University of Cincinnati): I think it important for

this interesting discussion to review briefly the history of the National Council on Radiation Protection report (WCRP 55) in this field.

We began the report in 1972. All of these issues were considered between that period and 1975 or 1976, when the report was published. There were three thyroidologists: Drs. John Stanbury, Jan Wolff, Richard Goldsmith, and myself as a radiologist, with Dr. Eisenbud and Dr. Hollis Ingraham, who at that time was the Health Commissioner of the State of New York, constituting the committee, along with about three people from the Nuclear Regulatory Commission and several people from the Environmental Protection Agency, who served as consultants. The document was then reviewed by the 65 members of the National Council on Radiation Protection, probably the most rigorous review with which I am familiar, at least, in the scientific literature. The recommendation of 130 mg of iodide was interesting in that it was one of the few times, if not the only time, that a recommendation was made to the Food and Drug Administration to lower the dose of a therapeutic agent (from a 300 mg dose, which was accepted for medical use, to 130 mg for a prophylactic use).

As far as the shelf life of iodide, this has been a very widely debated problem. The British, as you know, have used iodate. The preparation that they had about 10 to 12 years ago was put up in some aluminum foil, but had crumbled and seemed to have lost its activity so its shelf life is not ideal. I have tried to get some of the people at the Food and Drug Administration to make other studies in this regard, but so far without success.

You may be interested in what the states are doing. For example, Dr. Fowinkle, the Health Commissioner for Tennessee, had decided to order 7,000 doses of potassium iodide because he believes that is the number appropriate for the reactor around Chattanooga. It is my understanding that the Department of Defense has set aside at least several hundred thousand doses for this purpose.

In terms of trying to estimate what the reactions to iodide were, with the exception of hypocomplementemic vasculitis, which I do not think we explored very carefully in that report, we obtained a numerator, given in NCRP No. 55, from the records of the serious reactions reported to the Food and Drug Administration, and the denominator was the number of doses of potassium iodide per year supplied to the market by a number of pharmaceutical manufacturers. This was the best way, in our opinion, to get these data because, as was pointed out, there is really no other way to arrive at it.

One other thing I think you might be interested in. This morning, John Dunster, from the National Radiological Protection Board of the United Kingdom, presented a talk in Washington at the National Council on Radiation Protection at this meeting concerning the recent updating of the Windscale accident of 1957, an accident where a considerable amount of ^{131}I was accidentally released over the British countryside. They carried out some collective dose calculations based on International Council on Radiation Protection values, and came up with an upper limit that there might be an excess of 13 deaths from thyroid cancer. This very conservative upper limit estimate touched off a hullabaloo in the British press of some magnitude during the past two weeks. I think the point of all this is that the dose per individual of six times background or roughly six tenths of a rem is not an amount that anyone would get worked up over in terms of our experience with ^{131}I and thyroid cancer. But, in any event, I think that there are some problems of perception of risk that one has to keep in mind.

I think the other point that Dr. Robbins made is an important one, and that is that there seemed to be at Three Mile Island a net deficit in the release of radioactive iodines as opposed to expectations of the amount of release. This deficit is at present attributed to cesium combining with iodine within the reactor containment vessel. Recent thinking by the Nuclear Regulatory Commission is that this mechanism may minimize the release of radioactive iodines and may reduce the plume zone area to about a five-mile radius around the reactor. Thus, the dispersion zone of 100 or 200 miles, as some people had proposed, seems very unlikely. So maybe we have a problem which is not, perhaps, as complicated as some people would like us to think, based on our original recommendation.

DR. A. DUNCAN MACDOUGALL (Northeast Utilities, Millstone): The situation is that we have a person in a supervisory position in a reactor plant, for example, a station superintendent or head of maintenance. The decision has been made to give potassium iodide because of suspected releases. During his pre-employment examination he gave a history that he was allergic to a dye from an intravenous pyelogram. Would you give him potassium iodide tablets?

DR. ROBBINS: If he were my employee and was required to be in a dangerous situation of that sort, I think I would. One approach would be, at a time when there is no need for giving potassium iodide, to test him carefully with small doses under controlled conditions and find out if he reacts to it. If he is allergic, on the basis of what I said previously, at his

age he would be at low risk for developing radioiodine-induced thyroid tumors so potassium iodide could be omitted. There would still be another way to deal with this type of individual, although it is not a public health approach. He could be given replacement thyroid hormone to depress the pituitary and to prevent any uptake of radioactive iodine. It would have to be given for a period prior to exposure.

DR. MACDOUGALL: Let us go a little further. We are assuming that you will not have the time to test this man. Reviewing his history, you find he is allergic to the intravenous pyelogram. Would you give him thyroid hormone at that time or would you give him potassium iodide? Again, assume that we have no time. The incident has happened, and we are going to give the rest of the workers potassium iodide.

DR. SHLEIEN: I think that individual would be a prime candidate to use a respirator.

DR. YALOW: The probability of a 40-year-old man receiving 100 or 200 rads to the thyroid and having any deleterious effects observable within his lifetime is so remote that I do not even know why we discuss it. I think what we really have to discuss in your hypothetical situation is whether there is a way to have radioiodine released inside a reactor without release of other radioisotopes. My concern would be generalized body radiation. Half the people receiving 400 rems would die. One can be quite sick from 200 rems. I am not going to worry about late effects to the thyroid in 40 years.

DR. ALVIN M. WEINBERG (Oak Ridge National Laboratory): I fear that in the discussion this afternoon, from which I have learned a great deal, some of the participants perhaps did not take sufficiently to heart the advice given in the earlier discussion this morning, the discussion with Harold Lewis and Norman Rasmussen. And they tended perhaps to counterbalance the possibility of some kind of bad contingency with the possibility of that contingency.

Now, this has already been mentioned by a previous commentator. I assure you that within the nuclear community a release of 1% of the iodine inventory is considered an enormous release for a light water reactor. There have been in the history of the business some six or eight incidents in which iodine has come out of light water reactors. And there are now enough data to suggest that, for reasons that are not entirely understood, the probability of large iodine releases to the atmosphere from light water reactors is extremely small.

At Windscale in England 20,000 curies of iodine were released from an

air cooled reactor in 1957. By comparison, the 20 curies of iodine released at Three Mile Island was one millionth of the total inventory. So your figure of 1% represents a contingency of very, very small probability.

I do not want to leave this audience with the notion that this issue is totally understood. The Nuclear Regulatory Commission is coming out with a new estimate of what is called the source term, and this will probably start a good deal of additional argument, but the general impression we have from our analysis goes like this. Perhaps these data could be taken to heart and might be factored into the general planning for emergencies, that if the release is a slow release, as at Three Mile Island, it takes a long time for something to happen. Then the very strong probability, and this is strongly reinforced by studies in Germany particularly, as well in this country, the releases will be small, particularly the release to the environment.

On the other hand, if the release is a very fast one, which has extremely low probability, and in fact one of the things emerging from this discussion is that Rasmussen perhaps overestimated the probability of a fast release, that is, a steam explosion that blows the reactor vessel, seems to have a probability at least 100 times less than the probability stated in Rasmussen's study. This would put it in the category of probability of one in 10 million to one in 100 million per reactor year.

So we have two different possibilities that seem to be emerging which could perhaps lead to some clues as to how to handle these different situations. Our sense seems to be that in this very, very fast event, which has extremely low probability but cannot be excluded, we do not quite see how people can get away in that short a time, and that, therefore, in that event, the best thing to do is to shelter them.

We do not on the other hand see very much reason for people to evacuate in the situation where we have a very slow incident, because not enough bad things are really going to come out. I cannot state any of these things with absolute certainty, but our general impression is that probably the best philosophy is to stay put and stay indoors.

Whether or not one should also have some iodide on the shelves I leave to be argued between these three distinguished scientists before us. But I did want to really stress very strongly that the source term is going to change, that the sequence of accidents to worry about is not the one that the newspapers really worry about, and that highest probability accidents, in contrast to something that may have been said inadvertently by the

panel, are not ones that are likely to cause very much damage.

DR. LEONARD SOLON (New York City Department of Health): After the detailed investigations by the National Cancer Institute, so ably reported by Dr. Robbins, and after the thinking that has been given the matter by the Bureau of Radiation Health, and the protocol written by Dr. Shleien, why has there not been a more assertive government position? It seems to me that there is room for federal leadership which would constitute the basis for local action. I do not understand the inhibitions and reluctance. If you believe what you have said, and I believe that you do, where is the federal leadership which I think we are entitled to?

DR. ROBBINS: I want to go back to what I said at the beginning of my talk. I am a research scientist, not speaking for the Public Health Service, and not a regulator. I was trying to put forth the argument of the medical problem. I have been corrected by Dr. Weinberg, which I accept. I do not know much about reactors, but I think he also agreed that there is a problem as to just how much possibility there is of a significant accidental release. But, to answer your question, why is there not some direction? As I said in the beginning, when we know the answer to medical questions, what is required is a political decision.

DR. SOLON: United States agencies assert leadership in all kinds of areas when it comes to consumer products and other things which potentially have a much less decisive influence on public health than potassium iodide for reactor emergencies all the time. The reluctance of federal agencies to take a position here is really, in a certain kind of way, a scientific and public health delinquency.

DR. SHLEIEN: There is a very wide difference of opinion. If the federal government took the action Dr. Solon suggests, there would be as many persons saying that the decision to use potassium iodide belongs with the states. So, obviously, the judgement has been made. Whether to call it political or whether to call it a copout, whatever you call it, it had to be made. I think that this is appropriately a state and local decision. All that the federal government is responsible for is to make the drug available, to define the conditions in which it is to be considered for use. The federal government has taken the position it has on this issue because we believe the decision if and when to use potassium iodide rightfully belongs with the states.

MR. ANDREW P. HULL (Brookhaven National Laboratory): The protective value that one assigns to having potassium iodide available should, in my opinion, be related to the possibility of large amounts of iodine getting

abroad. At Three Mile Island the reactor fuel contained about 68 million curies of ^{131}I at the time of the accident. The distribution of the curies which escaped was established by assays made within the next few days. In the primary system itself, which contained about 90,000 gallons of water, there remained about 10 million curies; in the 600,000 gallons of water that escaped from the primary system to the bottom of the containment building there was about 20 million curies. Neither of these locations provided a direct route for iodine to get into the environment. However, there was about, in round figures, about 4 to 5 million ^{131}I curies that ended up in tanks in the auxiliary building. The iodine airborne in the environment resulted from discharge from the plant's stack of the ventilation building. It did not come directly from the reactor containment.

Only about 15 or 20 curies was actually released. Another 125 curies was retained in the filters themselves. So a maximum of about 140-150 curies became airborne from the 4 to 5 million curies that was present in the tanks in the auxiliary building.

These happen to be numbers that I know. The first assay of the sample of what was airborne in the containment, which was taken on the next day, after the core flow system had come on, indicated there was only about 4,300 curies airborne in the containment. This indicates that most of the radiative iodine which escaped from the 68 million curies in the fuel ended up in water and not as airborne radioiodines. I think this is one of the factors that Dr. Weinberg just mentioned about the water-cooled reactors. As long as you have water around, it appears that any iodine released from the fuel during an accident would be contained in the surrounding water, as long as there was any present.

The SL-1 accident represented the nearest thing we have had to a sort of steam explosion, which represents one of the maximum hypothetical cases in which after the explosion the radioactivity contained in the fuel was pretty well unconfined and could spew out into the air. Out of the 28,000 curies of ^{131}I in the fuel, only about 80 curies were released to the environment as airborne radioiodine.

The nearest model for what might happen in a "dry" accident was presented at Windscale, the accident to which Dr. Weinberg referred. During this accident about 20,000 curies of ^{131}I were released as airborne radioiodine. I do not know exactly what sector of the pile was involved, but there had to be something like 100,000 curies available as a possible source term. These real experiences are part of what is causing the experts to reexamine the existing models. It does not seem very likely that during

most imaginable reactor accidents the releases would be anywhere near what the pessimistic models, the worst-case models, predict in the way of airborne releases of radioactive iodines.

DR. YALOW: It is rather interesting when looking at the increased incidence of thyroid cancer, that there has not been any increased death rate due to this cancer. The apparent increase began in the late 1940s, and has persisted at about the same rate since. It is not without interest that this apparent increase was coincidental with the introduction of thyroidal scanning first with ^{131}I and now with radioisotopes. I am being provocative by asking whether there are more thyroid nodules or thyroid cancers now than in the earlier period, or whether it is increased diagnosis because of nuclear medicine scanning and overaggressive surgery. Perhaps we are finding things that were always there, intervening, and as a result damaging more people than we are helping.