PLANNING THE RESPONSE TO A FUTURE NUCLEAR ACCIDENT

As its second major theme, the Working Group focused on the further work necessary to determine how to deal with the health consequences of future nuclear accidents and the potential public health responses. Because future incidents might differ significantly from Chernobyl, public health planning — although it must be built on harmonized general principles — must be sufficiently flexible to respond to a variety of situations. This topic was addressed under the headings of:

- public health planning, including monitoring, ensuring the quality of radiation measurements, and international cooperation;
- intervention levels in food;
- non-food intervention levels;
- iodine prophylaxis; and
- public information and training.

Public health planning

The WHO Regional Office has already made significant contributions to rational public health planning through two publications produced before the Chernobyl accident *(13,15)*. Experience gained from the accident, however, showed that questions related to affected areas distant from an accident would need to be addressed more extensively, and that even the advice on action in areas close to an accident would need revision.

Public health planning to respond to nuclear accidents encompasses a wide range of issues, including mechanisms for: the early notification of an accident and an accidental release of radioactivity from a nuclear plant, to both international authorities and countries that might be affected by the cloud; the coordination and standardization of the monitoring of the extent and direction of the release; and the determination of the composition of the cloud, the pattern of deposition, and the organization necessary, at both national and international levels, to deal with the emergency.

Most European countries have already begun to establish a system of public health planning, including communication links between the authorities involved. In addition, IAEA, through its well established schemes for nuclear safety, provides valuable guidance for both international action and national authorities. In particular, the 1986 IAEA Convention on Early Notification of a Nuclear Accident is an important means for the international exchange of information, should an accident occur. Although unsolved problems remain in the definition of a "release which could have significant transboundary consequences" *(9)*, information given under the terms of the Convention would provide the important first warning of a radioactive release from a nuclear installation.

Monitoring

Rational decision-making at the national level following nuclear accidents depends on the availability of adequate monitoring data.

An important element of all emergency monitoring is the existence of a capability for routine monitoring, to provide the necessary baseline data and ensure that the necessary expertise is developed in the personnel involved. Such monitoring systems are operating in all European countries with nuclear power stations, and in many other countries in the Region. In some smaller European countries, however, such systems are likely to be inadequate or even nonexistent. The Convention on Early Notification of a Nuclear Accident should enable countries to receive sufficient information, in the first instance, to decide on the need to step up their monitoring to an emergency level. A country might also obtain such information through separately organized bilateral channels, from routine measurements taken in the country or even, in some instances, from the mass media.

The WMO Global Telecommunication System monitors meteorological conditions and provides information around the clock, every day, from measuring stations in virtually all parts of the world. Measurements of radioactivity in the atmosphere are not included in WMO programmes, although equipment for the measurement and sampling of radioactivity is installed at meteorological stations in several countries. Possible means for the collection and international exchange of radiological data through the Global Telecommunication System in case of a nuclear accident are currently under development within the Inter-Agency Committee for the Co-ordinated Planning and Implementation of the Response to Accidental Releases of Radioactive Substances.

The Working Group agreed that countries other than that in which an accident occurs need the following kinds of data to take necessary decisions on possible public health measures:

— data on the movement of the released radioactive material in areas close to the accident site;

— trajectories of the release;

— predictions on the transport, dispersion and deposition of the radioactivity in the longer term; and

— radiological data from the site of the accident as well as from a wider area around it, as applicable.

Initial data from local monitoring stations should be transmitted to regional centres that should have the ability to forecast through quantitative modelling. From these centres, data and predictions could be transmitted to all national centres concerned. In a discussion on whether data should be coded before transmission to national centres, the Working Group noted that, under the IAEA Conventions, the information provided by the Accident State in support of a notification may be used without restriction, except when it is provided in confidence. Arrangements for the dissemination of this support information through the WMO Global Telecommunication System were to be completed by the end of 1987, and demonstrated to the IAEA Board of Governors in February 1988.

NEA/OECD was in the closing stages of producing a report on monitoring, stressing the need for both measurements made in areas near an accident site and aerial surveys. WHO should be less concerned with such monitoring issues as the elaboration of sampling techniques and the transmission of data than with the interpretation of data with regard to health consequences.

A balance should be struck in the amount of radiological data transmitted in the event of an accident. On the one hand, sufficiently varied information (on, for example, the distribution and amount of radioisotopes, the nature of sampling and meteorological conditions) is needed to make reliable predictions. On the other hand, there is the inherent risk of having too much information, which could result in difficulties in assessing the situation and reaching conclusions. For this reason, a harmonized international standard form for radiation measurement would be of great importance. Particularly important information should be rapidly made available to countries through a harmonized system. This would include: the interpretation of the collected data in terms of health consequences, public health recommendations made by international organizations (primarily WHO), and public health action taken at national, regional or local level.

In general, the problems of monitoring, although difficult enough to deal with in the European Region, loom larger in many other parts of the world, where the scarcity of monitoring stations and trained manpower are often important constraints. The experience gained in the European Region should therefore be placed at the disposal of other regions of the world as quickly as possible.

Quality assurance of radiation measurements

Ensuring the quality of radiation measurements is an urgent need. This implies improved and expanded training programmes for a large group of personnel. The quality of modelling and prediction should also be assured.

The harmonization and development of radiation measurement techniques, sampling methods, and reporting practices are important tasks, although WHO will not be the prime mover in the work.

Coordination and collaboration at national and international levels

Appropriate, coordinated national public health plans need to be developed for response to nuclear emergencies.

First, in the event of an emergency, reliable national and international data should be available and frequently updated. Predictions should be available from international sources and/or from a national facility. In addition, an intersectoral emergency team should be rapidly formed.

All relevant national authorities should be involved in the response, and capable professional officers with sufficient authority should participate in making decisions or providing advice to people in authority in the relevant ministries. Further, the emergency team should have sufficient communication capacity to communicate with international organizations, neighbouring countries, the top management of the ministries or agencies involved, subnational or local levels of government, national monitoring stations and the mass media.

Such a response system would call for some sort of coordinating body at the national level, with appropriate equipment and staff. Each country would need to decide whether such a body should have the power to take public health action or only to advise higher political authorities. Likewise, each would decide whether the duty of providing information to the public should be entrusted to the coordinating body or a group created for the task. If the latter course is taken, however, the coordinating body and the public information group must establish and maintain very close links, to avoid giving ambiguous and contradictory instructions and advice.

It is also crucial that the national public health authorities should form an important element in the coordinating body, with the task of forging links with WHO. To strengthen these links, the Regional Office for Europe should invite its European Member States to nominate focal points within their national public health administrations for liaison with the Regional Office in the event of an accident. In addition, Member States should keep the Regional Office informed about the structure of their national systems of response to nuclear accidents.

One of the main tasks for a coordinating body at the national level would be to decide or advise on public health action based on reliable radiological data and sufficiently sound predictions. Such decisions should be communicated as quickly as possible to other levels of government, international organizations (and other countries, either directly or through these organizations), the mass media and, hence, the public at large. For this reason, the fast dispatch of information is essential.

Further, the functioning of a national coordinating body should be tested through realistic exercises.

Coordination and collaboration is equally important at the international level. A number of international organizations both within and outside the United Nations common system have responsibilities in the event of a nuclear accident. It is essential that they coordinate their activities to avoid the duplication of work and to prevent confusion during an emergency.

It is essential that WHO retain its position as the leading international organization in public health, but it is equally important that the other organizations fulfil their roles, for example, IAEA with regard to nuclear safety and FAO with regard to food.

In questions involving one or more international organizations (such as radiation measurement and monitoring), agreements might be reached to enable both the organizations and countries to accept fully the sharing of responsibilities.

In the event of a nuclear emergency, the WHO Regional Office for Europe must be able to repeat its excellent performance in the weeks following the Chernobyl accident. The Working Group felt that the appropriate facilities for such an operation should be available in the Regional Office; it is vital that the Regional Office be in a position to interpret and evaluate the large amounts of data that it might be expected to receive, and to disseminate relevant evaluations to Member States. Completing such a task would require the recruitment of special consultants to the Regional Office; this was seen as a difficult problem, as such experts might be in short supply, owing to the need for them at the national level.

The Group also felt that the WHO Regional Office for Europe was able to provide other WHO regions with the fruits of its experience with nuclear emergencies.

Derived intervention levels for food

After the Chernobyl accident, it was realized that international guidance on the management of the consequences of a nuclear accident did not adequately address the problems of contamination in areas distant from the site. Setting permissible levels of radionuclides in food and drink posed a particular problem. The lack of clear guidelines led to much confusion. In addressing these problems, the Working Group considered recent reports from WHO *(16)*, FAO *(8)* and OECD *(14)*.

WHO

The experts at an initial meeting organized by WHO headquarters had felt that agreement on an acceptable reference level of dose was not likely. They had therefore proposed an approach based on optimization. Consultation with Member States, however, had made it clear that this approach was not acceptable. A revised approach was developed and formed the basis of discussions held by the Task Group on Guideline Values for Derived Intervention Levels in September 1987 in Geneva. The Task Group finalized a document setting out guideline values for radionuclide contamination of food *(16)*.

The Task Group agreed that, in an accident, the source of the contamination is, by definition, out of control; therefore the dose limitation principles for normal operation are no longer applicable. The only option available is to determine whether any intervention is necessary to reduce exposures. Further, the Task Group confined its work to developing advice on derived intervention levels for radionuclides in food and drink. Because this advice concerned the areas distant from an accident, where non-stochastic risks do not occur, only stochastic risks from individual and collective doses were relevant.

The following general principles guided the Task Group and prompted its recommendations.

A reference level of individual dose of 5 mSv from the ingestion of radionuclides in food and drink in the first year after a nuclear accident was a reasonable basis for the development of derived intervention levels for food. Experience following the Chernobyl accident had shown that controls based on such a level had, in general, resulted in the measurement of considerably lower levels in exposed individuals. In addition, collective doses received by the population had to be considered, to assess the total detriment incurred and to decide whether any further intervention was justified to reduce the dose below 5 mSv in the first year.

Individual doses received in subsequent years would be likely to be considerably less than the doses received in the first year. If, in exceptional cases, annual individual doses approaching 5 mSv were received by members of a population for several years, the national authorities would need to reassess the situation and decide whether further action to reduce exposures was justified.

Further, the chance of two nuclear accidents occurring, each resulting in significant contamination of food in the same time period, is remote. In such a situation, however, exposures from both accidents should be considered together.

Special consideration was needed for three types of exposure. First, exposures to the thyroid gland from radioiodine needed separate discussion, but they should be kept below a reference level of dose of 50 mSv in the first year following an accident. Second, the metabolic parameters used in estimating doses to infants must differ from those applied to adults. Third, although the developing brain of the fetus is more sensitive to doses larger than 5 mSv between the eighth and fifteenth weeks of gestation, it was not yet clear whether a threshold for this effect existed. If there was no threshold, national authorities would need to take this fact into account when developing advice for their populations.

The WHO guidelines resulting from the work of the Task Group included a set of derived intervention levels for food and drinking-water. A framework to allow for additivity because of exposures from several food groups or radionuclides was also provided. The Task Group used this information to give a number of illustrative examples. A separate set of guideline values was calculated for infants.

The calculations of derived intervention levels based on individual risk were supported by an optimization exercise suggesting that levels in food of 1–10 mSv were likely to be justified. Higher doses could be permitted in minor foodstuffs, of which the normalized consumption rate is less than 20 kg per annum.

FAO

As previously stated, the FAO report on recommended limits for radionuclide contamination of foods *(8)* was prepared specifically to provide levels that would be acceptable in the context of international trade to countries distant from a nuclear accident, including both those affected by direct deposition of radionuclides and those in which such deposition was negligible. Although the values developed were intended to protect health, they were also based on a principle of trade: for toxins in food with no threshold for their health effects (including genotoxic carcinogens such as radiation), levels should be both as low as possible and consistent with the goal of avoiding serious compromise of the food supply and non-tariff barriers to trade.

The WHO and FAO approaches were therefore complementary. WHO provided reference levels corresponding to a particular level of risk to health; then actual levels are set as low as reasonably achievable. The FAO levels took account of other factors, such as:

— what was likely to be acceptable in imports to a country with no direct deposition of radionuclides; and

— the levels actually present in the food in international circulation.

OECD

NEA set up an expert group to critically review the accident responses and corresponding intervention levels adopted in OECD member countries in response to the Chernobyl accident. The group's preliminary report *(14)* was available to the present Working Group and was to be considered by the next full meeting of CRPPH in November 1987.

The expert group concluded that the existing basis for the development of accident response plans needs to be further developed, particularly in areas far removed from an accident site. Special consideration should be given to the implications of severe accidents having widespread, transboundary and long-term effects.

In areas distant from an accident, the Group felt a particular need to distinguish between two types of condition. In a type 1 situation, intervention is required to control exposures arising from both the deposition of contaminants (direct impact) and the importation of contaminated food from other affected countries (indirect impact). In type 2 situations, where there is no direct deposition, intervention is required only to control exposures arising from the importation of contaminated food from countries directly affected.

The Group thought that the guidance provided by ICRP needed clarification and expansion to include areas distant from an accident *(17)*. The existing guidance on the avoidance of non-stochastic effects, however, was still considered relevant.

Discussion

Having considered all three reports, the Working Group agreed that the WHO document *(16)* was a useful basis for the development of a harmonized approach to the setting of national intervention levels to protect health in areas distant from a nuclear accident. Nevertheless, it would be useful to amplify or develop the document further in a number of areas.

The WHO document resulted in a harmonized approach to the calculation of levels of radionuclides acceptable in various food classes. The use of this approach, however, would not result in harmonized intervention levels either within or between countries; because patterns of deposition differ, the use of the additivity formula could result in different intervention levels. The document therefore represented the first essential step in the development of harmonized, acceptable levels for radionuclides in food, but further work was needed to determine such levels for use in densely populated regions such as Europe.

The development of separate levels for children, while scientifically necessary, also further complicated the process of deciding on actual levels for control. The document did not show clearly how account is to be taken of special groups in setting such levels. It was necessary to address this point in more detail and to look at the implications of using various assumptions.

The document took account of the need for special metabolic factors for children. It was not clear, however, whether sufficient account had been taken of the fact that the risk per unit dose was considerably greater for children than for adults — possibly by as much as a factor of three; this was established by the recent information from studies on cancer rates in people who were under 10 years old at the time of exposure to the radiation from the atomic bombs in Japan. The risk estimate quoted in the document as equating to 5 mSv had taken account of the latest data from the Japanese studies, but not the greater sensitivity of children to radiation. The advice on age-related factors in calculations of dose being prepared by ICRP would be useful in this context. It was essential that the most recent studies of the health effects of radiation be taken fully into account.

In addition, specific guidance was needed on the way that groups of people with unusual dietary habits might need to be considered. For example, special advice had been necessary after the Chernobyl accident for the Lapps in northern Scandinavia, who consume large quantities of reindeer meat. Such critical groups would need special consideration, probably by their national authorities. A separate assessment of what was most reasonably achievable, taking into account all relevant factors, might need to be made for such people.

It seemed helpful to divide the areas far distant from an accident into two groups: those with the direct deposition of radionuclides and those affected only by the movement of foodstuffs. In countries in the second category, the application of the optimization principle would mean that lower levels could be applied to foods produced internally. For this reason, however, it was unlikely that such countries would be prepared to accept higher levels in imported foods. These lower levels were therefore likely to constrain international trade in food, and should be clearly seen as related to considerations of trade rather than health.

While there was consensus on the reference level of dose of 5 mSv for the first year after an accident, there was less agreement on what was acceptable in subsequent years. In most situations, exposures in the second and subsequent years would be expected to fall markedly. In certain situations, however, this would not happen. For example, where reindeer meat comprised a large proportion of the diet, levels would be expected to remain elevated for many years, owing to the continued contamination of the lichen forming the reindeer's major food source. Unexpectedly persistent levels might also be found in the second and third year in other food sources, such as the sheep grazing on high land in the United Kingdom.

Advice on acceptable levels in second and subsequent years after a nuclear accident had to take account of these facts and permit some flexibility. It would not be sensible to set a firm lower annual dose for this period that would mean the sudden imposition of more stringent controls in the second year; this would not increase public confidence in radiation protection principles.

One possibility, giving flexibility while emphasizing the need to reduce doses over time, would be to accept 5 mSv in the first year and a total of a further 5 mSv over the subsequent five years, with the expectation that, after this period, exposures could be contained within the ICRP dose limits for normal situations.

This subject needed more international consideration. The WHO Regional Office for Europe should consider it further, and ICRP might be expected to give advice when its formal guidance was revised.

It was agreed that WHO would need to take account of the Working Group's discussions in the proposed revision of the guideline document *(16)*.[a] The Regional Office for Europe needed to use the document to develop more directly applicable guideline values for use in the Region, both immediately after the accident and subsequently by countries that did not wish to develop national values.

It was important to realize that exposures from sources other than food also needed to be taken into account in setting action levels, and might affect the final decision on action levels for food in any circumstances.

Non-food derived intervention levels

Areas distant from an accident

In areas far from the site of a nuclear accident, intervening to control the supply of food to a population is relatively easy. Intervention to control exposures from other sources may be much more difficult, and involve much more societal disruption. For example, to avoid exposures from inhalation, the only realistic options are evacuation, sheltering or the wearing of a mask. Alternatively, such intervention may be relatively simple, such as advice to delay the changing of air conditioning filters.

The wide range of societal disturbance involved in applying such measures means that the setting of general intervention levels for non-food routes of exposure is difficult to standardize. It is more directly related to the practicability of the proposed action than to the anticipated dose.

Within this general framework, some guidelines may be helpful to national authorities.

Inhalation is unlikely to be a significant route of exposure in areas distant from an accident. Therefore, restrictions on outdoor activities or on the ventilation of houses are unlikely to be necessary, except when exposure to actinides or "hot particles" may occur. This topic was beyond the scope of the Working Group, but should receive further consideration from WHO.

Simple, inexpensive action that does not result in the introduction of further risk can be taken without defining specific intervention levels of dose. This would include, for example, advice on handling sewage sludge.

A group requiring special consideration is pregnant women, particularly those between the eighth and fifteenth weeks of pregnancy, when the fetus's developing brain is known to be especially sensitive to radiation.

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[a] The discussion and comments of the Working Group were indeed reflected in the final publication, *Derived intervention levels of radionuclides in food* (Geneva, World Health Organization, 1988).

Heavy rainfall while radionuclides from an accident are overhead could make external irradiation a significant source of exposure, if ground contamination in excess of several megabequerels per square metre occurs. In this context, it is useful to note that the maximum deposits of about 500 kBq/m^2 in parts of western Europe following the Chernobyl accident would have led to doses of not more than 0.1 mSv from external irradiation in the eighth to fifteenth weeks of pregnancy. Such levels of exposure do not appreciably alter the spontaneous probability of mental retardation in offspring, even if accumulated during this most critical period of pregnancy.

It has been determined that the effects on the intelligence of people irradiated *in utero* at Hiroshima and Nagasaki resulted directly from the effect of irradiation on the brain, not indirectly from damage to the fetal thyroid gland. The doses concerned were too low to have significantly affected the development of the thyroid.

No matter the action taken or advised, it is vital to provide the public with adequate information on the rationale used and on the magnitude of the risk being averted. Thus, undue concern will not be produced from simple measures to reduce exposure via minor routes (such as changing the sand in children's sand pits).

Areas near an accident site

The affected population in areas near a nuclear accident is likely to be smaller than that in more distant areas, and the need for action more urgent. Of necessity, such action is likely to depend much more heavily on local conditions and to be less amenable to general guidelines. Nevertheless, tables that facilitate a rapid estimation of doses and resulting risks from measured activity concentrations or dose rates would be useful.

Direct ground deposition from an accident in nearby areas may contribute a significant proportion of the lifetime dose to a population because the exposure is continuous and, when radionuclides with long half-lives are involved, does not decline much after the first year. Because measures to reduce these doses are likely to be expensive and disruptive, however, they would only be justified where exposures are significantly higher than those received by other populations from background radiation.

Countermeasures must be cautious, to minimize the probability of major hazards and take due account of the probability of further deterioration of what is already, by definition, an unstable situation. In such circumstances, evacuation may be justified, even at relatively modest predicted doses to a local population, if there is a real possibility of a larger release.

Once again, the special sensitivity of the fetus will be an overriding consideration, and is likely to justify the evacuation of pregnant women if doses of the order of 5–10 mSv are anticipated over a few days. Evacuating pregnant women, however, may entail the simultaneous evacuation of their children and even dependent relatives.

Considerable uncertainty exists in this area about the magnitude of and dose–response curve for effects; studies of the offspring of pregnant women exposed close to the Chernobyl site will obviously be of major importance in helping to provide further information on this important topic. It is hoped that the proposed WHO/IARC steering group will facilitate work in this area.

Documents from the WHO Regional Office for Europe on non-food interventions (including iodine prophylaxis, sheltering and evacuation) are being prepared.

Iodine prophylaxis — indications for use

In September 1987, WHO called together a small group of experts to consider the indications for the use of stable iodine prophylaxis, taking account of the new information from experience following Chernobyl. As a result, the Workshop on Iodine Prophylaxis following Nuclear Accidents was to take place in Brussels in July 1988, following which guidelines were to be prepared, to be used as a basis for contingency planning at national and local levels.

The present Working Group pointed out a number of aspects of stable iodine prophylaxis needing more detailed consideration.

The iodine status of an exposed population, for example, is an important factor determining the doses received. Average daily intakes of iodine vary widely around the world, depending on dietary habits and the regional abundance of iodine. The radiation dose to the thyroid will be higher in areas where iodine intakes are normally low (such as the upper regions in the Alps, Pyrenees, Himalayas and Andes, and some lowland areas such as the Great Lakes in the United States, the plains of Lombardy in Italy and parts of Finland and the Netherlands) than in those where intake is normally high.

Thus, in the United States, where there is, in general, an excess of iodine in the diet, 18% of a bolus of iodine would be trapped by the thyroid on average, while in Poland, where iodine intake is relatively low, the average uptake would be about 55%. Therefore, widespread iodination of salt in iodine-deficient areas could result in a reduction by a factor of about 3 in the thyroid uptake of radioiodine after a nuclear accident.

Further, because pregnant women are frequently told not to add salt to their food, those living in countries in which iodine intakes are low and iodized salt is recommended could become relatively iodine-depleted. This could affect levels of iodine in the fetal thyroid, and might mean that both the maternal and fetal thyroid would be more avid for iodine. This important area needs careful review and was scheduled for discussion at the WHO Workshop in Brussels in July 1988.

Areas of low iodine intake also have a higher incidence of nodular goitre in the adult population (those aged 35 years and more). Such people are more likely to suffer side effects from prophylaxis with stable iodine because the iodine may stimulate the thyroid nodules to become "autonomous" (Jod-Basedow syndrome).

Special consideration also needs to be given to the effect of an iodine load on the developing fetus and the neonate, since the fetal thyroid is less able to overcome the blocking effect of stable iodine on its ability to produce thyroid hormones (Wolff-Chaikoff syndrome). Following the experience in Poland, it also seems likely that those with controlled thyrotoxicosis are at increased risk of relapse following stable iodine prophylaxis.

Stable iodine can only block the accumulation of radioiodine in the thyroid gland if it is given within an hour of the exposure. In cases of prolonged exposure, however, such as those in certain countries in eastern Europe following Chernobyl, giving the prophylaxis hours or days after the exposure has commenced may result in significant benefit if the exposure is expected to continue for several days or a longer period.

These risks need to be balanced against the risk of the induction of thyroid nodules and thyroid cancer from irradiation. The risks may be greater in the young, owing to the probably increased sensitivity of the fetal and neonatal thyroid to irradiation; the risks will be greater because of the longer life expectancy of this group.

Because thyroid cancer has a latent period of 15–35 years, and because the risk of autonomous nodule development is greatest after the age of 45, the benefits of stable iodine therapy are likely to be marginal in people over 45 years of age. A different situation may exist for people who may be exposed to higher levels of radioiodine in the workplace. They can be carefully monitored subsequently, so that any side effects can be rapidly dealt with.

The place of stable iodine in averting exposures from ingestion needs more careful consideration in the light of the new data from Poland and the USSR; preliminary results from Poland suggest that up to 70% of the dose averted had been from ingestion.

The optimum iodine formulation needs further consideration. In Poland, KI solution was used; in the USSR, KI tablets; some countries recommend potassium iodate (KIO_3) tablets. The scientific basis of the different recommendations needs further study.

The optimum doses recommended for different age groups also need reassessment. Higher doses increase the effectiveness of blocking but may also increase the risk of the later development of auto-immune thyroid disease, or of effects on the fetus or neonate.

Finally, the frequency of administration needs to be considered in some detail. A single dose resulted in adequate protection for 7–10 days in Poland. Whether a second dose or daily doses are necessary depends to a large extent on the level and duration of exposure. This could perhaps best be assessed by monitoring the thyroid doses being received by the population.

There has been some concern that a very high dose of iodine, given in the third trimester of pregnancy, might result in an increased incidence of neonatal hypothyroidism, following some studies in India. In general, however, it is now accepted that the stable iodine actually had a beneficial effect on the development of fetuses in iodine-deficient areas; administration of the bolus of stable iodine reduced the high incidence of cretinism due to iodine-deficiency in these areas.

Very high doses of iodine can cause transient hypothyroidism, as does amniography.

Transient hypothyroidism is, however, easy to manage. It is unlikely to be accompanied by any long-term side effects, if the possibility of their occurrence is considered. Therefore, this possibility alone is not a contraindication for prophylaxis.

Public information

People perceive the risks associated with exposure to radiation — as they do other risks — in a way determined by a combination of their intellectual judgement, beliefs and emotions. Inevitably, unspecified fears play a larger role in the public perception of risks associated with genetic effects. This might be because people cannot sense radiation directly, but recognize that it can have harmful effects both on the individual and on unborn children. People's perception of risks from radiation may also be influenced by the fact that nuclear technology is a fairly recent development: newer risks may be viewed differently from those of long standing. As a result, the perceived risk of radiation exposure is often greatly exaggerated.

People should learn about the actual risks associated with the uses of nuclear energy. Educational material should deal with the risks associated with both normal and emergency operations, and should include information on the basic principles of radiation and radiation protection. Groups with particular responsibilities in the area should also receive more detailed information on these subjects. These include national authorities, politicians responsible for radiation protection at national and subnational levels, and the mass and specialist media.

International organizations with responsibilities in nuclear safety and radiation protection have a clear duty to provide both general and specific background information. National authorities in Member States could use such material in their own information programmes, suitably adapted to their needs. WHO is in a strong position, as the international health authority, to encourage such activities.

Building a better general understanding of nuclear risks in the public is only a part of what needs to be achieved if people are to be enabled to respond more rationally to a future emergency. Equally or even more important is the way in which the authorities should present information if an accident occurs.

The responsibility for transmitting information rests with both public authorities and the mass media. The authorities should take and retain the initiative in communicating with the public in the event of a nuclear emergency. Communication within the government should be well coordinated, and the authorities should seek to establish a climate of trust with the media, which should handle the information given in an open and unambiguous manner. To achieve these objectives, the national authorities responsible for the various aspects of radiation protection should coordinate their actions as far as possible. This coordination should extend to the provision of information to the public, as already underlined in this report.

If relations with the national authorities are sufficiently well developed, the mass media may feel less inclined to seek opinions from so-called experts, who have no specific responsibility for the management of a nuclear emergency, but are all too ready to give their subjective observations, very often without adequate background information.

The responsibility borne by national authorities is shared by international organizations. Diverse interpretations from these organizations of the potential public health consequences of an accident could seriously confuse the public, and create difficulties for national authorities.

Questions about the information to be given to the public in the event of a nuclear emergency should be explored further, taking into account the experience gained in the aftermath of the Chernobyl accident, developments in communication theory, studies of risk perception and other factors.

CONCLUSIONS AND RECOMMENDATIONS

Criteria for the control of levels of radionuclides in food and drink

1. An area of particular public concern in health protection is the criteria used to control the levels of radionuclides in food and drink after a nuclear accident.

2. A distinction was made between levels derived from principles for the protection of public health from radiation and those based on food control laws and recognized principles for international trade. These approaches are complementary, not contradictory, because the approach used to facilitate international trade would also result in levels compatible with the protection of health.

3. The WHO document giving guidelines for derived intervention levels for food *(16)* is a useful basis for a harmonized approach to the setting of national intervention levels to protect health in areas far removed from a nuclear accident. The Working Group made the following comments on the document.

(*a*) Infants and children form a particularly vulnerable group. Age-specific risk factors, dose conversion factors and food consumption data should therefore be applied. Although the WHO guideline values take account of some of these factors when considering population exposures, this aspect could usefully be made clearer in the document and might need further consideration.

(*b*) It is reasonable to calculate intervention levels in food based on an effective dose equivalent commitment of 5 mSv for the first year following a nuclear accident. National authorities in countries distant from an accident, however, and particularly those in countries with no direct deposition of radionuclides, would be likely to find it possible and desirable to keep the actual levels of exposure of their populations below 5 mSv.

(*c*) Exposures from food and drink in the second and subsequent years after a nuclear accident are likely to be lower than in the first year. The concept of aiming to keep the doses received from the second to the sixth year within a total of a further 5 mSv might provide a useful general framework for decision-making. Further guidance on this point from ICRP and other relevant international bodies would be helpful, after a more detailed examination of the relevant factors.

(*d*) Beyond this period, it would be likely that the ICRP dose limitation system for normal situations could be applied.

(*e*) The WHO Regional Office for Europe should develop emergency values, appropriate for European conditions, that can be recommended for use immediately after an accident, before the full extent of the accident is known or sufficient monitoring data are available, to permit the development of accident-specific advice. These values should be based on the WHO guideline values and take account of other international developments, such as the values under discussion by the CEC.

(*f*) The WHO document suggested a harmonized approach to the setting of intervention levels for food. Nevertheless, this approach could result in different actions being required in individual countries or even within a single country, because of possible variations in the levels of deposition and in dietary patterns in different areas. For example, two lakes in Switzerland were affected to markedly different extents; as a result, fishing was still forbidden in Lake Lugano, while Lake Maggiore, 30 km to the west, was hardly affected at all.

(*g*) Therefore, internationally agreed levels of radionuclides are also needed for food traded between countries. Account needs to be taken of the concerns of countries without direct deposition of radionuclides, but the levels could still be developed within a harmonized approach. The FAO report *(8)* addressed this important problem.

4. The discussions between FAO and WHO, following the meeting of the WHO Executive Board in January 1988, were welcomed. It was hoped that these would lead, *inter alia*, to joint proposals for presentation to the FAO/WHO Codex Alimentarius Commission.

Revision of WHO guidelines on nuclear accident response

5. Many accident-specific factors need to be taken into account in making decisions for the protection of the people living close to the site of a nuclear accident. Although ICRP and other international bodies developed general principles before the Chernobyl accident, final decisions on necessary action will greatly depend on local factors and must be made by the national authorities, who have the ultimate responsibility.

6. The WHO Regional Office for Europe should revise its two earlier publications on accidental releases *(13,15)*, with special reference to areas distant from the site of a nuclear accident. This work should take full account of the activities of ICRP, IAEA and other international bodies.

7. The revision should also include further guidance to public authorities on conditions in areas near the site, including advice on the medical management of people with acute radiation effects.

Rapid exchange of information

8. As shown by the experience gained after the Chernobyl accident, the WHO Regional Office for Europe should strengthen its ability to provide urgent public health advice on matters related to nuclear accidents. For this purpose, the Regional Office, in collaboration with other international

organizations, should be equipped with appropriate facilities for the rapid collection, collation, analysis and dissemination of relevant data and information, including details of actions taken in Member States to protect the health of the public.

9. Member States should establish focal points in their national public health administrations to liaise with the Regional Office in the event of a nuclear accident. The Regional Office should also be kept informed about the structure of national emergency systems relating to nuclear accidents.

10. The structure and content of standard forms for the collection of basic data related to nuclear emergencies should be coordinated among the different international organizations concerned.

11. International organizations should secure, to the highest degree possible, comparability of data. This is particularly important in the taking of samples for radiological measurements, measurement procedures and reporting practices. Appropriate training should be ensured for all personnel involved in monitoring and associated activities.

Informing the public

12. The public and bodies responsible for public health need to be informed of and educated in the basic principles of radiation and radiation protection. WHO should consider ways of encouraging such activities.

13. The public should receive open and unambiguous information from both national and international bodies in case of a nuclear emergency. The authorities should take and retain the initiative in communicating with the public in such periods. The modes of improved policies on public health information might be appropriately discussed at a meeting convened by the WHO Regional Office for Europe.

Stable iodine prophylaxis

14. The rationale for possible iodine prophylaxis should be evaluated and the potential side effects considered. Ways of applying such prophylaxis in the event of a nuclear accident should be described, and the WHO Regional Office for Europe was asked to convene a meeting to develop practical guidelines.

Epidemiology

15. One of the important issues for epidemiological studies following the Chernobyl accident is to evaluate the possible effects of low doses of

radiation on health. Follow-up studies of the evacuees and others in the region of the accident are a unique opportunity to examine health effects.

16. The WHO Regional Office for Europe and IARC play a valuable and continuing role in facilitating cooperation in the epidemiological studies in and beyond the USSR after the accident at Chernobyl. Following the resolution of the thirty-seventh session of the WHO Regional Committee for Europe (Annex 2) that requested the Regional Director to establish a coordinating mechanism for epidemiological studies, the Working Group welcomed the statement that the Regional Office, with IARC, would provide a joint secretariat for the scientific steering group. It was recognized that the work of the steering group would essentially be of a long-term nature.

17. It was considered important that some basic funding for the steering group be made available through the WHO Regional Office for Europe and IARC on a continuing basis, but it was recognized that additional financial and other support might appropriately be secured through the active cooperation of Member States, scientific institutions and other sources.

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