Assessments by International Organizations

WHO Reports (1/4)
Outline of the WHO's Dose Assessment

Purpose

- To identify areas requiring emergency measures in response to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS
- To estimate exposure doses for the first one year after the accident for that purpose
- To assess health risks of people in Japan and the whole world based on the estimated doses

Assessment method

- Set conservative conditions for dose estimation and assess exposure doses
- Estimate doses both from internal and external exposure
- Estimate exposure doses by age (one year old (infants), 10 year old (children), and 20 years old (adults)) and by area

The WHO is an organization responsible for assessing health risks posed by radiation in an emergency. Therefore, after the accident at TEPCO's Fukushima Daiichi NPS, it conducted assessment of exposure doses for the first one year regarding people in Japan and the whole world for the purpose of identifying areas and groups of people for which emergency measures should be taken.

The WHO assessed doses due to exposure to radiation via four pathways: (i) external exposure from the ground surface, (ii) external exposure from radioactive plumes (p.29 of Vol. 1, "Effects of Reactor Accidents"), (iii) internal exposure through inhalation, and (iv) internal exposure through ingestion. Doses due to external exposure via (i) and (ii) and internal exposure via (iii) were estimated through simulation based on information on contamination density on the soil surface as of September 2011, while doses due to internal exposure via (iv) were estimated based on the measurement values for foods and drinking water.

People's exposure doses are to be calculated by summing up estimated values for (i) to (iv), but in order to avoid underestimation, the WHO set conservative assumptions and calculated the largest exposure doses imaginable. Concretely, the WHO adopted the preconditions that protective measures such as deliberate evacuation, sheltering indoors, or shipping restrictions on foods were not at all taken.

As exposure doses vary by area and age, the WHO estimated doses by dividing areas into Fukushima Prefecture, neighboring prefectures (Chiba, Gunma, Ibaraki, Miyagi and Tochigi Prefectures), the rest of Japan, neighboring countries and the rest of the world, and by dividing people by age into those aged one year old (infants), 10 years old (children), and 20 years old (adults) at the time of the accident.

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WHO Reports (2/4) Effective Dose Estimation Method

Key points of effective dose estimation

- Doses due to internal exposure through inhalation and external exposure were calculated based on the measurement data concerning radionuclides deposited on the ground surface.
- Doses due to internal exposure through ingestion were calculated based on the measurement data concerning foods.
- The 20 km-zone from the NPS was excluded.
- For Deliberate Evacuation Areas, people were assumed to have stayed there for four months after the accident.

Exposure pathways

All major exposure pathways were taken into consideration.

- External exposure from groundshine*1
- External exposure from cloudshine*2
- Internal exposure through inhalation
- Internal exposure through ingestion

The key points of the WHO's effective dose estimation method are as follows.
· Doses due to internal exposure through inhalation and external exposure in Japan were calculated based on the data for measured concentrations of radionuclides deposited on the ground surface.
· Doses due to internal exposure through ingestion in Japan were calculated based on the data on measured concentrations of radionuclides in foods.
· For the 20 km-zone from Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, dose estimation was not conducted as people evacuated therefrom immediately after the accident.
· Regarding Namie Town, Iitate Village and Katsurao Village, which were designated as Deliberate Evacuation Areas, dose estimation was conducted assuming that people stayed in these areas for four months after the accident without taking into account evacuation or other measures actually taken.

The WHO assumed four exposure pathways, namely, external exposure from (i) groundshine*1 and from (ii) cloudshine,*2 and internal exposure through (iii) ingestion of foods and drinking water and through (iv) inhalation.

For external exposure, doses were estimated as 60% of those to be received when being outdoors all day long under the assumption that people stay indoors for 16 hours a day.

*1: Groundshine: External exposure from radionuclides deposited on the ground
*2: Cloudshine: External exposure from radionuclides in radioactive plumes (p.29 of Vol. 1, "Effects of Reactor Accidents")

[Relevant parts in the reports]
· WHO Report on preliminary dose estimation (prepared based on Figure 5 on page 25)
· WHO Report on health risk assessment, FAQ (Q.4)
· WHO Report on preliminary dose estimation, FAQ (latter half of Q.3)
· WHO Report on preliminary dose estimation (pages 38 and 86)

Included in this reference material on March 31, 2015

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WHO Reports (3/4) Summary of Health Risk Assessment

Assumptions for risk assessment

- Assuming that there is no threshold dose for radiation carcinogenesis, the linear model and the linear quadratic model were adopted for dose-response relationships for solid cancer and leukemia, respectively.
- Dose and dose-rate effectiveness factors (DDREF) were not applied.

Results

- People's exposure doses were below all thresholds of deterministic effects.
- Even in the area where the highest exposure dose was estimated, no significant increase would be observed in risks of childhood thyroid cancer and other types of cancer or leukemia and increased incidence of these diseases exceeding natural variation is hardly expected.
- Risks of hereditary effects due to radiation exposure are further smaller than the risks of generating cancer.
- The results suggest that increases in the incidence of diseases attributable to the additional radiation exposure are likely to remain below detectable levels.

Conclusion

- Values in this Report are for roughly ascertaining current risk levels and are not intended to predict future health effects.

The WHO's health risk assessment was conducted for the purpose of examining the scopes of people to be subject to health management and diseases whose incidence should be monitored. This assessment was based on exposure doses estimated under considerably conservative assumptions in order to avoid underestimation. Accordingly, resulting values in this Report are for roughly ascertaining current risk levels and are not intended to predict future health effects.

[Relevant parts in the reports]
WHO Report on preliminary dose estimation (Tables 3 and 4 on pages 40 to 47)
WHO Report on health risk assessment (pages 8 and 92 to 93, and Table 43 on page 156)

Included in this reference material on March 31, 2015

WHO Reports (4/4)
Evaluation of Uncertainties

- Uncertainties concerning the estimation of radioactive concentrations in the air based on measured values of radionuclides deposited on the ground surface
- Uncertainties concerning compositions and chemical forms of radionuclides
- Uncertainties due to a lower assumption of shielding effects of buildings
- Uncertainties in internal dose coefficients due to unique metabolism of radioactive materials in Japanese
- Uncertainties concerning information on release of radioactive materials (source terms) and the Atmospheric Transport and Dispersion Model (ATDM) simulation
- Uncertainties due to assumptions for dose estimation for exposure through ingestion of foods

The WHO mainly explains as follows regarding the uncertainties in the results of effective dose estimation.

• Estimating radioactivity concentrations in the air based on the amounts deposited on the ground surface involves uncertainties. For example, the chemical form of iodine influences the deposition rates, which causes a significant uncertainty in the estimation of exposure doses through inhalation. Additionally, compositions of radionuclides, such as percentages of I-131 and Cs-137, differ by area and this is also a source of uncertainties.

• Dose assessment was conducted assuming wooden houses, whose shielding effects are weaker than those of buildings made of concrete. This is one of the sources of uncertainties that might result in overestimation.

• When estimating internal exposure, dose coefficients (doses due to the intake of 1 Bq in the body) specified by the International Commission on Radiological Protection (ICRP) were used. However, Japanese people take in a lot of marine products and are said to have relatively larger amounts of stable iodine in the body. If this is the case, even if they take in radioactive iodine temporarily, the amount of radioactive iodine entering the thyroid would be smaller. However, such possibility was not taken into consideration and this is also one of the sources of uncertainties.

• Internal exposure through the intake of foods was estimated under assumptions that might lead to overestimation, such as that people had eaten only foods produced in Fukushima Prefecture and neighboring prefectures, which also causes uncertainties.

[Relevant parts in the reports]

• WHO Report on preliminary dose estimation (4.7 "Main sources of uncertainty and limitations" on pages 60 to 62, and 2.6.1 "Ingestion doses inside Japan" on pages 31 to 33)

Included in this reference material on March 31, 2015