

Research Report (Summary)
Research on Thyroid Gland Examinations, etc. of Workers at the TEPCO
Fukushima Daiichi Nuclear Power Plant

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Summary of the Research

Among all workers engaged in emergency work at the TEPCO Fukushima Daiichi Nuclear Power Plant (emergency workers), we selected an exposed group (emergency workers exposed to radiation exceeding a thyroid equivalent dose of 100mSv [equivalent to an effective dose of 5 mSv]) and collected the results of their ultrasonic examinations of the thyroid gland. Additionally, we set a control group (thyroid equivalent dose of 100 mSv or less; workers with as low exposure dose as possible) and conducted an ultrasonic examination of the thyroid gland by setting criteria based on the thyroid nodule (mass) ultrasonic diagnostic standard, which is adopted for health checkups being conducted in Fukushima Prefecture. We compared the examination results between the exposed group and the control group.

Upon making a comparison, we reviewed various parameters applied by TEPCO and the contractors in the process of calculating committed effective doses mainly for the purpose of managing the health of their workers, and recalculated the results to obtain more realistic thyroid equivalent doses. Furthermore, with regard to workers who are registered with the Radiation Dose Registration Center for Workers, we received data on their cumulative doses prior to the accident from the center.

We conducted the ultrasonic examination of the thyroid gland for 627 examinees in the exposed group (out of 1,972) and 1,437 examinees in the control group mainly between January and March 2014. Comprehensive judgment for the 627 examinees in the exposed group and the 1,462 examinees in the control group was as follows. Those judged to be normal (level A1) numbered 320 (51.0%) for the exposed group and 907 (63.1%) for the control group; those for whom a secondary examination was judged unnecessary (level A2) numbered 239 (38.1%) for the exposed group and 392 (27.3%) for the control group; those to whom a secondary examination was recommended (level B) numbered 67 (10.7%) for the exposed group and 136 (9.5%) for the control group; and those for whom a secondary examination was judged necessary (level C) numbered one (0.2%) for the exposed group and two (0.1%) for the control group. By age group, there were higher percentages of older examinees for whom a secondary examination was judged unnecessary (level A2) and to whom a secondary examination was recommended (level B) for both the exposed group and the control group.

We re-evaluated the results for 982 examinees, excluding 1,082 who had no possibility of internal exposure as they did not engage in emergency work or they had no possibility on other grounds and had no record of committed effective doses. Reliability distribution (reliability level A is the most reliable) was 65 for reliability level A, 238 for reliability level B, 445 for reliability level C, and 234 for reliability level D. Based on this, we estimated thyroid equivalent doses.

Comparing the workers by re-evaluated doses, the percentage of those to whom a secondary examination was recommended (level B) was relatively higher for examinees with high doses, but this was not statistically significant. On the other hand, the percentage of those for whom a secondary examination was judged unnecessary (level A2) was higher for examinees with high doses, and this was statistically significant. The same result (the percentage of those for whom a secondary examination was judged unnecessary (level A2) was higher for examinees with high doses) was obtained when limiting the analysis to the examinees who have not received an ultrasonic examination of the thyroid gland before or when excluding from the analysis the examinees whose evaluated thyroid equivalent doses due to internal exposure are less reliable. From now on, we will endeavor to collect and analyze the results of detailed examinations for examinees in whom an abnormality was detected in this screening for both the exposed group and the control group, and will also endeavor to collect and analyze the results of previous ultrasonic examinations of the thyroid gland of examinees in the exposed group.

A. Purpose

For the long-term health care of workers at the TEPCO Fukushima Daiichi Nuclear Power Plant, health checkups, etc. depending on workers' effective doses are being conducted by relevant business operators based on the Guidelines on Maintaining and Improving the Health of Emergency Workers at the TEPCO Fukushima Daiichi Nuclear Power Plant (hereinafter referred to as the "MHLW Ministerial Guidelines"). In the meantime, in addition to health checkups based on the MHLW Ministerial Guidelines, TEPCO decided to independently conduct ultrasonic examinations of the thyroid gland, focusing on 1,972 emergency workers exposed to radiation exceeding a thyroid equivalent dose of 100 mSv (equivalent to an effective dose of 5 mSv), to utilize the results thereof for their health care. Considering the age of the workers being focused on (average age: 44.0 years), an ultrasonic examination is expected to detect certain symptoms at a certain percentage. In order to examine the correlation between radiation and the thyroid gland examination results, the same examinations need to be conducted for workers whose thyroid equivalent doses are relatively low to make comparisons.

Therefore, in this research, we set a control group (thyroid equivalent dose of 100 mSv or less; workers with as low an exposure dose as possible) that is comparable to the emergency workers exposed to radiation exceeding a thyroid equivalent dose of 100 mSv (exposed group) and conducted

the same examinations to compare the results thereof, thereby analyzing the effects of radiation exposure on the thyroid gland epidemiologically, with the aim of evaluating the analysis results in terms of radiation effects and from the viewpoint of the thyroid gland clinical medicine.

B. Methods

1. Study subjects

As the exposed group, we selected emergency workers exposed to radiation exceeding a thyroid equivalent dose of 100 mSv (equivalent to an effective dose of 5 mSv) (1,972 workers in total [employees of TEPCO: 976; employees of contractors: 996]). As the control group, we selected workers, mainly employees of TEPCO (including office workers), whose thyroid equivalent doses were 100 mSv or less in principle, and from those with as low an exposure dose as possible. Considering the number of subjects in the exposed group by age group, we intended to select 2,000 workers for the control group.

2. Ultrasonic examination of the thyroid gland

We conducted an ultrasonic examination of the thyroid gland for the focused on workers and classified them into levels A1, A2, B and C depending on the presence/absence and the size of nodules or cysts, while referring to the thyroid nodule (mass) ultrasonic diagnostic standard, which is adopted for health checkups being conducted in Fukushima Prefecture. When it was difficult to determine into which level an examinee should be classified, the final judgment was made by the separately established judging panel through deliberations on image data or printed images of the relevant examinations. The results of the judgment were sent by mail to examinees classified into level A1 or A2 with necessary explanations. For those classified into level B or C, we sent the results by mail and recommended that they have detailed examinations within the framework of their health insurance. We obtained copies of the detailed examinations (test results of the free T3, free T4, TSH, anti-thyroglobulin antibody, anti-thyroid peroxidase antibody, etc.) to the extent possible, with the consent of the relevant examinees, to use such data for reference in making analysis.

3. Collection of data concerning confounding factors, etc.

When conducting the ultrasonic examination, we asked the examinees to fill in a questionnaire concerning (i) their height and weight; (ii) medical history; (iii) family medical history (occurrence of any thyroid diseases); (iv) history of medical exposures (experiences of CT scanning of the head and neck or the chest; if any, the number of times scanned, etc.); (v) lifestyle habits (alcohol/tobacco consumption); (vi) experience of receiving ultrasonic examinations of the neck for thyroid diseases. Furthermore, as basic attributes, we confirmed their name, address, and age.

4. Ascertaining and re-evaluation of exposure doses

We obtained data on thyroid equivalent doses resulting from the emergency work for both the exposure group and the control group from TEPCO and the contractors, and also obtained data on cumulative doses under normal conditions prior to the accident for examinees who are registered with the Radiation Dose Registration Center for Workers, with the consent of the relevant examinees, from the Radiation Effects Association. We examined the validity of the methods employed in estimating thyroid equivalent doses (measurements using thyroid monitoring, estimates based on neck measurements using a survey meter, estimates based on Cs-137 measurements using a whole body counter, etc.) and information relating to the results thereof that we obtained from TEPCO and the contractors. We also reviewed various parameters applied in the process of calculating committed effective doses and recalculated the results to obtain more realistic thyroid equivalent doses.

5. Statistical analysis

For both the exposed group and the control group, we prepared separate datasets for analysis, including the age, thyroid examination result, thyroid equivalent dose, cumulative effective dose, lifestyle habits, the presence or absence of a medical history of thyroid diseases, history of medical exposures, and experience of receiving ultrasonic examinations of the thyroid gland. Then, we tested the difference in the discovery rate of thyroid nodules between the two groups by using such methods as the χ^2 test. Furthermore, in order to examine the correlation with thyroid equivalent doses, we compared the discovery rate of thyroid nodules for each group categorized depending on thyroid equivalent doses. With regard to the correlation between doses and examination results (with adjustment for age effects), we used the Cochran-Mantel Haenszel test to examine the distribution of the comprehensive judgments of the thyroid gland examination and any difference in percentages of examinees judged to be categorized into certain levels. We used the statistical package SAS 9.3 for the analysis.

6. Ethical considerations

The research team provided the selected workers with explanations on the outline of the research in writing and obtained their consent for participation in the research. The research team also explained in writing that data for exposure dose control are to be utilized in addition to image data. If there are any findings requiring detailed examinations, we have recommended the relevant examinees receive detailed examinations at medical institutions under their health insurance and have collected from medical institutions the results of these detailed examinations for those who have given their consent.

Personal information of the selected workers is being properly managed by the research secretariat

(Jichi Medical University) under an environment inaccessible from outside, while we have been working on collected data. The research secretariat added research IDs to the data to make them anonymous in a linkable fashion and personal data were managed at research institutions by using said research IDs (Chart). Survey slips and questionnaire sheets that contain personal information are to be disposed of immediately after completing the research. When we publicize any data we have obtained, we will give due consideration to ensure that individuals are not identified and perform statistical processing as required in advance. Since commencing this research, we have strictly observed the Ethical Guidelines for Clinical Studies and the Ethical Guidelines for Epidemiological Studies and obtained approval of the ethics committees at Osaka University, Jichi Medical University, the Japan Atomic Energy Agency (which outsourced the research to Osaka University), and the National Institute of Radiological Sciences.

C. Results

1. Characteristics of the study subjects

The number of workers who gave consent and received the examinations was 2,064 in total (627 in the exposed group and 1,437 in the control group). The percentage of workers in the exposed group who received the examinations was 31.8% (Table 1). The percentage of employees of contractors who received the examinations was very low at 2.2%, compared with 62.0% for such employees of TEPCO. As the control group, a total of 1,437 workers received the examinations, out of which 1,300 were employees of TEPCO. Many of them received health checkups at the TEPCO head office (471), Fukushima Daini NPP (697), or Kashiwazaki-Kariwa NPP (834), while the remaining 62 directly visited medical institutions to receive health checkups (Table 2). At first, we expected that a total of 1,972 workers in the target group would participate in the research and held briefing sessions in three districts, and the secretariat also endeavored to increase participants. However, the final number of participants remained at 672, about one-third of the initial plan. Incidentally, one person in the control group and three in the exposed group were willing to receive the examinations but they did not give their consent to participation in the research. The following are the examination results for the 1,437 examinees in the control group and the 627 examinees in the exposed group who have given consent to the participation.

Age distributions were almost the same for the exposed and the control groups, with the average age being 43.0 for the former and 41.7 for the latter (Table 4-a). All examinees were males.

2. Ultrasonic examination of the thyroid gland

A cyst was detected in 253 examinees in the exposed group and in 426 examinees in the control group, showing a significantly larger percentage for the exposed group ($p < 0.001$). The maximum dimension (average: mm) was 4.8mm for the control group and 4.2mm for the exposed group. A

nodule within a cyst was detected in 45 examinees in the control group and in 24 examinees in the exposed group, and the maximum dimension (average: mm) was 6.6mm for the control group and 3.3mm for the exposed group.

A nodule was detected in 92 examinees in the exposed group and in 173 examinees in the control group, so relatively more frequent in the exposed group ($p=0.07$). The maximum dimension (average: mm) was 9.3mm for the control group and 9.7mm for the exposed group.

Comprehensive judgment for the 627 examinees in the exposed group and the 1,437 examinees in the control group was as follows. Those judged to be normal (level A1) numbered 320 (51.0%) for the exposed group and 907 (63.1%) for the control group (Table 5-a); those for whom a secondary examination was judged unnecessary (level A2) numbered 239 (38.1%) for the exposed group and 392 (27.3%) for the control group; those to whom a secondary examination was recommended (level B) numbered 67 (10.7%) for the exposed group and 136 (9.5%) for the control group; and those for whom a secondary examination was judged necessary (level C) numbered one (0.2%) for the exposed group and two (0.1%) for the control group. By age group, there were higher percentages of older workers for whom a secondary examination was judged unnecessary (level A2) and to whom a secondary examination was recommended (level B) for both the exposed group and the control group (Table 5-c3, Table 5-c4, Table 5-c5, Table 5-c6).

Regarding smoking habits, smokers had a relatively large number in the exposed group, while there was no big difference between the exposed group and the control group in terms of drinking habits (Table 6-a, Table 6-c4, Table 6-c6, Table 7-a, Table 7-c4, Table 7-c6). No difference in percentage was observed between the exposed group and the control group with regard to having experienced CT scanning (Table 8-a, Table 8-c4, Table 8-c6), but the percentage of workers who had received ultrasonic examinations was extremely high, at 56.9%, for the exposed group, compared with 5.6% for the control group (Table 9-a). This tendency was common both in workers of the contractors and of TEPCO (Table 9-b). There was no difference by age in the percentage of workers who had received ultrasonic examinations in the exposed group, while in the control group, the percentage was relatively higher for older workers (Table 9-c4, Table 9-c6).

3. Re-evaluation of exposure doses

We reviewed various parameters applied by TEPCO and contractors in the process of calculating committed effective doses mainly for the purpose of managing the health of their workers, and we recalculated the results to obtain more realistic thyroid equivalent doses.

Nuclides detected from the bodies of emergency workers were ^{134}Cs , ^{137}Cs , ^{131}I and $^{132}\text{Te}/^{132}\text{I}$, but in evaluating thyroid equivalent doses due to internal exposure in this research, we decided to focus only on ^{131}I , which contributes most significantly to thyroid equivalent doses. In cases where measured values of ^{131}I were obtained from the results of the thyroid monitoring (measurement of

the thyroid gland using a thyroid monitor or a NaI scintillation survey meter) or the whole body monitoring using a whole body counter (WBC), which were conducted after engaging in the emergency work, we evaluated the intake of ^{131}I based on said measured values. In cases where measured values of ^{131}I were not obtained from these results, we estimated thyroid equivalent doses by way of estimating the intake of ^{131}I based on the WBC detection limit of ^{131}I or on the measured values of ^{137}Cs and the intake ratio of $^{131}\text{I}/^{137}\text{Cs}$. As the contribution of external exposure to thyroid equivalent doses, we added up doses resulting from engaging in the emergency work after the accident and doses resulting from other radiation work, including the previous work, up to 31 March 2013.

Depending on the reliability of the results, we made classifications as follows: reliability level A, measurements of ^{131}I in the thyroid gland using a thyroid monitor; reliability level B, measurements of the thyroid gland using a NaI survey meter or measurements of ^{131}I in the whole body using a NaI-WBC; reliability level C, estimation based on minimally detected activity (MDA) of ^{131}I or the results of ^{137}Cs using a NaI-WBC and the intake ratio of $^{131}\text{I}/^{137}\text{Cs}$; and reliability level D, estimation based on the results by a PI-WBC and the ratio of I/Cs, or estimation based on data of workers engaged in the same type of work.

We re-evaluated the results for 982 examinees, excluding 1,082 who were free from the possibility of internal exposure as they did not engage in the emergency work or who were excluded on other grounds and have no record of committed effective doses. The numbers of workers for the reliability distribution were: 65 for reliability level A; 238 for reliability level B; 445 for reliability level C; and 234 for reliability level D. Based on this, we estimated the respective thyroid equivalent doses (Table 10-a1, Table 10-a2).

4. Comparison of examination results by dose group

We classified the examinees into six groups depending on their thyroid equivalent doses (units of mSv: 0-50, 51-100, 101-200, 201-500, 501-1000, and more than 1000), and we analyzed the correlation between doses and comprehensive judgment after making adjustment for age. As a result, significant correlation was observed between doses and comprehensive judgment ($p=0.0003$) (Table 10-c1-1, Table 10-c2-1). Significant correlation was also observed between doses and the percentage of those for whom a secondary examination was judged unnecessary (level A2) ($p=0.0002$) (Table 10-d4, Table 10-d5), but not between doses and the percentage of those to whom a secondary examination was recommended (level B) (Table 10-d6, Table 10-d7) or those for whom a secondary examination was judged necessary (level C) (Table 10-d8, Table 10-d9) ($p=0.1904$ or 0.5073).

When limiting the analysis to the examinees who have not received an ultrasonic examination of the thyroid gland before, correlation between thyroid equivalent doses (6 groups) and comprehensive judgment was significantly different even after age adjustment ($p=0.0295$) (Table 10-g10), and the

percentage of those for whom a secondary examination was judged unnecessary (level A2) was significantly higher for those whose doses were higher ($p=0.0018$) (Table 10-g13, Table 10-g14). On the other hand, no significant correlation was observed between doses and the percentage of those to whom a secondary examination was recommended (level B) or those for whom a secondary examination was judged necessary (level C) ($p=0.9704$ or 0.5441) (Table 10-g15, Table 10-g16, Table 10-g17, Table 10-g18). When conducting an analysis by excluding the examinees whose results of internal exposure evaluation are extremely unreliable (classified into reliability level D), significant correlation was observed between doses and examination results ($p=0.0002$) (Table 10-h1), and the percentage of those for whom a secondary examination was judged unnecessary (level A2) was significantly higher for those whose doses were higher ($p=0.0003$) (Table 10-h4, Table 10-h5). However, the percentage of those to whom a secondary examination was recommended (level B) or those for whom a secondary examination was judged necessary (level C) did not increase significantly irrespective of doses ($p=0.1428$ or 0.4741) (Table 10-h6, Table 10-h7, Table 10-h8, Table 10-h9).

Furthermore, when limiting the analysis to the examinees classified into reliability levels A to C (other than reliability level D) who have not received an ultrasonic examination of the thyroid gland before (Table 10-h10), significant correlation was observed between doses and examination results or the percentage of those for whom a secondary examination was judged unnecessary (level A2) ($p=0.0119$ or 0.0009) (Table 10-h13, Table 10-h14), but not between doses and the percentage of those to whom a secondary examination was recommended (level B) or those for whom a secondary examination was judged necessary (level C) ($p=0.8702$ or 0.5627) (Table 10-h15, Table 10-h16, Table 10-h17, Table 10-h18).

Tables indicated in parentheses correspond to the respective tables in the research report titled “Epidemiological Studies on Thyroid Gland Examinations, etc. of Workers at the TEPCO Fukushima Daiichi Nuclear Power Plant” (by Tomotaka Sobue, Shinji Yoshinaga and Kazutaka Doi).

D. Discussion

1. Interpretation of the results

In this research, we set an exposed group (emergency workers exposed to radiation exceeding a thyroid equivalent dose of 100 mSv) and a comparable control group (thyroid equivalent dose of 100 mSv or less), and conducted the same examinations to compare the results thereof, thereby analyzing the effects of radiation exposure on thyroid glands.

The results of the comprehensive judgment of the ultrasonic examination of the thyroid glands showed no difference in the percentage of those to whom a secondary examination was recommended (level B) or those for whom a secondary examination was judged necessary (level C) between the exposed group and the control group. On the other hand, the percentage of those for

whom a secondary examination was judged unnecessary (level A2) was relatively higher for the exposed group than the control group, and the analysis using the re-evaluated thyroid equivalent doses showed the same tendency in those whose doses were higher. As the percentage of workers who have received ultrasonic examinations was extremely high, at 56.9%, for the exposed group, compared with 5.6% for the control group, attention is required in interpreting these results, but the results were almost the same even when limiting the analysis to the examinees who have not received an ultrasonic examination of the thyroid gland before. From now on, we will endeavor to collect the results of the previous ultrasonic examinations of the thyroid gland for the exposed group. With regard to those whose comprehensive judgment was level B or level C, we will endeavor to collect and analyze the results of their detailed examinations on abnormalities pointed out in this screening, including their test results of the free T3, free T4, TSH, anti-thyroglobulin antibody, anti-thyroid peroxidase antibody, etc.

2. Validity of the results of dose estimation

The method of evaluating workers' doses based on the standard evaluation technique that TEPCO decided under the guidance of the Ministry of Health, Labour and Welfare is based on a conservative assumption, such as assuming a scenario that workers acutely inhaled radiation on the first day of the emergency work or considering that when measurement data such as the residual volume of ^{131}I in the thyroid gland are not available, the intake ratio of $^{131}\text{I}/^{137}\text{Cs}$ is to be the maximum value in the environmental monitoring data. Such a method is considered to be suitable for controlling personal exposure and managing health of emergency workers. In contrast, the research team adopted a more realistic method of evaluating doses, such as by determining the approximate ratio of $^{131}\text{I}/^{137}\text{Cs}$ by the least squares method within the scope of available measurement data.

This time, we tried to show the validity of the results of dose estimation in a qualitative manner in the form of the reliability of the results based on the measurement methods. However, there is room to study the necessity of adopting a more detailed quantitative approach in the future. At present, we consider that the following points need to be noted in applying the estimation results in epidemiological studies. Reliability level A: these are realistic evaluation results based on an individual's measurement data necessary for dose evaluation and they are suitable for being applied in epidemiological studies. Reliability level B: these are the results of realistic evaluations based on limited measured values, and their application in epidemiological studies is appropriate. Reliability level C: as these are the results of estimations within the scope of limited measured values under an assumption based on the environmental monitoring data, etc. and they contain the possibility of considerable uncertainty, it should be noted that considerable uncertainty is involved in applying them in epidemiological studies. Reliability level D: as these include cases where considerable uncertainty is involved in the estimation and estimation results based on an assumption that, in the

absence of measured values, doses of the relevant workers are the same as those of other workers engaged in the same work, and thus they contain extremely significant uncertainty, prudence is required for their application in epidemiological studies at the present stage.

3. Control of quality for examinations

Accuracy control is necessary for interpreting the examination results. In this research, we confirmed the following three points. First, as detection and judgment of tiny thyroid masses of 10 mm in diameter or smaller are often very important, we confirmed that the examination bodies would use ultrasound equipment and probes with high resolution performance that are suitable for thyroid gland examinations. Next, examiners must have high capacity and skills. The results of ultrasound examinations highly depend on the capabilities of technicians and doctors and vary significantly depending on whether they are skilled or not, even if the same equipment is used. Therefore, we demanded that examiners should be technicians who are registered medical sonographers (in the field of body surface or health checkups) certified by the Japan Society of Ultrasonics in Medicine or who have experience and capabilities equivalent thereto. Furthermore, in order to confirm each person's capabilities, we required the candidates to obtain a certain score in a test of ultrasonic imaging prepared by the accuracy control committee of the research team. The third point is the judgment criteria for examinations. When conducting ultrasonic examinations focusing on a large number of people, judgment often varies widely depending on examiners. In this research, we prepared and used the judgment criteria (levels A1, A2, B and C), while referring to the health management survey being conducted in Fukushima Prefecture. These judgment criteria are based on the thyroid nodule (mass) ultrasonic diagnostic standard prepared by the Japan Society of Ultrasonics in Medicine and explain benign findings and malignant findings regarding the behavior of nodules, inside echoes, borders, etc. In this research, experienced clinical technicians are required to carry out examinations and are expected to have made a judgment above a certain level of reliability. However, it is sometimes difficult for even experienced doctors to correctly diagnose 10 mm in diameter or smaller cancers. Therefore, we placed emphasis on the detection of even small thyroid cancers by judging a nodule of 5.1 mm in diameter or larger as level B. It should also be noted that we judged a cyst of 20.1 mm in diameter or larger as level B, and this is because a large cyst may cause symptoms in the neck.

E. Conclusion

We estimated thyroid equivalent doses for individual workers who engaged in the emergency work at the TEPCO Fukushima Daiichi NPP, based on assumptions considered realistic at present, depending on differences in approaches to dose evaluation applied to each worker. With regard to the results classified into reliability level C or D, quantitative evaluation should be conducted carefully.

The results of the ultrasonic examination of the thyroid gland for the 627 examinees in the exposed group and the 1,437 examinees in the control group showed no difference in the percentage of those to whom a secondary examination was recommended (level B) or those for whom a secondary examination was judged as necessary (level C) between the exposed group and the control group, and the results showed no correlation with thyroid equivalent doses observed. In contrast, the percentage of those for whom a secondary examination was judged as unnecessary (level A2) was relatively higher for those whose doses were higher and the analysis using the re-evaluated thyroid equivalent doses showed the same tendency in those whose doses were higher. However, these results should be interpreted carefully taking into account any bias due to the selection of the study subjects and uncertainty in estimated exposure doses. From now on, we will endeavor to collect and analyze the results of detailed examinations for examinees in whom an abnormality was detected in this screening for both the exposed group and the control group, and we will also endeavor to collect and analyze the results of previous ultrasonic examinations of the thyroid gland of examinees in the exposed group.

F. Health Risk Information

None

G. Publication of Research Results

1. Publication of theses
2. Conference presentation

1) Sobue T, Yoshinaga S, Taniguchi N, Miyakawa M, Momose T. Thyroid Survey Plans for TEPCO Workers. The International Workshop on Radiation and Thyroid Cancer, Tokyo, Feb 21-23, 2014

H. Application and Registration of Intellectual Property Rights (including those scheduled to be registered)

1. Acquisition of patents

None

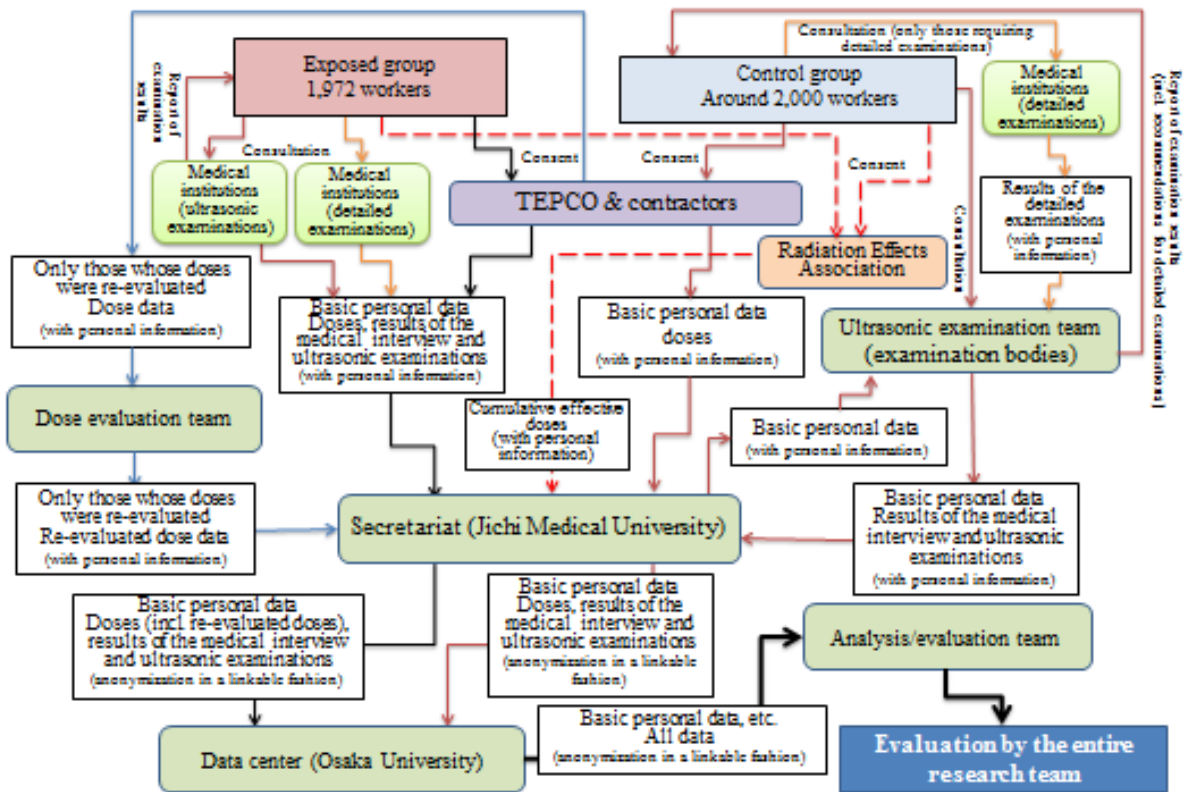
2. Registration of utility models

None

3. Others

None

Chart: Flow of Data



I. Supplement

1. Comparison of the screening results by dose level group

When examining the correlation between the comprehensive judgment and doses for the 1,189 study subjects with no prior experience of receiving ultrasonic examinations, excluding those classified into reliability level C or D (Table 10-h19 to Table 10-h27), the percentage of those for whom a secondary examination was judged unnecessary (level A2) was relatively high for those whose doses were higher, as in the case of examining the results of all 2,064 cases, and there was a significant correlation between doses and those judged as level A2 ($p=0.0161$). However, no significant correlation was observed between doses and those to whom a secondary examination was recommended (level B) or those for whom a secondary examination was judged necessary (level C) ($p=0.3714$ or 0.4063).

Furthermore, we examined the correlation between the presence/absence and the size of cysts and nodules in all 2,064 cases (Table 12-1 to Table 12-4). Cysts were not found in nearly two-thirds of them and no cyst of 20.1 mm in diameter or larger was found (0.0%). Nodules were not found in nearly 85% of the total cases, but nodules of 5.1 mm in diameter or larger were found in 9.5%. As a result of the analysis of the correlation between doses and the presence/absence and the size of cysts and nodules after age adjustment, no clear correlation with equivalent doses was judged to be found for nodules, but the incidence of relatively larger cysts seemed high for workers with high doses ($p=0.0044$). The same results were obtained by examining the correlation between the comprehensive judgment and doses for the 1,189 study subjects with no prior experience of receiving ultrasonic examinations, excluding those classified into reliability level C or D (Table 12-9 to Table 12-12).

According to the research results, the percentage of workers who had the experience of receiving ultrasonic examinations was high and the percentage of workers who received this screening was low for the exposed group, which suggests the possibility of a considerable bias in the incidence of cysts and nodules among workers with high doses. In other words, there is a possibility that workers for whom a secondary examination was judged as unnecessary (level A2) in their previous ultrasonic examinations selectively participated in this research. Further, people in whom thyroid cancer was detected as a result of ultrasonic examinations they previously received might have selectively dropped out of this research. Therefore, it would be dangerous to make a conclusion based only on the results of this research. We need to also collect and analyze data for those with high doses who did not receive this screening.

2. Re-evaluation of exposure doses

(1) Corrections in relation to the administration of stable iodine

In this research, we could not obtain data concerning whether the study subjects have taken stable iodine or, if they did so, when, for all those categorized into the exposed group. Therefore, we made no corrections to the evaluation results in relation to the administration of stable iodine. With regard to 38 workers in whom residual ^{131}I in thyroid gland could be directly detected by thyroid monitoring (classified into reliability level A) and for whom it was confirmed that they did not take stable iodine, individual differences were too large to find any correlation between the $^{131}\text{I}/^{137}\text{Cs}$ ratios and intake dates of stable iodine. This may be because we could not ascertain the timing of each individual's taking of stable iodine tablets in this research, and because the behavior of iodine

varies by individual, and whether they wore protective clothing or not also exerts an influence on such ratios.

(2) Unit of thyroid equivalent doses

We used the dose coefficient (Sv/Bq) in ICRP Publication 71 for calculating thyroid equivalent doses (Sv) due to internal exposure. Equivalent doses due to internal exposure indicate committed doses for fifty years by definition, but equivalent doses at the time of the thyroid gland examination are considered to have reached the committed doses and their application in epidemiological studies would pose no problems. The unit “Sv” of thyroid equivalent doses due to internal exposure may be replaced with the unit “Gy.”

3. Thyroid gland ultrasonic examinations

Regarding judgment on cysts and nodules, we followed the judgment criteria used for the health management survey being conducted in Fukushima Prefecture, but in evaluation of the size of a nodule within a cyst, we adopted a different method and measured the size of an inner nodule as the diameter of the nodule. Therefore, sizes of nodules within cysts classified in this research were smaller than those in the Fukushima prefectural survey and the average maximum diameter (only among those in whom nodules were detected) was 8.2 mm (8.8 mm in the Fukushima Prefectural survey) (Table 13-1 to Table 13-2).