The BiDAS-2009 : Bioassay Data Analysis Software for Evaluating a Radionuclide Intake and Dose

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1. Introduction

The BiDAS-2007[1] (Bioassay Data Analysis Software 2007) computer code was developed in 2007 by KAERI (Korea Atomic Energy Research Institute) for the purpose of estimating the radionuclide intakes and doses of a radiation worker. The BiDAS-2007 computer code enables the user to estimate the intakes of radionuclides on the basis of the bioassay measurements and the internal dosimetric parameters[2] such as the intake type (acute, chronic), the intake pathway (inhalation, ingestion), the absorption type (Type F, M, S), and the particle size(AMAD; activity median aerodynamic diameter).

However there is no function concerned with the injection of radionuclides in BiDAS-2007. In addition there is a serious problem for the evaluation logic of the Automatic mode for a chronic intake. Besides these problems, some trivial matters have been found.

To solve these problems of BiDAS-2007, the BiDAS-2009 computer code has been developed in this study. This paper describes not only the improved evaluation logic of the Automatic mode for a chronic intake but also the new and useful functions of the BiDAS-2009 computer code.

2. Methods and Results

2.1 Chronic Automatic Evaluation Mode of BiDAS-2009

The Automatic mode is based on the reconstruction of the intake on a basis of a multi-points approximation of observed trends of measurements. In other words, the intake of a radionuclide is automatically evaluated for several measurement data sets in the Automatic mode. When the chronic intakes are evaluated from two sets of bioassay measurement data that the time after an intake is different, an evaluation for the second bioassay data is depended on the result of an evaluation for the first bioassay data.

The chronic Automatic mode of BiDAS-2007 performs only two evaluation logic like as the IMIE computer code[3]. If the second bioassay measurement value is higher than the expected chronic intake retention at the second bioassay time on the basis of the chronic daily intake rate evaluated by the first bioassay measurement data, another chronic daily intake rate is evaluated after the first bioassay measurement time. Otherwise, the chronic intake rate is re-evaluated considering the two sets of bioassay measurement data, and the duration of a chronic intake is up to the second bioassay measurement time.

However if the second bioassay measurement value is not higher than the expected chronic intake retention evaluated by the first bioassay measurement data, the evaluation logic has to be divided into the four conditions as follows.

1) The 2nd bioassay data is included in the expected chronic intake retention according to the daily intake rate evaluated by the 1st bioassay data
2) The 2nd bioassay data is between the expected chronic intake retention according to the daily intake rate by the 1st bioassay data and the expected retention without any more chronic intake after the chronic intake up to the 1st bioassay measurement time
3) The 2nd bioassay data is included in the expected retention without any more chronic intake after the chronic intake up to the 1st bioassay measurement time

In the case of the 1st condition, the chronic intake rate is re-evaluated considering the two sets of bioassay measurement data and the duration of chronic intake is up to the second bioassay measurement time in the same way like BiDAS-2007. In the case of the 2nd condition, another new chronic daily intake rate is evaluated by the 2nd bioassay data. In the case of the 3rd condition, the 2nd bioassay data is regarded as the retention after the chronic intake up to the 1st bioassay measurement time and is not considered in the evaluation of chronic intake.

In a case that the thyroid bioassay data of ^{131}I are the same as Table 1 which is the 3rd condition mentioned above, the chronic intake of ^{131}I evaluated by the Automatic mode is 0.11 MBq in BiDAS-2007 and 0.22 MBq in BiDAS-2009, respectively. Figure 1 shows the result by the chronic Automatic mode of BiDAS-2007 on the basis of Table 1. In contrast, Figure 2 shows the result by the chronic Automatic mode of BiDAS-2009, 2nd bioassay data was regarded as the retention after the 1st chronic intake, on the basis of Table 1. Consequently, the chronic intake has been up to the 2nd measurement times with 2.45 kBq/d daily intake rate in BiDAS-2007. On the other hand, the chronic intake has been up to the 1st measurement times with 7.18 kBq/d daily intake rate in BiDAS-2009.

Table 1. Simulated thyroid bioassay measurement data of ^{131}I (Work start date: 2009-01-01)

Measurement date	Thyroid activity	Measurement error
2009-02-01	10 kBq	20%
2009-02-15	3 kBq	20%

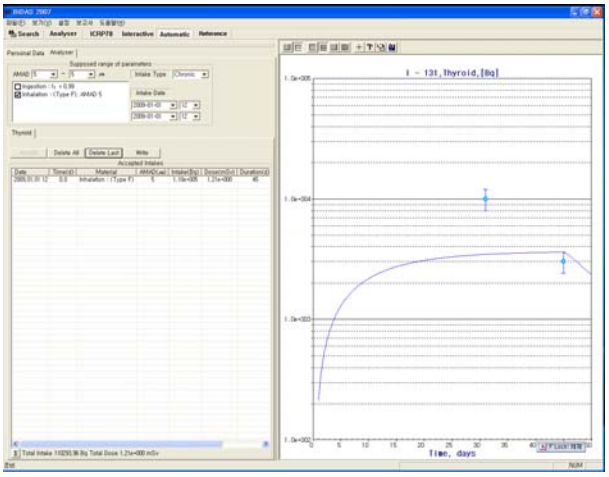

Fig. 1. Result by the chronic Automatic mode of BiDAS-2007 on the basis of Table 1.

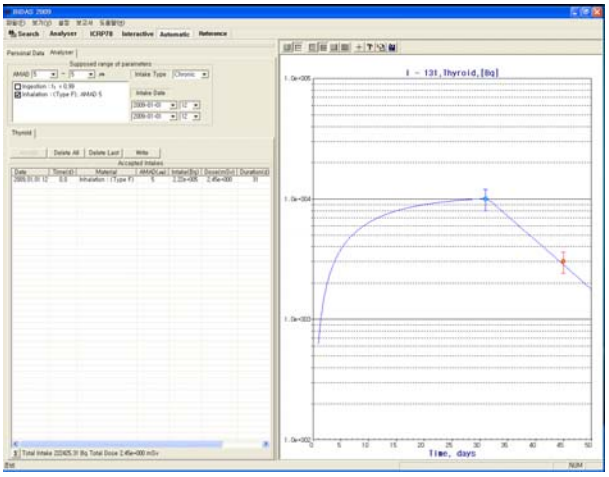

Fig. 2. Result by the chronic Automatic mode of BiDAS-2009 on the basis of Table 1.

2.2 Addition of an Injection in the Intake Pathway

The function of injection has been added to the intake pathway in the BiDAS-2009. The intake retention rates of the whole-body, thyroid, urine or feces excretion rates and the dose coefficients due to the injection of a radionuclide are expected to adopt and able to be used for the evaluation of injected intakes in the BiDAS-2009. The intake retention rates of the whole-body, thyroid and urine or feces excretion rates after an injection of radionuclides have been calculated by using the Mathcad software program. The dose coefficients in the IDEA System[4] computer code have been used as the dose coefficients for injection of radionuclides in the BiDAS-2009

2.3 Upgrade of Reference Mode and other function

The Reference mode of the BiDAS-2009 shows a half life and the committed effective dose coefficient depended on a radionuclide and several dosimetric parameters such as the intake pathway, AMAD (activity median aerodynamic diameter, and absorption type (Type F, M, S) or f_1 value as well as the intake retention fraction or excretion rate after injected intakes. Figure 3 shows the upgraded Reference mode of the BiDAS-2009.

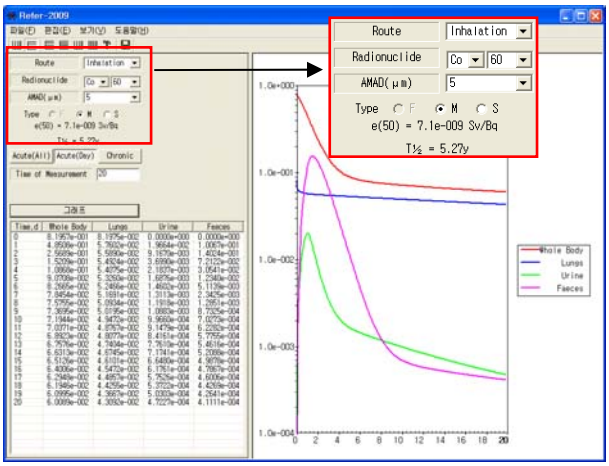

Fig. 3. Reference mode of BiDAS-2009.

Besides these, The User's Guide for BiDAS-2009 has been added to the Help mode. This User's Guide describes the outline, the functions (Data processing, Evaluation, Information processing, Reporting, Graph, Reference mode and so forth), and the verification for BiDAS-2009.

3. Conclusions

The BiDAS-2009 computer code has been developed and upgraded from the BiDAS-2007 computer code developed in 2007 by KAERI for the purpose of estimating the radionuclide intakes and doses of a radiation worker. The features of the BiDAS-2009 are the new evaluation logic for the chronic Automatic mode, the injection function of an intake pathway, the upgraded Reference mode, and the User's Guide in the Help mode. In conclusion, the BiDAS-2009 is more useful and user-friendly as well as more reliable to estimate the radionuclide intakes and doses of a radiation worker than the BIDAS-2007.

REFERENCES

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