



## Evaluation of Internal Doses for Chronic Intakes after the Fukushima Daiichi Nuclear Power Plant Accident

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### 1. Introduction

- The Fukushima Daiichi nuclear power plant accident that occurred in March 11, 2011 has resulted in the radionuclide releases to atmosphere and the contamination of large areas, drinking water and foods. The Japanese government implemented an intake restriction of water and foods as urgent protective measures.
- To identify the success of the protection strategy for an emergency exposure situation, it is required to calculate internal doses for chronic intakes to the public and to evaluate the dose prevented by the application of intake restrictions—averted dose.
- In this study, the authors have extended an internal dose calculation code (DSYS) to evaluate internal doses for chronic intakes—DSYS-chronic code—and then evaluated averted doses by the application of tap water restrictions.

### 2. Objectives

To evaluate internal doses for the accident in Fukushima,  
 ■ extend an internal dosimetry code, DSYS code to calculate doses for chronic intakes.  
 ■ calculate the doses for chronic intakes to the public that took daily drinks of tap water contaminated radioactive <sup>131</sup>I.

### 3. Methods

- DSYS code consists of four codes (Fig.1). The code could treat dose evaluations for only acute intakes (Eq.(1)).
- In the present study, the DSYS code was extended to calculate doses by chronic intakes (Eq.(2))—DSYS-chronic code.
- After the accident, the radioactive <sup>131</sup>I was monitored in tap water at a local area of Fukushima (Fig.2). The authors have assessed chronic exposure of 1-year-old children with the monitoring data and evaluated averted doses using the DSYS-chronic code.

#### ◆ Retention equations for acute and chronic intakes

$$\frac{dq}{dt} = A \cdot q + I(t)$$

$$\begin{cases} q(t) = q_0, & I(t) = 0 & \text{for acute intake} & (1) \end{cases}$$

$$\begin{cases} q(t) = 0, & I(t) = a \times t + b & \text{for chronic intake} & (2) \end{cases}$$

q:[Bq], Retention

A :[1/day], Transfer and decay rate

I(t):[Bq/day], Intake rate

(continuous or discontinuous linear function)

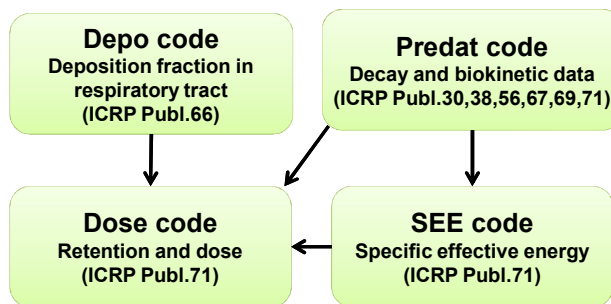


Fig. 1 DSYS formation and data flow.

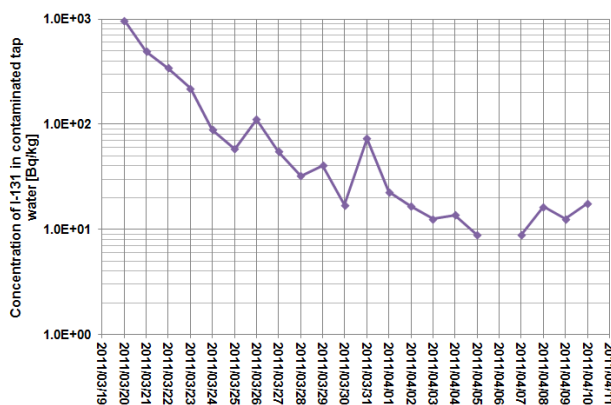


Fig. 2 The concentration of <sup>131</sup>I in tap water.

### 4. Results

- If the drinking rate of water was 1.4 liter/day for 1-year-old children, the total amount of intakes would be 3677.8 Bq for 21 periods (one day of data missing) as shown in Fig.3.
- Table 1 shows equivalent and effective doses for chronic ingestion of 21 periods. The greatest equivalent dose is **13mSv** of thyroid. Effective dose is **0.66mSv**.
- Figure 4 shows retention and daily excretion following chronic ingestion of 21 periods. These retention and daily excretion rapidly decrease after 22 days of the final chronic intakes. The curve of urine excretion reflects shapes of the daily intake rate until 22 days.

Table 1 Doses by chronic ingestion of <sup>131</sup>I.

1-year-old	Committed dose [mSv]
Thyroid	1.3E+01
Effective dose	6.6E-01

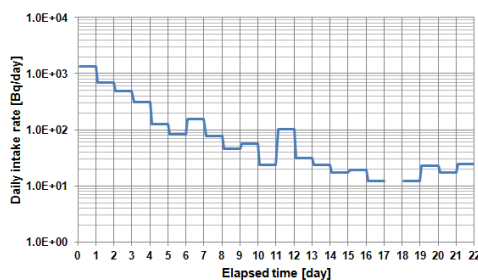


Fig. 3 Daily intake rate of tap water contaminated <sup>131</sup>I for 1-year-old children.

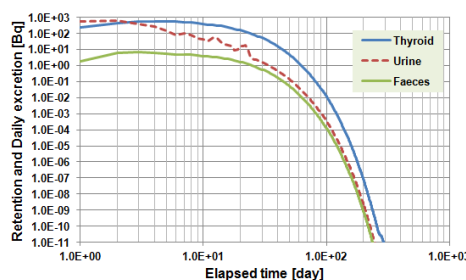


Fig. 4 Retention and excretion by chronic ingestion of <sup>131</sup>I for 1-year-old children.

### 5. Conclusions

The greatest equivalent dose would be **13mSv** of thyroid if 1-year-old children drank tap water contaminated <sup>131</sup>I for 21 periods. The children in a local area of Fukushima could avert the dose by not drinking tap water contaminated <sup>131</sup>I. The DSYS-chronic code would be useful for internal dose evaluations for chronic intakes.