Effect of Change of Biokinetic Models on Interpretation of Bioassay Data

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Introduction

- Since ICRP 78 was published, biokinetic models have been changed.
- Human Respiratory Tract Model (HRTM) in ICRP 66 has been revised
- Human Alimantary Tract Model (HATM) in ICRP 100 replaces the GI tract model in ICRP 30.
- Systemic Model have been changed into more realistic model.
- For these reason, retention and excretion function should be changed.
- This change influences interpretation of bioassay data, i.e, prediction of the amount of intake.
- Thus, we calculated the Intake Retention Functions (IRF) with changed biokinetic models for intake of ^{60}Co.
- Using the calculated functions, amount of intake was predicted.

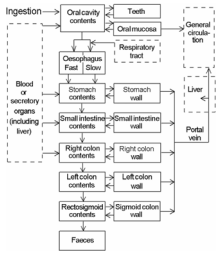

Fig 1. The HATM in ICRP 100

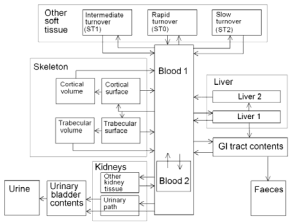

Fig 2. The Newest Systemic Model for Cobalt

Materials and Methods

- In order to assess the effect of change of the each model, we established several cases of combination of models as shown in Table 1.

Table 1. Set of Cases to Assess the Effect of Change of the each Model

Inhalation				Ingestion		
Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
-ICRP 67 Cobalt Model -HRTM -GI Tract Model	-ICRP 67 Cobalt Model -Revised HRTM -GI Tract Model	-ICRP 67 Cobalt Model -HRTM -HATM	-New Cobalt Model -HRTM -GI Tract Model	-ICRP 67 Cobalt Model -GI Tract Model	-ICRP 67 Cobalt Model -HATM	-New Cobalt Model -GI Tract Model

- Since the HRTM has not been completely revised, only change for absorption rates was considered for revised HRTM in this study.
- Table 2 shows the change of absorption rates in the HRTM.

Table 2. The Change of Absorption Rates in the HRTM (Value from original HRTM is indicated in brackets)

Type		F(fast)	M (moderate)	S (slow)
Fraction Dissolved Rapidly	f_r	1 (1)	0.2 (0.1)	0.01 (0.001)
Dissolution Rates:				
Rapid (d^{-1})	s_r	15 (100)	1 (100)	3 (100)
Slow (d^{-1})	s_s	-	0.003 (0.005)	$8x10^{-5}$ (0.0001)

- In order to obtain the IRFs, compartment model for each case was analyzed using the inverse matrix method with MATLAB.
- Using the calculated IRFs, the amount of intake, I is calculated using this equations if measurement quantities are assumed to follow log-normal distribution.

$$\log I = \frac{\sum_i \frac{\log(\frac{m_i}{IRF_i})}{(\log \sigma_i)^2}}{\sum_i \frac{1}{(\log \sigma_i)^2}}$$

where m_i is i_{th} measurement quantity, and σ_i is the absolute error of i_{th} measurement quantity.

- In order to compare the effect on prediction for the amount of intake, we established the example of bioassay data as shown in Table 3.
- Relative error of measurement quantities was assumed as 10%.
- AMAD, absorption type, and fractional deposition (f_1) were assumed as 5μm, type M, and 0.1, respectively.
- Intake pathway was assumed as inhalation or ingestion.

Table 3. The Example of Bioassay Data

Measurement Day	Whole Body Counts (Bq)
3	7.00E+4
4	6.50E+4
9	5.00E+4
31	4.00E+4
64	3.50E+4
108	2.00E+4

Results and Discussion

- Figure 3 and 4 show whole body retention function for inhalation and ingestion of ^{60}Co, respectively.

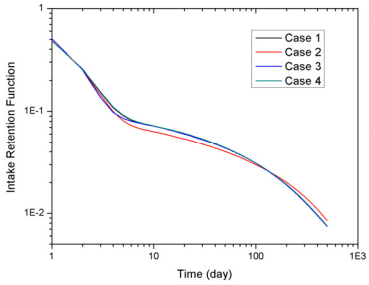

Fig 3. Whole Body Retention Function for inhalation of ^{60}Co

- As shown in Fig. 3, case 1, 3, and 4 have almost equal retention pattern, but case 2 has somewhat different pattern.
- From this result, it can be concluded that revision of the HRTM has significant effect on IRF.

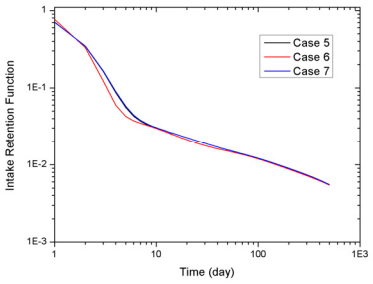

Fig 4. Whole body Retention Function for ingestion of ^{60}Co

- As shown in Fig. 4, case 5 and 7 have almost equal retention pattern, but case 6 has somewhat different pattern.
- From this result, it can be concluded that the change from GI tract model to HATM has significant effect on IRF.
- Table 4 shows the prediction of the amount of intake for each case.
- The amount of intake for case 2 and 6 were about 10-15% higher than that for other cases.
- This difference may be larger for short term bioassay.

Table 4. Prediction of the Amount of Intake for each Case

	Inhalation				Ingestion		
Case	1	2	3	4	5	6	7
The Amount of Intake (Bq)	6.56E+5	7.06E+5	6.70E+5	6.48E+5	1.33E+6	1.47E+6	1.29E+6

Conclusions

- In this study, we calculated IRFs for several cases with changed biokinetic models.
- Using the calculated IRFs, the amount of intake was predicted for each case.
- According to the new biokinetic model, predicted amount of intake has certain difference, which may be larger for short term bioassay case.
- From the results, we found that occupational dose from internal exposure can be somewhat different by the newest biokinitic models

Presenting Authour

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