Requirements on Development of Health Effect Assessment Module for the Korean-specific Level 3 PSA Code

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1. Introduction

So far, the MELCOR Accident Consequence Code Systems (MACCS) code, and its successor code, MACCS2, has been used for most of the level 3 probabilistic safety assessment (PSA) performed in our country. However, it is not appropriate to apply the domestic population data to the consequence analysis using MACCS2 since the health effect assessment model employed uses risk coefficients derived from U.S. population data [1]. Accordingly, it is necessary to develop a new computational code to assess the Korean-specific health effect caused by radiation exposure.

The principal function of the health effect assessment code to be developed is to calculate the lifetime attributable risk (LAR) for any given radiation exposure scenario with the Korean population data. In addition, similar to MACCS2, the code must have an ability to evaluate cancer incidence and mortality risk coefficients.

In this study, we reviewed the existing codes used for calculating health effect from radiation exposure, and derived some requirements for the code to be developed in the future on the basis of the review results.

2. Methods and Results

2.1 Review of the existing codes

First of all, the existing codes such as HEINPUT, RadRAT, ProZES and IREP used for calculating health effect resulting from radiation exposure are reviewed. Table I summarizes comparison results of these codes, and detailed description for each code is as follows.

Table 1. Comparison of Codes for Health Effect Assessment

	HEINPUT	RadRAT	IREP	ProZES
Base model	NUREG/ CR-4214, EPA 1994, EPA 2011,	BEIR VII	Various models	Various models
Input	Dose and Dose rate, DDREF*, Population data, etc.	Dose and Dose rate, Population data	Personal information including diagnosis data	Personal exposure history, Population data, etc.
Output	LAR, Loss of life	LAR with uncertainty analysis	ERR$, Assigned share with distribution	ERR, Assigned share with distribution

* DDREF: Dose and Dose Rate Effectiveness Factor
$ ERR: Excessive Relative Risk

2.1.1 HEINPUT [2]

HEINPUT is one of the preprocessor for probabilistic accident consequence assessment code OSCAAR developed by Japan Atomic Energy Agency (JAEA). This code calculates cancer risks including LAR and loss of life year using one of the following models: NUREG/CR-4214, EPA 1994 and EPA 2011. The main inputs are exposure dose, DDREF, model parameters and population data including cancer incidence and mortality, and survival rate.

The population library writing module is included to make population data input easy. And, the output files contain the calculation results and are printed in the form of CSV files.

2.1.2 RadRAT [3]

RadRAT is a web-based calculator for estimating LAR developed by National Institutes of Health (NIH) in the U.S. This code calculates LAR using BEIR VII models in accordance with the user-specified inputs shown in Fig. 1. User can specify information on population and multiple exposure situations.

Furthermore, it is available to set uncertainty analysis options. The final estimation of LAR with uncertainty range is presented in a web page.

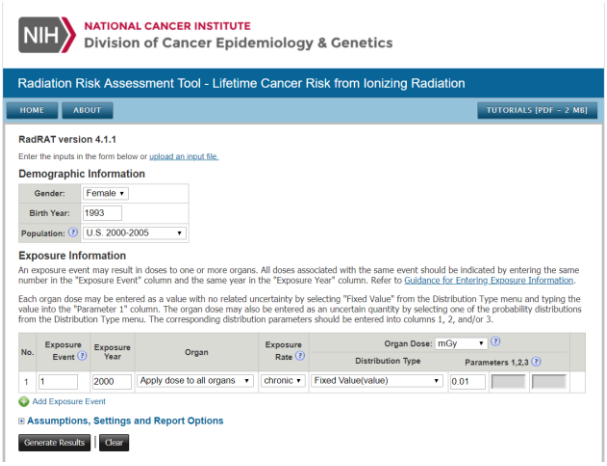

Fig. 1. Graphical Interface of RadRAT [4]

2.1.3 IREP [5]

IREP is a web-based radiation-induced risk calculator for radiation workers, developed by NIOSH (National Institute for Occupational Safety and Health) in the U.S. This code uses the cancer models derived from the Japanese atomic bomb survival data and other radiation exposure data. User can specify personal information including year of diagnosis and uncertainty analysis options. The cancer risks are evaluated in terms of assigned share with ERR instead of LAR.

2.1.4 ProZES [6]

ProZES is for estimating the radiation-induced cancer risk, developed by Bundesamt für Strahlenschutz (BfS) in Germany. The cancer models implemented are selected based on reviews of experts in the field, considering suitability for occupational exposure scenario. In the program, the statistical data on cancer incidence in Germany is involved. Finally, this code calculates cancer risks in terms of assigned share with ERR using personal exposure history as in IREP.

2.2 Requirements for the code to be developed

Fig. 2 schematizes the flow diagram of the health effect assessment module for the Korean-specific level 3 PSA code. The detailed functions and requirements of the code to be developed in the future are as follows.

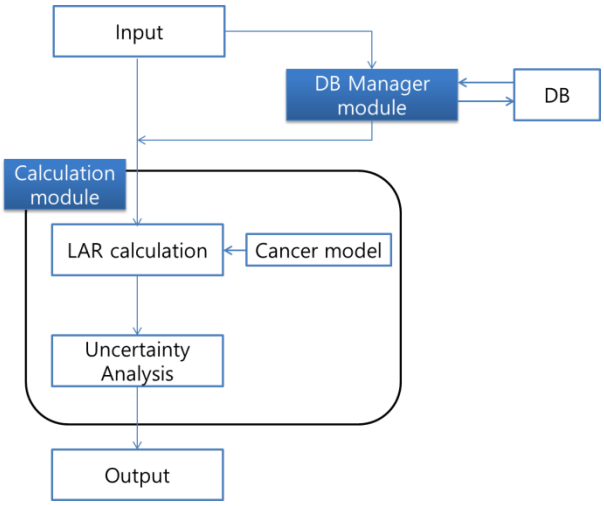

Fig. 2. Flow Diagram of Health Effect Assessment Module for the Korean-specific Level 3 PSA Code

- Users enter the input for risk calculation including exposure scenario, DB options and uncertainty analysis.
- The code is mainly consists of two (2) modules, i.e. DB manager and calculation.
- The main functions of DB manager module are to select and organize data from DB file, so that the calculation module could use the data properly. The data of certain specific year or averaged over certain years could be used. DB manager also have to be able to generate user-specific data set used for calculation.
- The DB file contains data for population distribution, baseline cancer incidence, baseline cancer mortality, survival rate and coefficient information for cancer risk models.
- The calculation module takes information from input options and DB manager, and generates the estimated LAR (including uncertainty analysis) for each cancer type using cancer models embedded.
- LAR estimates with 95% confidence interval, median and mean values, and variance should be provided in output files. And, the risk coefficients to be used for the level 3 PSA code should be calculated.

3. Conclusions

As part of a research project being performed for establishing the Korean-specific cancer risk models and level 3 PSA code, the health effect assessment module will be developed. In this paper, the detailed functions and some requirements of the code to be developed are derived based on the review result of the existing codes for assessing health effect.

This module will be used for estimating the cancer risks for given radiation exposure scenario and deriving cancer incidence and mortality risk that is one of input data for the Korean-specific level 3 PSA code.

Accordingly, this code will be developed in both forms of a console application to provide compatibility with a level 3 PSA code and a graphical user interface (GUI). Using this code, it is possible to perform the consequence analysis reflecting the Korean-specific statistical data.

ACKNOWLEDGMENT

This work was supported by the National Research Foundation of Korea (NRF) grant (No. 2017M2A8A40 15292) funded by the Korean government (MSIP: Ministry of Science, ICT and Future Planning).

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