CONCEPTUAL STRUCTURE OF JAVA-ORIENTED ENVIRONMENT FOR INCORPORATED RADIONUCLIDES BIOKINETICS MODELLING AND INTERNAL RADIATION DOSES CALCULATIONS

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1. Background and Purpose An ongoing revision of major ICRP publications affects models of biokinetics of chemical elements in human body, which along with clarification of weighting coefficients values for tissues and organs, decay schemes and radionuclides emission energies, switch to using of voxel-phantoms etc., should lead to changing the dose coefficient values pertained to internal exposure. A development of a software tool, which allows performing biokinetics calculations rapidly in case of changing the models describing radionuclides behavior in human body and calculating the dose coefficient values accordingly to various scenarios, is an important practical stage. **The purpose of the paper** is to present the description of developed software system, and used technologies.

2. Materials and Methods Data storage containing information about nuclides used in computations and their various properties is developed basing on ICRP publication 107 "Nuclear Decay Data for Dosimetric Calculations" and implemented as a relational database.

Computational algorithm in the system is implemented according to the paper "A Microcomputer Algorithm for Solving First-order Compartmental Models Involving Recycling" by A. Birchall and A.C. James (Health Phys. 56, 857–868 (1989)). This paper introduces a general algorithm for solving first-order compartmental models including recycling systems. The ODE system solution for any compartmental model in matrix form was obtained, which was expressed via the exponential of a rate constants matrix.

3. Software technologies Software tool is designed as a Java desktop application. Open-source PostgreSQL DBMS is selected to store data in this system, because PostgreSQL is one of the most reliable and high-productive data storage systems. A set of various free cross-platform software libraries and engines is used to perform numerical calculations in developed system. List of used tools and technologies is shown below (Figure 1).

(a) GNU Octave - free math engine

(b) SciLab – free math engine

(c) JBLAS – free linear algebra package for Java

(d) R – free math and stat environment

(e) PostgreSQL – free DBMS system

Figure 1 – Integrated software packages

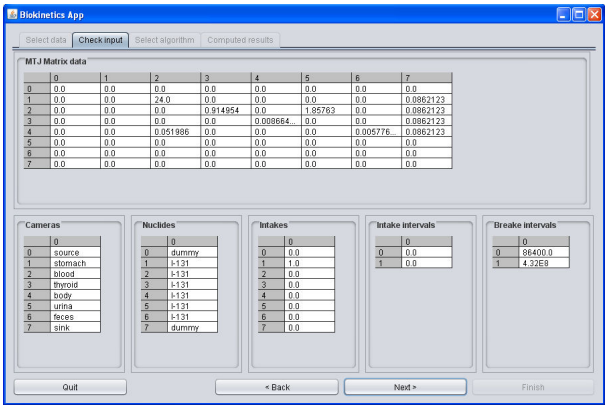
4. Results and Discussion Test calculations were carried out using biokinetics models of ICRP Publication 30 because the intermediate data (nuclear disintegration number etc.) for these set of models were published. So it allows the correctness check for the obtained test results. The biokinetics calculations process showed that results necessary for internal radiation dosimetry (estimations of the accumulated activity (nuclear disintegrations number) and the radionuclide contents in tissues and organs of the main deposition) could be obtained with the necessary performance and precision. An example of calculations results for iodine-131 are shown in tables listed below (Table 1 and Table 2). Some screenshots of our software application are shown in Figure 2.

Table 1 – Contents of I-131 in compartments

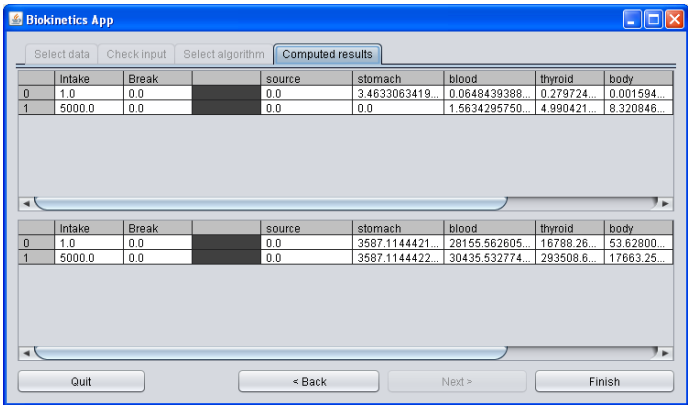
Time after the intake, days	Organ of deposition			
	stomach	blood	thyroid	body
1.0	3.5E-11	6. 5E-02	2.8E-01	1.6E-03
5000.0	0.0	0.0	0.0	0.0

Table 2 – number of I-131 disintegrations

Time after the intake, days	Organ of deposition			
	stomach	blood	thyroid	body
1.0	3.6E+03	2.8E+04	1.7E+04	5.3E+01
5000.0	3.6E+03	3.0E+04	2.9E+05	1.8E+04



(a) Biokinetics App – Checking input. Source data is read from *.mtx (Matrix Market) files using MTJ package (Matrix Toolkits Java) and shown to user.



(b) Biokinetics App – Computed results. After checking input and selection of algorithm the application executes all computations and shows results in tables. The results are also saved in Excel files.

Figure 2 – Application screenshots