WEB-ACCESS TO A LUNG DEPOSITION MODEL FOR RADIATION PROTECTION AND PHYSIOLOGICAL MODELING*

Richard C. WARD, Ph. D.
Computational Sciences and Engineering Division
Keith F. ECKERMAN, Ph. D.
Life Sciences Division
*Oak Ridge National Laboratory***
Oak Ridge, Tennessee, USA

Lin S. AHMAD, B. Sc. N.
Student in the Computer Sciences Department,
University of Houston-Downtown, Houston, Texas, USA

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A C++ implementation of the ICRP Lung Deposition Model was validated and made accessible by creating a web interface using Perl. Considerable understanding of this lung deposition model was obtained and a small number of errors identified in the code during this process. Documentation was developed using MathML and scalable vector graphics (SVG).

We have developed an implementation of the International Commission on Radiological Protection (ICRP) Publication 66[1] lung deposition model that can be accessed via the World-Wide Web. The ICRP 66 lung deposition model is used in physiological or radiobiokinetic modeling for intake and deposition of aerosol particles of specified size distribution and mass density. The model incorporates physiological ventilation parameters such as tidal volume, fractional residual capacity, etc., which are assumed to scale with height. Standalone implementations of this model exist, but to our knowledge a web-accessible version does not exist.

Our web implementation is based on a standalone C++ code[2]. Launched by a Perl script, the standalone C++ module computes the deposition for a specified set of input parameters and the results are posted back to the user. As part of the development process, a thorough validation was done on the C++ code by comparing results of the code to results from a FORTRAN implementation[3]. The codes produced identical results.

Since we expect a wide range of users of the web version, we are implementing extensive documentation that takes advantage of new XML-based paradigms including scalable vector graphics (SVG), which is used to display a schematic of the ICRP 66 deposition model (see Fig. 1), and MathML, which is used to display equations. Utilizing sophisticated XML-based tools greatly improves the availability of the deposition model to a wider research community.

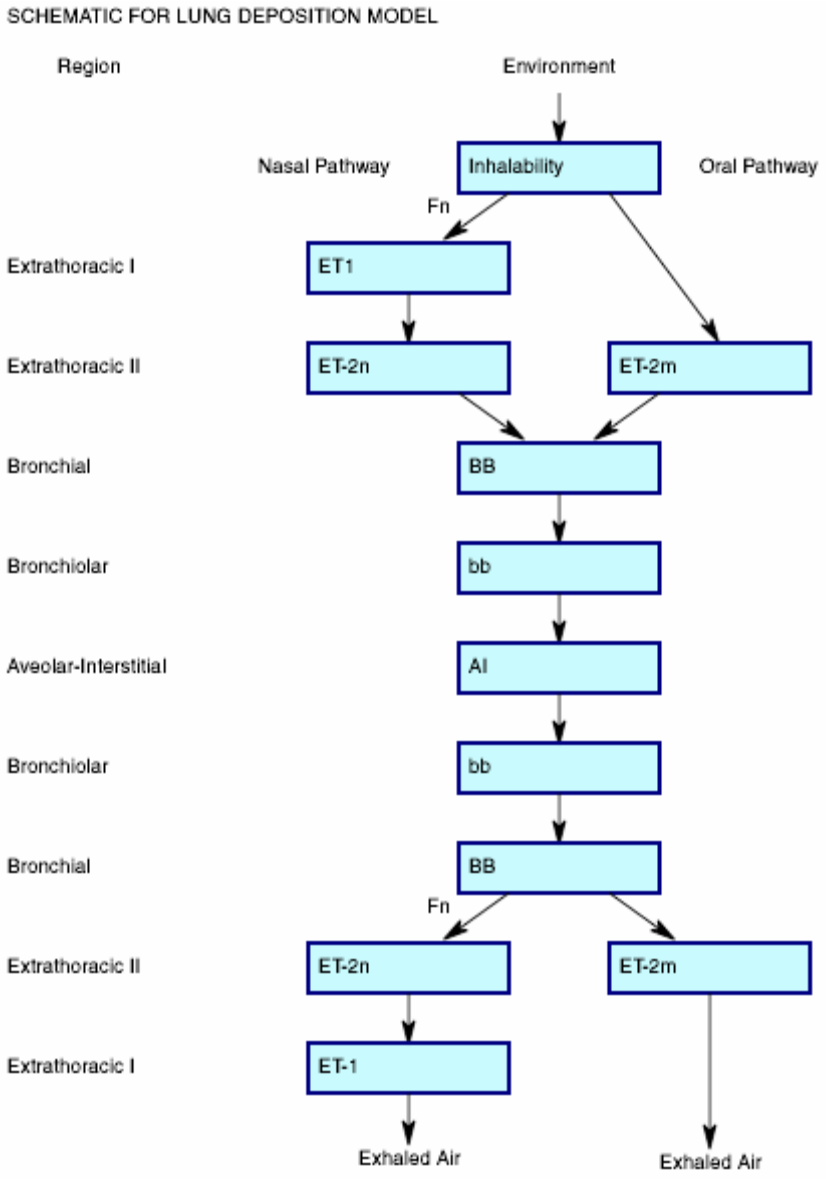

Figure 1. The Lung Deposition Model (inhalation followed by exhalation) using Scalable Vector Graphics (SVG).

The web-accessible implementation of the ICRP 66 deposition model improves its use in radiation protection and introduces use of the model to the wider physiological modeling community. The validation of the C++ standalone code, which forms the core of the web implementation, will allow us to create a DLL module that can be used with other radiation dosimetry software.

In conclusion, we have created a web-accessible implementation of the ICRP 66 deposition model. In the process of doing this we thoroughly validated the C++ code that forms the core of the web implementation. Thus, we can now create a DLL module from this C++ code that can be incorporated into other radiation dosimetry applications. In addition, the web implementation can be used by those doing radiobiokinetic and physiological modeling for deposition of particulates in the lung. The well-documented, web-accessible implementation of the ICRP 66 deposition model greatly improves the understanding of this model and broadens it use in physiological applications beyond the radiation dosimetry community. This work established a procedure and methods that can

be used to create web-accessible implementation of other models used in health protection; e.g., compartment models that describe the clearance and fate of the material deposited in the lung.

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References

1. "Human Respiratory Tract Model for Radiological Protection" *Annals of the ICRP, ICRP Publication 66*, Pergamon, Elsevier Science Inc. New York (1994).
2. Stefanie Holmes, Standalone ICRP Publication 66 C++ code (1999).
3. Private communication