system with 46% of this burden in the liver and 46% in the skeleton. The liver/skeleton ratio is in good agreement with ICRP Publication 30 recommended 45%/45% distribution.[5] A more detailed report of the measured soft tissue and individual bone values is in progress.

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DEPOSITION OF INHALED PARTICLES IN THE RESPIRATORY TRACT AS A FUNCTION OF AGE AT EXPOSURE

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The lung model initially recommended by the ICRP[1] was developed to be applied in the workplace. Thus, it used only adult values for anatomical and physiological input parameters, such as those dealing with tidal volume and breathing rate. To deal with environmental exposures of humans, the model was changed to accommodate such parameters as the population changes with age from 1 month to adulthood. The alterations required age-related input concerning the respiratory tract gross anatomy and respiratory physiology. Quantification of these parameters is not precise and is highly variable among individuals, but ample data are available to make acceptable estimates.

The wide use of the ICRP lung model[1] led us to generally follow its derivation for extrapolation from adults to children, realizing that much sophistication has been applied to the respiratory tract anatomy and physiology since its publication in 1966. We chose to use Landahl's basic approach,[2] which incorporates much of Findeisen's original work,[3] utilizing a respiratory tract divided into only 11 airway segments. Weibel[4] and Yeh and Schum[5] have recently suggested the use of 23–25 airway segments, with individual branching angles for each segment. The Landahl model divides the respiratory tract into more broader segments by radius, length, and volume than do some of the newer models. Landahl[2] also used constant branching and gravitational angles throughout his calculations. Our major goal was to develop a respiratory tract deposition model that would accommodate age 1 month to adulthood as an initial step in calculating radiation dose following inhalation.

Deposition in each of the airways of the respiratory tract is by the forces of inertia (impaction), gravitation (sedimentation), and diffusion. The importance of each of these forces will differ according to particle size, airflow, and dimensions of the airway. Approximations of the deposition by Landahl[2] were used for impaction and sedimentation, and the equations of Gormley and Kennedy[6] as implemented by Hofman et al.[7] were applied to diffusion.

The approach to changing respiratory tract and physiological parameters to be applicable to children was to derive an analytical function describing the ratio of the child value to the value for a reference adult with the desired characteristics. Functions were derived for the number of airways, radius of the airway, volume of the airway, tidal volume, and breathing rate. In some cases data were available only as a function of body weight, and these were used with an average curve for body weight versus age to convert from body weight to age. As would be expected, the results from this process have a sizable uncertainty but are believed to be adequate for radiation protection purposes.

A computer program has been written to carry out the tracing of airflow through the respiratory tract and deposition in each of the sections for monodispersed particles of known density and diameter. The program is now being debugged, although some preliminary results are available.

Work for the future includes finishing the program and studying the effect on age of monodispersed particles. Attention will then turn to examining logarithmic distributions and the derivation of a reasonable model analogous to the ICRP model for the calculation of radiation dose to organs.

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