DOSIMETRY FOLLOWING INTERNAL CONTAMINATION: COMPARISON OF SOME BIOASSAY MODELS

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ABSTRACT

A Task Group of the ICRP is currently reviewing the model to be used for the respiratory tract. The choice of the model will not only change the dosimetry, but will also have consequences for the whole body burden as a function of time following an internal contamination. Therefore the data for the evaluation of the intake derived from the measurement of the body burdens must be recalculated, to be included in the new release of our compilation. Examples of the results of two models are given for the inhalation of ^{60}Co and compared to the current model and to measured data.

INTRODUCTION

An earlier compilation of data ¦1¦ provides predicted whole body retention functions for over 400 radionuclides, based on the models given in ICRP-30 ¦2¦. Due to the development of a revised respiratory tract model by the ICRP, all inhalation data are now being recalculated. We also use this opportunity to include excretion functions in the new release of the report. The models we have used include the proposed ICRP-model ¦3¦ and the more simple version as given by Johnson and Milencoff ¦4¦. The proposed ICRP-model involves 14 compartments, each with one or more subcompartments. All transfer rates are constant. The second model employes only three compartments, but the transfer rates are time dependent. Both models use mechanical transport of particles, independent of solubility. We compare the results of both models to the current version of the lung model.

MATHEMATICAL TREATMENT

The preliminary ICRP-model is incorporated in a PC-based programme, the Lung Dose Evaluation Programme, LUDEP |5|.
We have used this code to calculate the whole body burden (fraction of intake as a function of time) for ^{60}Co. In the calculation default values are used for all parameters, i.e. a 1 µm AMAD aerosol is inhaled by a nose breathing lightly working adult male. The total deposition for this case is 45.6% of the intake: 28.5% in Extra-Thoracic, 5.6% in Bronchial and 11.5% in Alveolar/Interstitial.
The same default values are used for the three compartment model. However, here the deposition amounts to only 28%. This may be compared to the currently used value of 63%.
The three compartments (Extra-Thoracic, Slow-clearing and Fast-clearing Thoracic) are cleared mechanically to the GI-tract, described by three time dependent functions G(t). The solubilisation is given by a function B(t). After solving the set of coupled differential equations numerically (one for each compartment), all activities are added to obtain the whole body burden. The calculations are performed on a Tulip[1] personal computer. The programming language is Turbo Pascal[2] with its numerical toolbox. The whole body burden from the current ICRP-model is taken from our earlier compilation ¦1¦, based in ICRP-30.

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[1] Tulip is a registered trade mark of Tulip Computers, 's Hertogenbosch, The Netherlands.

[2] Turbo Pascal is a registered trade mark of Borland International, Inc., Scotts Valley, CA, USA.

RESULTS FOR ^{60}Co

As an example we have recalculated the body burden for inhalation of ^{60}Co, both for Class Y and W (called S and M in the new model). The results are given in Figures 1 and 2.

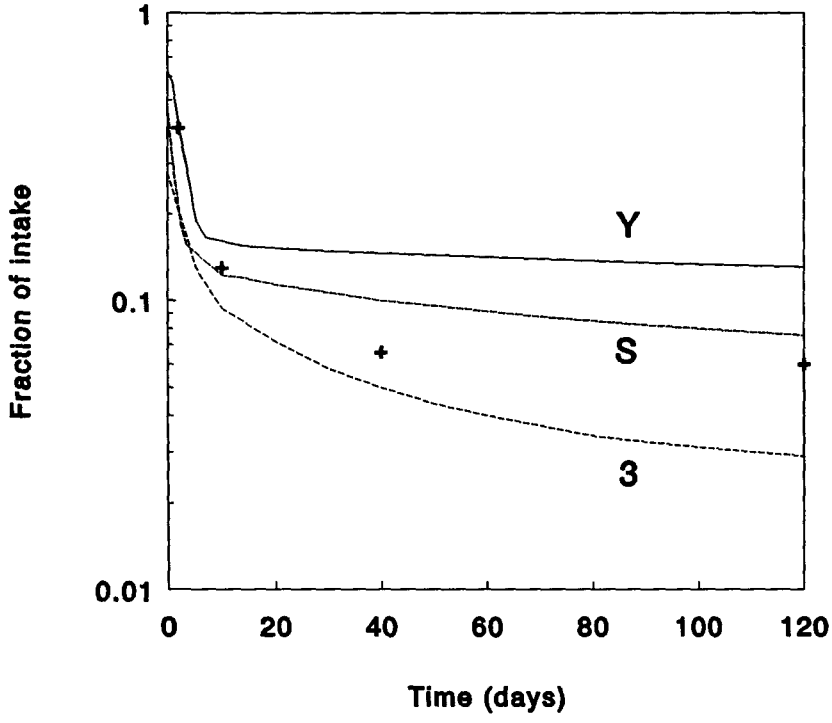

Figure 1 Calculated body burden after inhalation of ^{60}Co. + = example of actual measured data.
Y = Class Y current ICRP-model
S = Type S proposed ICRP-model
3 = Class Y 3-compartment-model

It is clear from this information that the main difference stems from the lower deposition values. In Figure 1 we have tentatively included the relative whole body burden measured for an actual inhalation case. There seems to be no real favorite among the models, but the new models predict the long term retention better in relation to the original deposition. This is probably the result of the inclusion of the fast mechanical clearing of the ET-compartment.

The more detailed nature of the proposed ICRP-model, however, makes a more precise calculation of the dose to different parts of the respiratory tract possible.

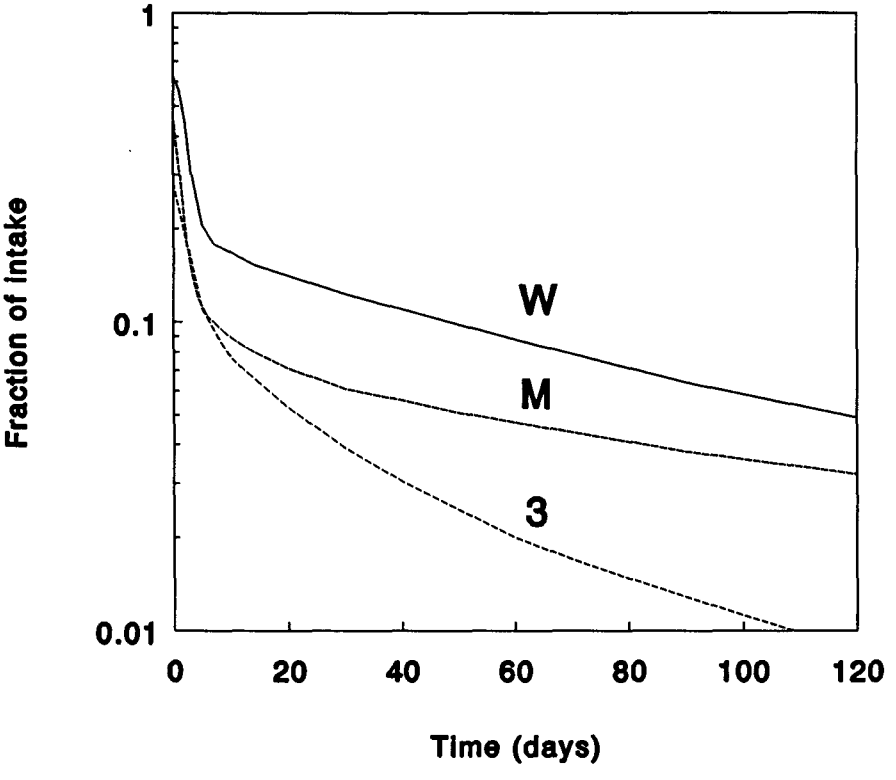

Figure 2 Calculated body burden for inhalation of ^{60}Co.
W = Class W current ICRP-model
M = Type M proposed ICRP-model
3 = Class W 3-compartment-model

The three compartment model predicts a faster clearance in both cases.

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