SOLVING THE NEW MODEL OF CAESIUM (ICRP 134) AND ITS VALIDATION

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The activity incorporated by people exposed to Caesium 137 and 134 (i.e. in case of accidental emission from Nuclear Facilities) can be estimated by measurements of the Caesium isotope activity in the whole body, in parts of the body, or in the urine or fecal excretion. In these cases, a mathematical model of the distribution of the caesium is used (Fig. 1): the human body is divided in compartments and the time-dependent activity of radionuclide in each compartment is represented as a function of time after intake (Fig. 2). We have solved the new caesium model (ICRP 100, ICRP 130 and ICRP 134) developing a package for BIOKMOD (Fig. 3). Data from real contaminated individuals are compared to the model's predictions (Fig. 4)

The more complex scenario is inhalation, since it involves the regions of the respiratory tract and the transfer to blood with the subsequent distribution in the body with recycling between compartments (Fig. 1).

Inhalation: input (b) from outside to compartments: {ALV, bb', bbseq, BB' ,BBseq, ET2', Etseq) = {IRF for AMAD 5 µm: (0.05319, 0.0110079, 0.00002206, 0.0177345, 0.00003554, 0.257684, 0.0005164, 0.4795) being fr= 0.2, for type M}

Ingestion: b to Buccal Cavity (not represented) and then, immediately, to Oesophagus (Oes)

Injection: b to Blood

The whole-body retention and the excreted activity (urine or faecal) have been calculated as a function of time after the intake.

The package can be downloaded from http://oed.usal.es/biokmod (Mathematica is required). A web version –including some of the features- is also available (Fig. 3).

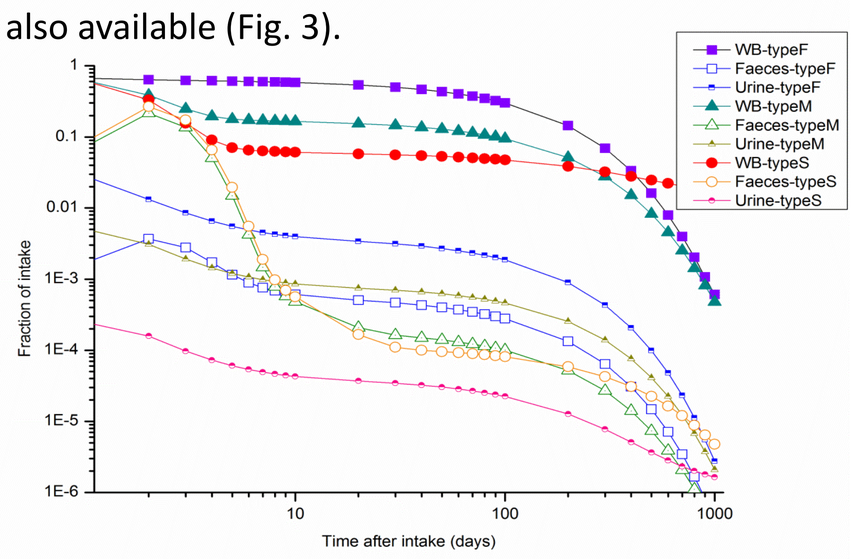
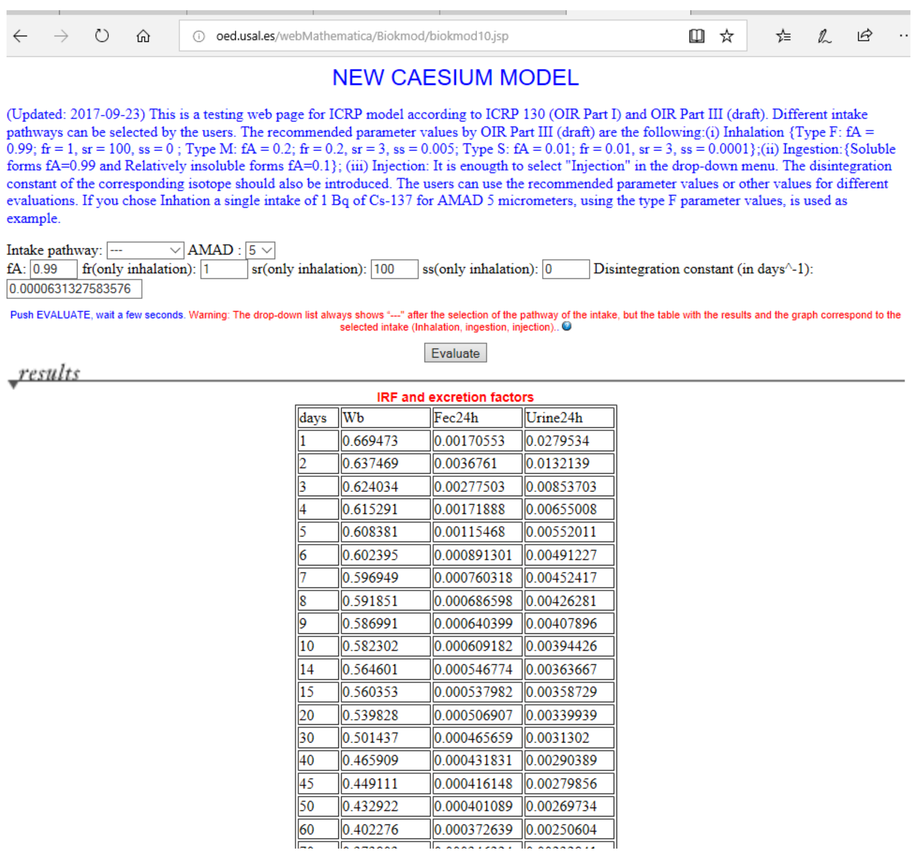


Fig. 2.- Activity retained in whole body (WB) and daily excreted activity (in faeces and urine) expressed as a fraction of the intake after inhalation of 1 Bq of ^{137}Cs AMAD 5 µm for different absorption types



days	Wb	Fec24h	Urine24h
1	0.669473	0.00170553	0.0279534
2	0.637469	0.0036761	0.0132139
3	0.624034	0.00277503	0.00853703
4	0.615291	0.00171888	0.00655008
5	0.608381	0.00115468	0.00552011
6	0.602395	0.000891301	0.00491227
7	0.596949	0.000760318	0.00452417
8	0.591851	0.000686598	0.00426281
9	0.586991	0.000640399	0.00407896
10	0.582302	0.000609182	0.00394426
14	0.564601	0.000546774	0.00363667
15	0.560353	0.000537982	0.00358729
20	0.539828	0.000506907	0.00339939
30	0.501437	0.000465659	0.0031302
40	0.465909	0.000431831	0.00290389
45	0.449111	0.000416148	0.00279856
50	0.432922	0.000401089	0.00269734
60	0.402276	0.000372639	0.00250604

Fig 3.- Example of output from the web version http://oed.usal.es/webMathematica/Biokmod/biokmod10.jsp

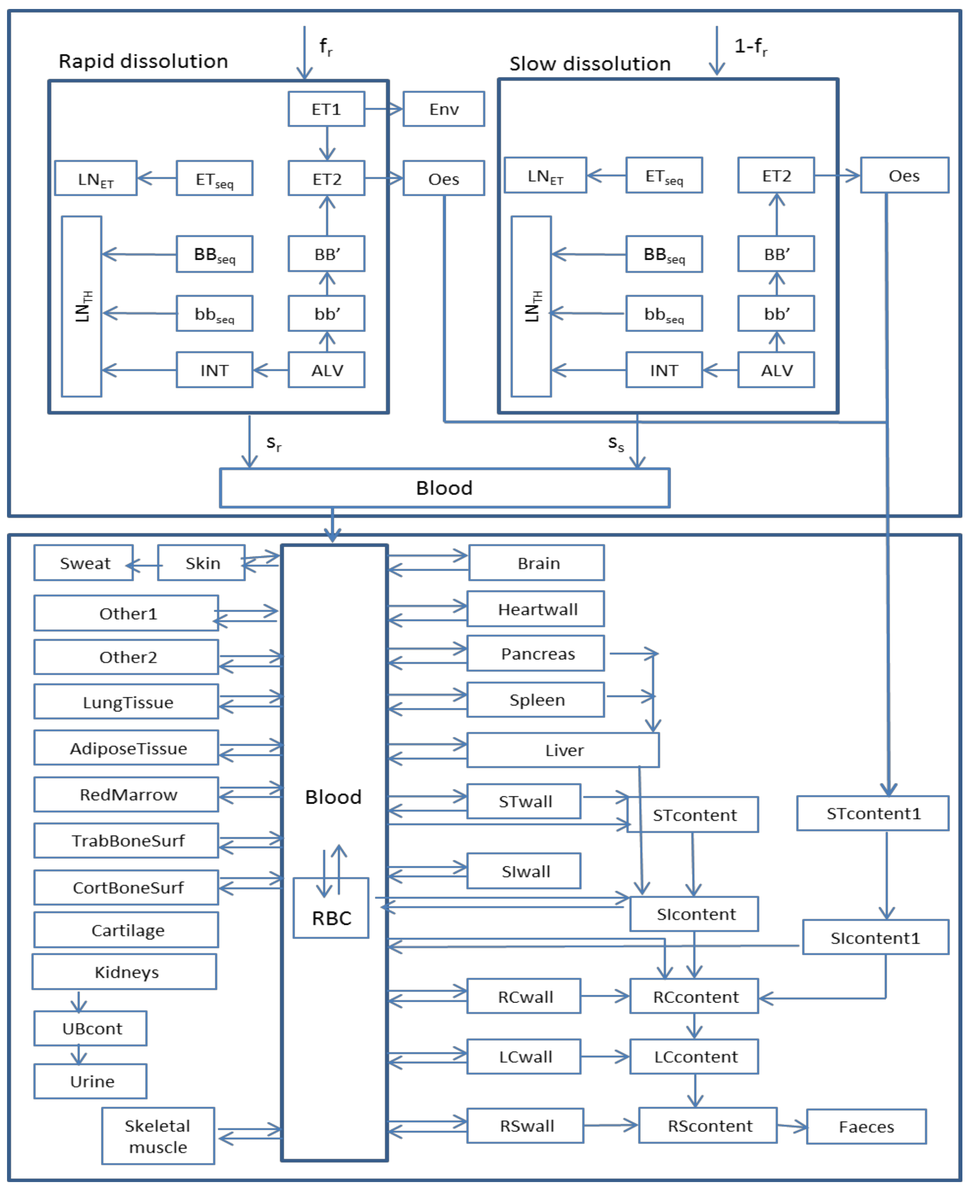


Fig 1.- Caesium model including the new Human Respiratory tract model (ICRP 130), systemic model (ICRP 134) and HATM (ICRP100)

The time-dependent whole-body activity estimated has been compared with real in-vivo measurements performed after some accidental intakes of ^{137}Cs and a good agreement between them was found.

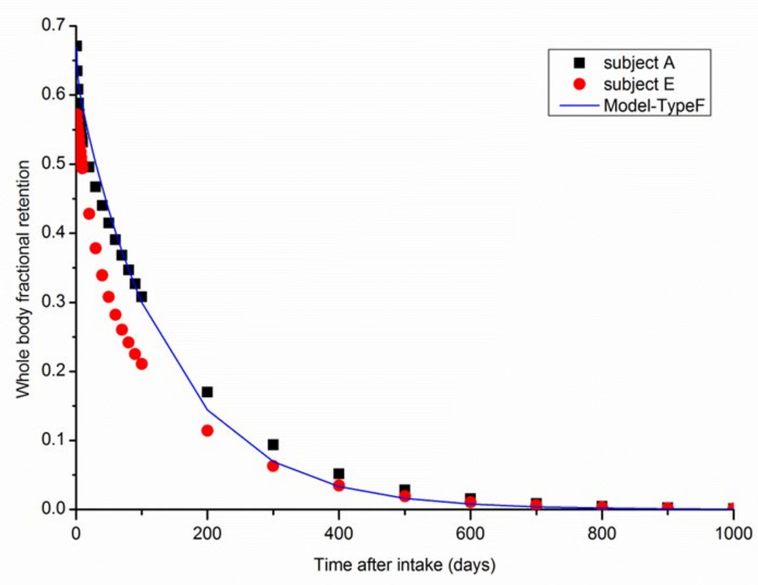


Fig.4.- ^{137}Cs retention measured in the body of two contaminated subjects expressed as a fraction of the intake in case of inhalation and the whole body retention calculated with BIOKMOD using Caesium model of ICRP Publication 134