COMPARISON OF ABSORBED RADIATION DOSES FOLLOWING A CHRONIC CONTAMINATION THROUGH INGESTION OF EITHER 137-CESIUM OR 90-STRONTIUM

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1- Introduction

Since several years the main aim of the IRSN research program ENVIRHOM is to delineate the non-cancerous effects of chronic ingestion of low concentrations of radionuclides. These studies showed that chronic contamination through ingestion of 137-Cesium induces a modification of the sleep-wake cycle in rats (Lestaevel *et al.*, 2006), which may be associated with a neuro-inflammatory response (Lestaevel *et al.*, 2008). Other physiological systems are also modified after a chronic ingestion of 137-Cesium such as the cardio-vascular system (Gueguen *et al.*, 2008), vitamin D metabolism (Tissandie *et al.*, 2006) and the metabolism of steroid hormones (Grignard *et al.*, 2008) in the rat. However, most of the observed modifications are at the molecular level: modification of gene expression and variations in protein synthesis. However, none of these effects have any major consequence on the health status of animals. In this context it is of outstanding importance to know the absorbed radiation dose due to the chronic ingestion of radionuclides (RN) in order to delineate possible mechanisms underlying the occurrence of these biological affects.

To this aim, we used the dose conversion factors (DCF) proposed by the publication 108 of ICRP, together with previously published biokinetic studies both for ^{137}Cs (Bertho *et al.*, 2010) and ^{90}Sr (Synhaeve *et al.*, 2011).

2- Material and methods

Mouse model: Biokinetic experiments were made with Balb/C mice ingesting contaminated water at a concentration of 20 KBq per litre of either ^{137}Cs or ^{90}Sr. Ingestion of contaminated water started 2 weeks before mating in parents animals and continued until 20 weeks of age of offspring (Figure 1), resulting in a daily ingestion of 70-90 Bq per animal and per day. RN content in organs was then measured at various ages of offspring (Bertho *et al.,* 2010, Synhaeve *et al*, 2011).

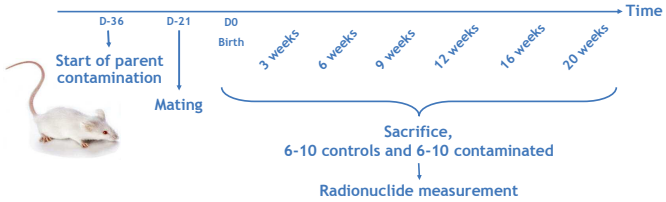


Figure 1: Schematic representation of biokinetic experiments for ^{137}Cs and ^{90}Sr in the mouse model.

Dose calculation: We used the rat model from publication 108 of ICRP, which is represented by a solid ellipsoid of 20 cm length, 5 cm height and 6 cm large, and 315 g of body mass. Since radionuclide concentration varied according to the age of offspring, we used mean RN concentration by class of body weight, as defined by the interval between to age of sacrifice. We then used the DCF for internal exposure for each RN to compute absorbed radiation dose.

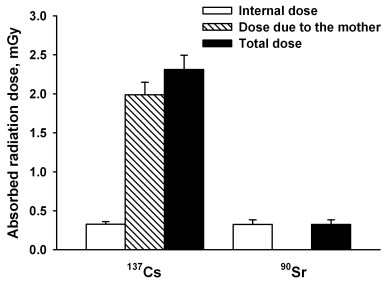
In order to take into account the exposure of the fetus by the internal contamination of the mother, we considered the mother as an external medium uniformly contaminated by RN as measured at the time of sacrifice of the mother. We thus used the corresponding DCF for exposure from an external medium.

Details of calculation are presented in Bertho *et al.,* 2012.

3- Results

3.1- Absorbed doses during foetal life

Figure 2: Absorbed radiation doses during fetal life for ^{137}Cs (left panel) and ^{90}Sr (right panel). The contribution of the mother to the total dose received by the fetus is close to 80% for ^{137}Cs and less than 0.1% for ^{90}Sr



3.2- Absorbed doses during post-natal life

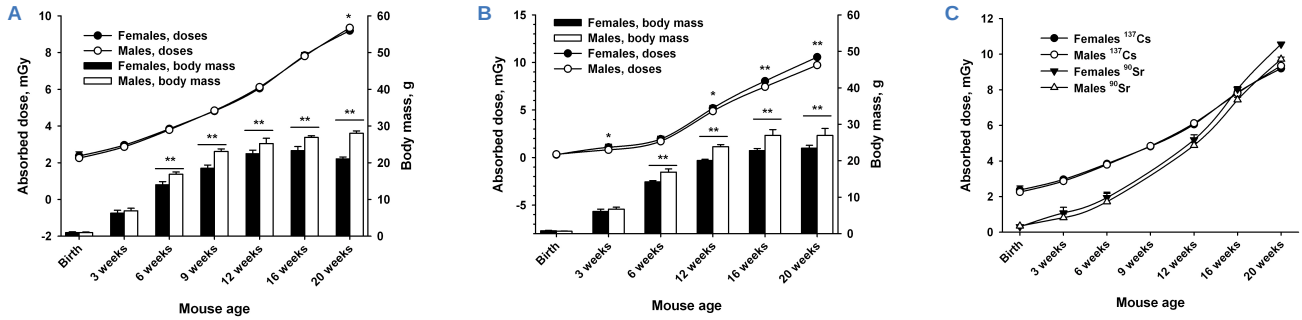
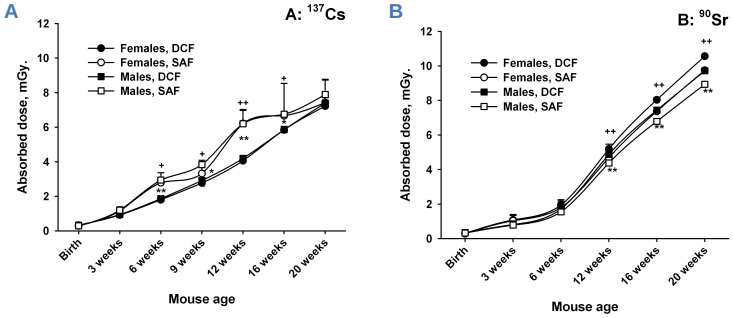


Figure 3: Absorbed radiation doses during contamination for **A:** ^{137}Cs and **B:** ^{90}Sr. Absorbed radiation doses (left axis) are indicated for males (open circles) and females (closed circles). Absorbed doses during foetal life are included in the presented results. The body mass of animals at various ages (right axis) are represented by vertical bars. Significant differences between males and females are indicated for *: p<0.05 and **: p<0.001. **C:** Direct comparison between the two RN of the evolution of absorbed radiation doses during contamination.

Figure 4: Comparison of results obtained with DCF (closed symbols) with calculation using absorbed fractions of energy defined in a mouse voxel phantom (open symbols), as previously defined (Stabin *et al.*, 2006). Significant differences are indicated for *:p<0.05 and **:p<0.001, both for males (circles) and females (squares). For ^{137}Cs (panel **A**), absorbed doses were overestimated by DCF calculation, while for ^{90}Sr (panel **B**), absorbed doses were underestimated. Nevertheless, differences between the results by the two method of calculation were always lower that 8% of the absorbed dose.



4- Discussion

The use of DCF provides a rapid and simple way to calculate absorbed radiation doses in experiments with laboratory rodents ingesting RN on the long term, provided that biokinetic data are available. However, the use of DCF is based upon several hypothesis. Animals and their environment are represented by a simplified geometry, with a medium of homogeneous density and an homogeneous distribution of RN in the body. Obviously, these hypothesis represent simplification. However, by using previously published absorbed fractions of energy (Stabin *et al*, 2006), we were able to show that these hypothesis did not induced large uncertainties in these calculations.

Nevertheless, the use of rodent voxel phantoms, such as the ones already published (Keenan *et al.*, 2010) is of interest, not only in order to reduce uncertainties, but also to more precisely define the absorbed radiation dose by specific organs.

5- References

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