^{137}Cs METABOLISM IN PREGNANT WOMEN

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Abstract

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Data from two pregnant women contaminated with ^{137}Cs, body burdens of 0.2 and 300 MBq, respectively at the time of the Goiânia accident, were compared. The first one, with lower body burden was exposed during the fourth month of pregnancy, while the second became pregnant three years and eight months after ^{137}Cs intake. For the first woman ^{137}Cs concentrations were equal for the mother, infant and placenta, indicating an easy and homogeneous transport of ^{137}Cs from mother to foetus. The whole body monitoring data from the second woman, who became pregnant four years after intake, did not show a reduction in biological half-life during the pregnancy. Cs concentration in the mother was found to be 13 times higher than in the infant. One possible reason for this result is that four years after intake, Cs is supposed to be concentrated mainly in skeletal muscle tissue. During the pregnancy the blood flux becomes higher in most of the organs and tissues except brain, liver and skeletal muscle tissue.

1. INTRODUCTION

According to the ICRP publication 56, the ^{137}Cs retention in the adult's body can be adequately expressed by the sum of two exponential components of the form:

$$R(t) = 0.1\ e^{-0.693t/2} + 0.9\ e^{-0.693t/110} \qquad \text{(eq.1)}$$

Retention half-lives for the long-term component in females are reported to be less than in males. It has been reported at ICRP publication 56 average values of 61 and 65 days, for females. Melo *et al.* (1994) reported an average value of 65 days from women internally contaminated in the Goiânia accident.

Bengtsson *et al.* have published that pregnancy accelerates the ^{137}Cs excretion from the female body, and the half-lives becomes 50 to 65% of the non-pregnant women. Possible mechanisms for the decreased retention of Cs in pregnancy might be: elevated oestrogen, progesterone and aldosterone levels, rapidly growing tissue mass, increased metabolic rate or changes in renal function. Zundel *et al.* have investigated some of these possibilities through the oral administration of two hormones (oestrogen and progesterone) to normal women, but it appeared to have little or no effect on caesium metabolism, but it is unknown whether the half-lives might have been altered if the injection, or if other hormones had been used. Another possible reason for the enhancing of caesium elimination from the body might be due to a 50% increase in the blood flux that occurs during pregnancy (Rezende, 1982).

This paper is a comparison between data from two women that became contaminated with ^{137}Cs in the Goiânia accident. The first one became internally contaminated in the fourth month of pregnancy and the second one became pregnant three years and eight months after ^{137}Cs intake. A complete analysis of the data from the first pregnant woman has been published by Bertelli *et al.*, 1992.

2. 1st CASE — WOMAN WHO BECAME INTERNALLY CONTAMINATED WITH ^{137}Cs IN THE FOURTH MONTH OF PREGNANCY

The ^{137}Cs body burdens of the mother and infant, when the baby was born, are summarised in Table I. The values of ^{137}Cs concentration for mother, placenta and infant are similar. This similarity indicates an easy and homogenous transport of caesium from mother to foetus and also a lack of any placental barrier for ^{137}Cs.

TABLE I. DATA FROM PREGNANT WOMAN THAT BECAME INTERNALLY CONTAMINATED IN THE FOURTH MONTH OF PREGNANCY, AT TIME OF BIRTH

#	Activity (Bq)	Concentration (Bq/kg)
Mother	61,087	912
Infant	3,885	971
Placenta	377	919

Figure 1 shows the ^{137}Cs retention curves of the mother and infant. Just one measurement was performed during pregnancy, in the sixth month. The second measurement was done one week after birth. A ^{137}Cs biological half-life of 46 days was estimated for the mother, through regression analysis using a single exponential model for the set of data after birth. This biological half-life refers to the long-term of Cs retention equation, since the first whole body measurement was done two months after intake. It is interesting to note that the single datum from measurement performed during pregnancy fits well in the regression curve of the data taken after delivery, contradicting literature. As is seen in Figure 1, during the first 60 days, the ^{137}Cs body burden of the infant did not change. In this period of time breast feeding was the only source of nourishment. These data reflect an equilibrium between intake

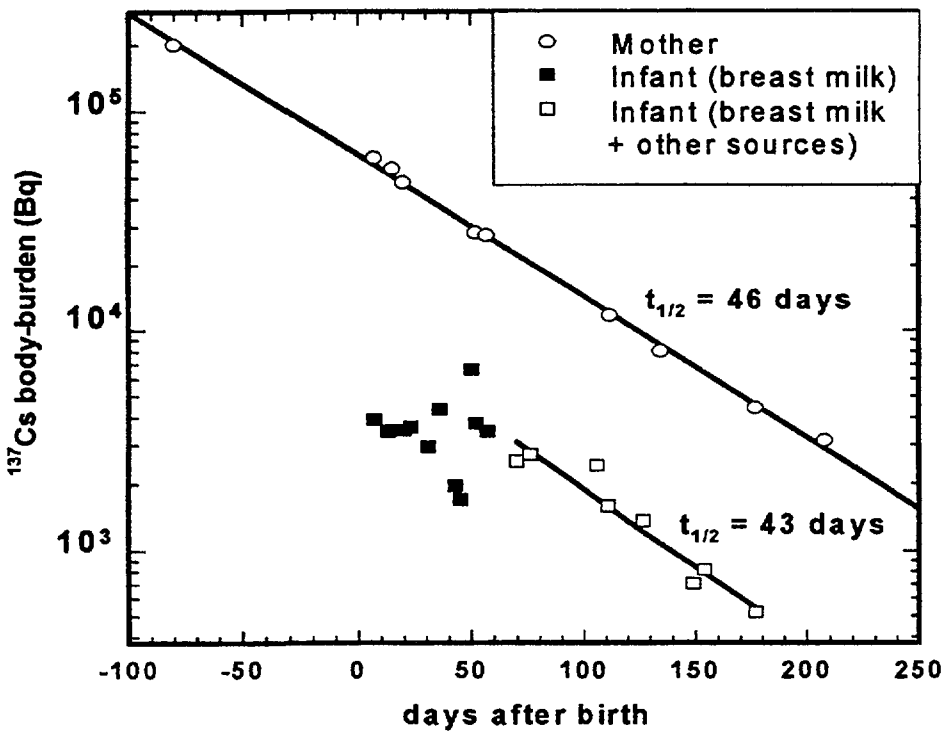

FIG. 1. ^{137}Cs retention curves of woman that became contaminated in the fourth month of pregnancy and her baby.

from mother's milk and loss by excretion. After this period, the baby mixed breast milk and other sources of nutriment. The biological half-life estimated for this period, until 7 months of age, was 43 days, similar to the mother.

3. 2nd CASE — WOMAN WHO BECAME PREGNANT THREE YEARS AND EIGHT MONTHS AFTER ^{137}Cs INTAKE

This woman was highly contaminated during the Goiânia accident. Some data from mother, infant and placenta are presented in Table II. There was no measurable caesium activity in the placenta. The caesium concentration in the mother's body was 13 times higher than in the infant's body. One possible reason for this result is that almost four years after intake, caesium is supposed to be concentrated mainly in skeletal muscle tissue. According to Rezende, 1982, during the pregnancy the blood flux becomes about 50% higher in most of organs and tissues except brain, liver and skeletal muscle tissue.

TABLE II. DATA FROM WOMAN THAT BECAME PREGNANT THREE YEARS AND EIGHT MONTHS AFTER INTAKE

#	Activity (kBq)	Concentration (Bq/kg)
Mother (initial body burden)	300,000	
Mother (at time of birth)	9,77	132
Infant	0.037	10
Placenta	< MDTA[a]	

[a] MDTA = 0.16 Bq (for 6 hours of counting time)

Figure 2 shows the ^{137}Cs retention in this woman for the whole period that she was monitored in the whole body counter. The first portion of the curve represents the 7 months during which period she was submitted to Prussian blue treatment, in dosages that varied from 6 to 10 grams per day. The biological half-life was 37 days. The second portion, for which the biological half-life was 58 days, represents the period after Prussian blue treatment. This value of biological half-life is within the range of half-lives from the Goiânia's women that never

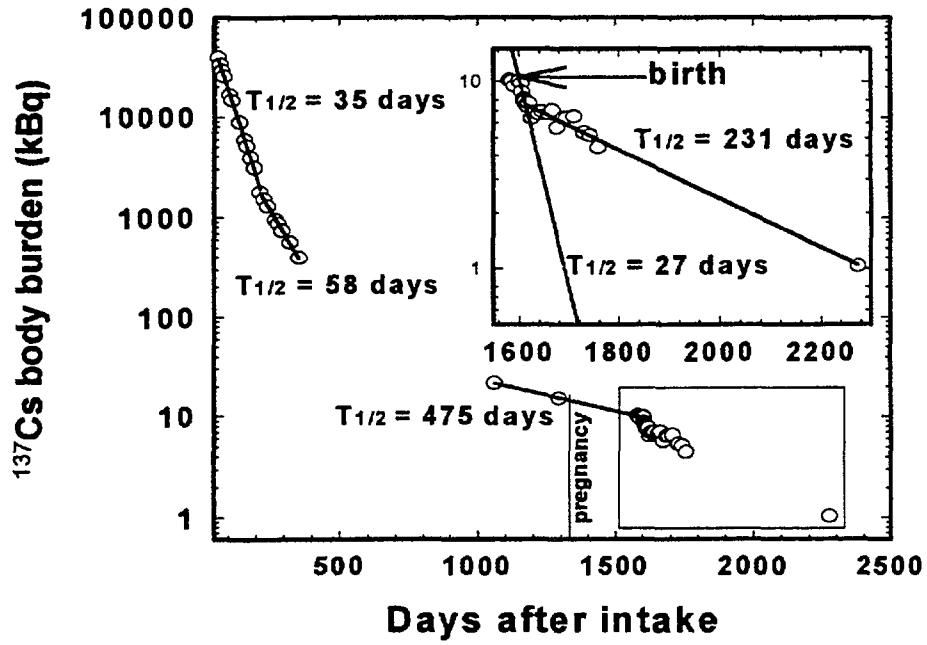

FIG. 2. ^{137}Cs retention curve of woman who became pregnant three years and eight months after intake

were submitted to Prussian blue treatment (average: 65 days, range 43 to 90 days). The third biological half-life might refer to a third component in retention equation (eq.1) with a long half-life, 475 days. It might be related to uptake in skeletal muscle tissue, since the largest

fraction of ^{137}Cs in the body is located in this tissue, Melo 1994. Unfortunately we have only data from the last month of pregnancy and they seem to fit in the same regression curve of the data before pregnancy. In this case, pregnancy again, did not modify ^{137}Cs retention, as described in literature. During the first sixteen days after birth, the ^{137}Cs biological half-life decreased to 27 days. This decrease might be associated to the loss of water from the body. During this period of time a strong correlation between ^{137}Cs body burden and body weight

($r^2 = 0.99$), was found. This woman had a high water retention during pregnancy and probably when she eliminated this extra water from her body the ^{137}Cs was removed together with the water. After this period, the biological half-life increased to 231 days.

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