Red Marrow Dosimetry for Former Radium Workers

Richard E. Toohey, Ph.D., CHP
M. H. Chew & Associates
Oak Ridge, TN 37830
2376 Ra cases including 89 Ra-related tumors

Year of first exposure

Radium Intake, $\mu$Ci
1955: Norris function:

$$R(t) = 0.54 \ R(0) \ t^{-0.52}$$

Based on measured retention in patients at Elgin (IL) State Hospital injected with $^{226}$Ra for treatment of schizophrenia.

However, some question as to the exact injected amounts.

$R(50 \ y) = 0.35\%$
1973: ICRP 20 Alkaline Earth Retention Model (Ca, Sr, Ba, Ra)

\[ R = (1 - p)e^{-mt} + p\varepsilon^b(t + \varepsilon)^{-b}[\beta e^{-r\lambda t} + (1 - \beta) e^{-\sigma r\lambda t}] \]

\[ R (50y) = 0.9\% \]

1982: Schlenker modified 5 parameters in the ICRP 20 model for retention in soft tissue

\[ R (50y) = 0.2\% \]
1993: Rowland furthered modified the ICRP 20 model, changing the value of $\lambda$ (the apposition and resorption rate in cortical bone) from 1.5% to the originally proposed 2.5%, resulting in

$$R(50y) = 0.1\%$$

ICRP-30 model: $R(50y)^* = 0.15\%$

ICRP-78 model: $R(50y)^* = 0.5\%$

* Corrected for $f_1 = 0.2$
RM Dose Coefficients for $^{226}$Ra

- ICRP 67 DC = $8.9 \times 10^{-7}$ Sv/Bq adult
- ICRP 67 DC = $4.1 \times 10^{-6}$ Sv/Bq 15-yr old

- ICRP 78 DC = $2.8 \times 10^{-7}$ Sv/Bq$^{-1}$ adult
- ICRP 78 DC = $1.5 \times 10^{-6}$ Sv/Bq$^{-1}$ 15-yr old

But what is the appropriate $w_R$ value?
WR Values

• Alpha emitters, stochastic effects: 20
• Alpha emitters, tissue reaction effects: 2
• The P-H anomaly is a specific mutation of the lamin-B receptor in leukocytes
• So we decided to stick with absorbed dose, because for a biodosimeter, that is the quantity of interest.
## Summary results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
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<tbody>
<tr>
<td>Number of cases</td>
<td>166</td>
</tr>
<tr>
<td>Date of first exp.</td>
<td>1914-1950</td>
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<tr>
<td>Age at first exp.</td>
<td>13-40 years old</td>
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<tr>
<td>Duration of exp.</td>
<td>1-1800 weeks</td>
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<tr>
<td>Dates of blood draws</td>
<td>~1960 -- ~1975</td>
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<tr>
<td>RM absorbed dose</td>
<td>0--6.8 Gy</td>
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