

**A MATHEMATICAL MODEL FOR REGIONAL AND WHOLE LUNG
VENTILATION STUDIES WITH RADIOACTIVE TRACERS**

Ž. Bajzer

Institute "Ruđer Bošković", Zagreb, Yugoslavia

J. Nosil

Clinical Hospital "Dr. Mladen Stojanović", Zagreb, Yugoslavia

The study of regional lung ventilation with radioactive gas tracers can be performed in a quantitative way using the appropriate mathematical model. We have developed¹⁾ such a model for continuous inhalation of a tracer, taking into the account the following basic assumptions: i) the lung is represented by an appropriate number of lung units (LU) arrayed in parallel; ii) the gas flows through lungs constantly; iii) the concentration of radioactive tracer in LU is changing because of gas flow and radioactive decay. Under these assumptions the number $M(t)$ of decays during time interval $[t-\tau, t]$ in a given LU satisfies the differential equation¹⁾:

$$\frac{dM}{dt} + DM = \lambda C \phi \quad , \quad M(\tau) = \lambda C \phi [\tau + (e^{-D\tau} - 1)/D] \quad , \quad D = \lambda + \phi/V \quad . \quad (1)$$

C is input tracer concentration, λ its decay constant, ϕ gas flow i.e. ventilation, V volume of LU and ϕ/V specific ventilation. The number of decays in a) whole lungs and b) four lung regions defined by iso-activity lines²⁾ is measured for healthy subject with ^{81m}Kr . The data are fitted with expression for $M(t)$ given by eqn. (1), assuming that any region or the whole lungs can be represented by one LU. The following results are obtained:

$$\begin{aligned} \text{a) } \phi/V &= 0.019 \text{ s}^{-1} & EC\phi &= 6.13 \cdot 10^2 \text{ s}^{-1} \quad , \\ \text{b) } \overline{(\phi/V)} &= \sum_{i=1}^4 (\phi_i/V_i)/4 = 0.020 \text{ s}^{-1} \quad , & EC\phi &= \sum_{i=1}^4 EC\phi_i = 6.55 \cdot 10^2 \text{ s}^{-1} \quad , \end{aligned}$$

where E is the efficiency of a measuring system.

These results confirm the assumption that the lung consists of lung units which are acting in parallel. The parameters ϕ/V and $EC\phi$ were calculated²⁾ for patients and healthy subjects and their clinical merit is shown.²⁾

References

1. Ž. Bajzer, J. Nosil, Phys. Med. Biol., to be published
2. J. Nosil, Ž. Bajzer, Š. Spaventi, Nucl. Med. 16 (1977) 13