STOCHASTIC MODELS FOR THE DISTRIBUTION OF RADIOACTIVE MATERIAL IN A CONNECTED SYSTEM OF COMPARTMENTS

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1. Introduction

The purpose of this report is to consider the problem of nonuniform distribution of bone seeking radionuclides, such as the alkaline earth elements, and the effect of age on the retention of these radionuclides in organisms via a mathematical study of a compartmental system in which the connections between the compartments are random variables. In most compartmental studies it is generally assumed that the contents of the compartments are uniformly distributed (see for example, Sheppard and Householder [7], Berman and Schoenfeld [1], Hearon [4]). This is not a realistic assumption for the case of bone seeking elements such as radium, where it has been well demonstrated that hot spots of activity occur as many as 20 or 30 years after intake of ^{226}Ra by man [5]. Rowland states that the concentrations in the hot spots exist in regions of bone where new mineral was laid down at the time the radium was acquired and that in this mineral the original concentration of Ra, expressed as the ratio of Ra to Ca, was essentially the same as the Ra to Ca ratio that existed in the blood plasma at the time the new mineral was formed. There is also a second type of distribution which is much lower in concentration and rather uniform. This is believed to be the result of an exchange process which continually transfers Ca and/or Ra atoms from blood to bone and back again and which is characterized by an unusually long time constant.

It is customary to think of bone tissue in terms of two types—the trabecular

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