Abstract

Methods for Quantitating Radioactivity

in vivo, by External Counting Measurements

by

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Three methods for quantitatively estimating radioactivity in patients by external γ-ray counting measurements were investigated. These were the combined transmission-emission method, ratioing of Compton to photopeak counts, (C/P), and the dual-isotope methods. A general mathematical description of quantitative measurements was obtained, which was then used to assess the possible sources of error in each method. It was found that of all parameters involved, source depth within the patient has the greatest effect, but that this effect can be accounted for by each of the methods studied. Source thickness and uniformity were found to have relatively small effects ($\lesssim$10%), particularly in the (C/P) ratio and dual-isotope methods. Source thickness effects could be accounted for with reasonable accuracy in the transmission-emission method by modifi-

cation of the equations derived for point sources. In the (C/P) and dual-isotope methods these effects were small enough that they could be ignored, and point source equations could be used. The mathematical analysis was tested in a series of studies involving various radionuclides in water phantoms measured on a linear scanning device. Good agreement between theory and experimental results was obtained over a wide range of photon energies and in several counting geometries. The combined transmission-emission method and (C/P) method were used to study the distribution and total body content of radioactivity in a series of patients injected with ^{59}Fe and ^{99m}Tc sulfur colloid. Both methods were found to improve accuracy in total body counting (absolute error $\lesssim$10%). The transmission-emission method also gave an apparent improvement in accuracy for determining distribution, and reduced overall random errors in total body counting to about 5% (S.D.), as opposed to 13% for uncorrected data. Distributional accuracy and random error were not found to be improved by the (C/P) method.

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