THE ASSAY OF IODINE-123

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Compounds labeled with ^{123}I are becoming more common in scintillation imaging due to the convenient combination of the 13.3-hr half-life and the 159-keV gamma radiation. Here attention is drawn to the particularly large summing effects observed when ^{123}I is counted in a well counter. These could lead to errors in the assay of doses if the analyzer windows used are too narrow.

The properties of ^{123}I make it very suitable for use in scintillation camera studies and other nuclear medicine investigations. Its 13.3-hr half-life ensures considerably reduced patient exposure to radiation compared with ^{131}I, and the principal gamma-ray at 159 keV can be detected with high efficiency. Only limited use has been made of ^{123}I until recently, due to its restricted availability. However, an increasing interest is now being shown in its use (*1–4*) and it seems desirable to comment on the strong sum peaking that may arise when samples containing ^{123}I are counted in a well counter.

MATERIALS AND METHODS

The ^{123}I used in this laboratory is prepared in the Medical Research Council cyclotron by the method of Silvester et al (*5*). The principal contaminants found in the preparation are ^{124}I (half-life 4.2 days), ^{125}I (60 days), and ^{126}I (13 days). The typical concentrations of these isotopes relative to ^{123}I are 5%, 0.9%, and 0.5%, respectively, at approximately 5 hr after the end of bombardment. These levels rise significantly if there is any substantial delay in the use of the preparation.

Assay of doses for injection is frequently carried out with a NaI well counter and the intercomparison of doses and blood samples in the course of an investigation may involve the counting of samples at different geometries to avoid excessive deadtime losses. For a 0.5-μCi dose of ^{123}I dispensed in 2 ml of saline into a polythene vial for counting in a standard well counter (Fig. 1), very different spectra were observed when the vial is supported at, for example, the level of the top face of the well (Fig. 2) and when the vial is fully inserted into the well (Fig. 3).

The spectrum of Fig. 2 shows the peaks of the 159-keV ^{123}I gamma-ray, the 28-keV Te x-ray, and 74-keV Pb x-ray. Figure 3 shows additional peaks at 61 keV and 187 keV. (The Pb x-ray is no longer visible because the sample is almost totally surrounded by the NaI crystal.) The additional peaks have been identified by Hupf, Eldridge, and Beaver (*6*) as arising from x-ray/x-ray coincidences at 61 keV and from x-ray/gamma-ray coincidences at

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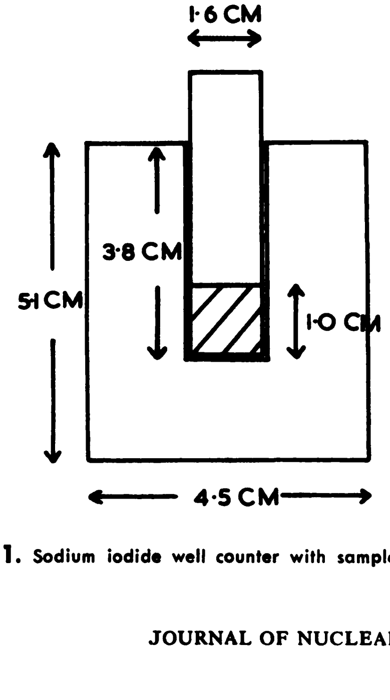

FIG. 1. Sodium iodide well counter with sample vial fully inserted.

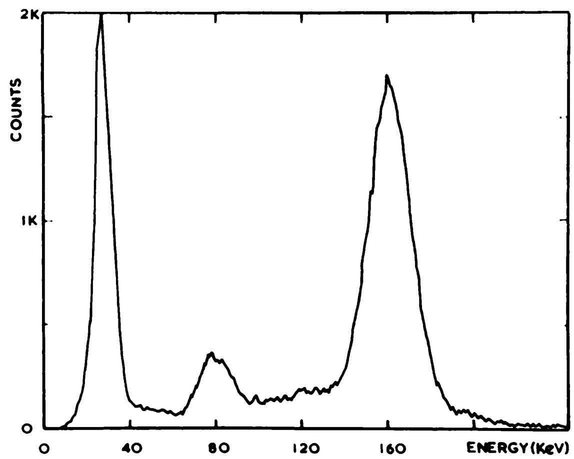

FIG. 2. Energy spectrum for ^{123}I sample with vial base level with top of crystal face.

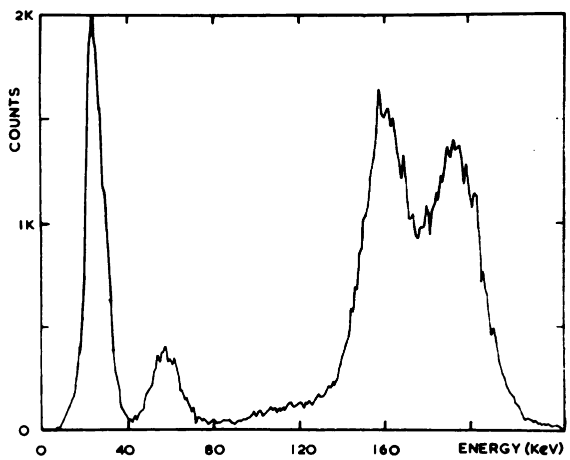

FIG. 3. Energy spectrum for ^{123}I sample with vial fully inserted.

187 keV. The x-ray/x-ray coincidences arise from summing the x-ray that follows the ^{123}I electron capture and the x-ray that follows the internal conversion of the 159-keV gamma-ray of ^{123}Te. The summing effects are unusually strong in ^{123}I and a calibration has been carried out to show the magnitude of the errors that might arise if sources are counted under different geometric conditions with narrow analyzer window settings.

A sample of ^{123}I was dispensed into a standard polythene counting vial in 2 ml of saline. As the sample was withdrawn from the well, counts were taken in a 145–175-keV window and in a 145–205-keV window. The ratio of the two counts is plotted against the distance of the center of the sample from the base of the well in Fig. 4.

RESULTS AND DISCUSSION

Examination of Fig. 4 shows that errors up to 50% may occur if samples are counted under different geometric conditions with narrow analyzer window settings. This could happen if activities are assayed in different volumes; absorption of the 28-keV x-ray within a sample or sample container could also affect the strength of the summing effects. Remember that the entrance of the well counter is different for samples placed in the well and for samples supported above the well. This difference may be significant for low-energy counting.

The way in which the detector–sample geometry affects this formation of sum peaks is illustrated in Fig. 5. This shows why the intensity of the 187-keV sum peak falls steadily when a sample is withdrawn from the well and why it is difficult to define the sum peak unambiguously if the sample is counted at the face of a standard 7.5 × 7.5-cm NaI crystal.

Examination of the ^{123}I decay scheme in the *Nuclear Data Tables* (*7*) shows that ^{123}I decays to ^{123}Te by electron capture. The 28-keV Te x-ray is thus emitted in coincidence with the 159-keV gamma-ray.

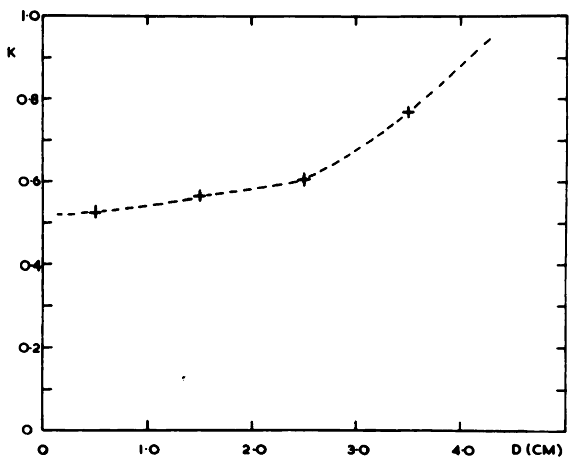

FIG. 4. Variation of K with D, where K is ratio of counts in 145–175-keV window to counts in 145–205-keV window and D is height of sample's center over well base.

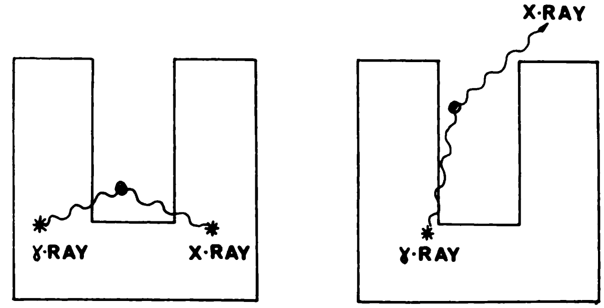

FIG. 5. Geometry dependence of summing effects illustrated by decay event (left) deep in counter well which produces summing and by decay event (right) near counter surface which does not produce sum peak.

The summing of these photons is particularly strong as the gamma-ray and the x-ray occur in 82.9% and in 86.5% of decays, respectively. The sum peak at 187 keV is clearly separated from the primary gamma-ray peak. This separation occurs only in nuclides of mass number greater than approximately 100. The sum peak for ^{123}I is also easy to observe since it lies in a clean region of the spectrum.

Summing of this magnitude is not common among nuclides in regular use in nuclear medicine as it is unusual for the x-ray intensity to be so high. However, ^{203}Pb, proposed by Stark et al (*8*) as a potentially useful agent for cisternography, shows similar effects. Clearly, therefore, when a comparison is made between a standard and an unknown containing a summing nuclide, they should be counted in the same geometry whatever window system might have been chosen. If the count rate of a specimen produces deadtime problems, then the specimen should be diluted and not just placed at a less efficient geometry farther away from the crystal.

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