ERRATUM

This article is reprinted in its entirety, with corrections, from *J Nucl Med* 21:971–977, 1980. The original manuscript and proofread galleys submitted by the author were correct. Errors introduced at a later stage resulted from the implementation of new software, for which the printer accepts full responsibility and deeply regrets any inconvenience caused to the author and the readers. This unusual problem has been fully corrected and will not occur again. Please place this insert in the October 1980 issue.

PHYSICS AND RADIATION BIOLOGY

Method for Optimizing Side Shielding in Positron-Emission Tomographs and for Comparing Detector Materials

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This report presents analytical formulas for the image-forming and background event rates seen by circular positron-emission tomographs with parallel side shielding. These formulas include deadtime losses, detector efficiency, coincidence resolving time, amount of activity, patient port diameter, shielding gap, and shielding depth. A figure of merit, defined in terms of these quantities, describes the signal-to-noise ratio in the reconstructed image of a 20-cm cylinder of water with uniformly dispersed activity. For 1-cm-wide NaI(Tl) detectors, a 50-cm patient port, an activity of 200 μCi per axial centimeter, and a shielding gap of 2 cm, the optimum shielding depth is 20 cm, which requires a detector circle diameter of 90 cm. For a 25-cm patient port and other conditions as above, the optimum shielding depth is 14 cm. Results are presented for the scintillators NaI(Tl), bismuth germanate (BGO), CsF, and plastic; and for Ge(Li) and wire chambers with converters. In these examples, BGO provided the best signal-to-noise for activity levels below 1000 μCi per cm, and CsF had the advantage for higher activity levels.

J Nucl Med 21: 971–977, 1980

In positron-emission, transverse-section tomography, the image is derived from the detection of unscattered coincident annihilation pairs. Almost all positron-emission tomographs use shielding on either side of the detector plane to block activity external to the transverse section being imaged (*1–8*). Shielding is also used between detector planes in multiple-section devices (*9–15*). In spite of this shielding, image contrast is degraded by true coincidences of scattered annihilation pairs and by accidental coincidences of unrelated annihilation photons (Fig. 1). Most positron-imaging systems operate with scattered and accidental backgrounds that are each typically 20% of the detected coincidences. Even if these backgrounds can be perfectly estimated and subtracted from the detected coincidences, the random fluctuations in the result are greater than if the backgrounds did not exist. In the following sections we examine the trade-off between sensitivity and backgrounds and describe a procedure for determining the optimum shielding depth for single-ring circular positron-emission tomographs. This treatment does not consider, but can be extended to include, nonparallel shields and multislice configurations.

The procedure consists of (a) measuring image and background event rates from a 20-cm phantom using the type of detector system being considered; (b) fitting analytical expressions to these rates; and (c) varying the shielding depth in those expressions to maximize the statistical accuracy in the reconstructed image.

As an example, this procedure is carried out for circular detector arrays using the Donner 280-Crystal positron tomograph with NaI(Tl) and bismuth germanate (BGO) detectors. Since the results depend significantly on detector characteristics, additional examples are provided for a variety of detectors, using typical

Received Nov. 5, 1979; revision accepted June 18, 1980.

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