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THE AUTHOR'S REPLY

In relation to the comments on our recent publication, we should like to record the following observations.

The comments on the size of sulfur colloid particles and general observations about colloids are well recognized.

The possibility of flocculation during or after injection for reasons based on the instability of particle size does not seem a likely explanation as this phenomenon is observed so infrequently and other patients injected from the same batch of colloid fail to exhibit lung uptake. The available evidence would suggest that this phenomenon is related to the condition of the patient rather than of the colloid.

We agree that kits for the production of antimony sulfide colloids provide a simple method of obtaining a satisfactory liver scanning agent; however, in defense of those who produce their own sulfur colloid I would point out that the three simple chemicals required, namely, hydrochloric acid, sodium thiosulfate, and phosphate buffer are readily available at minimal cost in most hospitals.

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DEADTIME LOSSES

This letter is written in reference to the Concise Communication—"Unexpected Deadtime Losses in a Modified Rectilinear Scanner System" by Philip Cooper, et al (*1*). The authors have presented data and calculated deadtime correction factors that appear to deviate from a theoretical calculation of correction factor versus observed counting rate. No attempt was made to explain the wide deviation, and a set of empirical equations are derived to represent the correction factors thus found. These equations have, however, no physical basis. If the data are analyzed to obtain the system deadtime using the familiar equation:

$$R_{true} = \frac{R_{obs}}{1 - R_{obs}\tau}$$

where R_{true} is the true counting rate, R_{obs} is the observed counting rate, and τ is the system deadtime, then one finds that the data can be fit essentially with a deadtime of approximately 170 μsec. This sets a saturation counting rate at approximately 360K cpm and gives a curve with the shape of that given for the experimental data. If the deadtime of the multichannel analyzer is 32 μsec as stated, then the rest of the system must be the limiting factor with an inherent deadtime of about 170 μsec.

The actual operation of the analyzer in the reported study is somewhat difficult to ascertain from the paper. A few comments on the possible ways of using an analyzer for such studies is in order and from this an insight into the reported use may be gained. Modern multichannel analyzers (MCAs) operate in two modes, analog (PHA) and multiscale (MCS), and both modes can be used to some degree to obtain quantitative data from instruments such as scanners.

In the PHA mode an analog voltage from a position-sensitive potentiometer can be fed to the analog input and a signal from the scanner SCAs can be fed into the coincidence/sample input. The analog input is sampled on command by the signal from the SCA. A count is then added in the memory channel that corresponds to the position of the scanner at the time of the valid SCA pulse output. In this manner a histogram is obtained of counts versus scanner position. Readout of the memory must be performed at the end of every pass and a composite image reconstructed at a later time. Using a nuclear ADC in this mode has the disadvantage that the digitizing time is dependent on the height of the analog pulse being digitized. Thus, deadtime (digitizing time plus memory storage time) is also a function of scanner position and the data must be corrected accordingly.

In the multiscaling or MCS mode, the scanner SCA outputs are fed to the MCS input and counts are sorted in memory as a function of scanner position. A crude method of doing this would be to set the dwell time per channel such that the MCA's memory steps through the total number of channels in a time equivalent to that of one scanner pass. (Dwell time per channel equals time per scanner pass divided by the number of channels.) Data accumulation will be started with a signal from the scanner indicating the start of a pass. If scanner speed is constant, a reasonable representation of count distribution can be obtained.

In this mode deadtime is only a function of storage time, is constant, and of the order of a few tens of microseconds. Also, the ADC need not be operated in the internal time mode but rather the multiscale channel advance may be produced by an external signal from a position-sensitive device that produces an output signal when the scanner traverses a given distance. Distance traversed between such signals would be equal to the distance of one scanner pass divided by the total number of channels used. These data would then be independent of scanner mechanical deviations. The deadtime correction would be relatively simple as noted before.

In addition to the possible uses noted above, some old nuclear multichannel analyzers were constructed so that at the time of a given input signal, data were stored in memory as a function of a voltage level at an analog input. This is similar to the analog use noted above; however, the deadtime is not as great as that given above. This appears to be the mode in which the analyzer was used in the paper referred to. Information on these old units is difficult to obtain so that one has to surmise that that is how the study was performed. This work clearly points out the need to understand fully all the aspects of a system being used when quantitative information is desired. Any results obtained should be understood on a physical basis before attempting to use such data. In conclusion, the apparent large deviation from the quoted deadtime indicates that there is an unknown system component with $\simeq 170$-μsec deadtime or that the system is not being used as surmised above and that actual MCA deadtime for that data set is about 170 μsec and system deadtime may actually be a function of scanner position.

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REFERENCE

1. Cooper PH, Lerner SR, Pircher FJ: Unexpected deadtime losses in a modified rectilinear scanning system. *J Nucl Med* 14: 828–829, 1973

AUTHOR'S REPLY

Dr. Tatarczuk has rightly pointed out that we used the TMC Model 401D multichannel analyzer in the analog (Mossbauer) mode for addressing counts to channels assigned by the detector head position ramp voltage. The statements in his last paragraph reemphasize the view expressed in our last paragraph: "The main point to be made is that such a difference can occur when an instrument is used in a manner slightly different from its designed purpose."

As for our use of the exponential equations for calculation of correction factors, these equations were convenient but not the only useful function for computer correction of the data and were not imputed to have a physical explanation; they were only functional. Equipment modifications have been made which have eliminated the 401D from the system.

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