Application of a matrix calibration method for *in vivo* measurement of ^{241}Am in the lungs, liver, and skeleton

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The conventional method for performing direct, *in vivo* measurements of ^{241}Am deposited in the lungs uses an array of detectors placed on the anterior thorax, an arrangement that may be confounded by activity deposited in the skeleton or liver. A matrix calibration method, originally developed for Phoswich detectors, has been applied to *in vivo* measurement results obtained using an array of germanium detectors to account for interference from activity deposited in organs other than those being directly measured. The method uses the traditional calibration factors for measuring ^{241}Am in the lungs, liver, and skeleton plus additional individual calibration factors for contributions to these measurements from activity deposited in other organs. For example, the contribution to a direct *in vivo* measurement of the lungs from activity deposited in the liver is determined by placing detectors in the lung counting geometry on the torso calibration phantom in which only in the liver contains activity.

A series of three simultaneous equations were generated to account for the measured organ count rate, R_i, where the subscript i equals 1, 2 or 3 for the lungs, liver and skeleton, respectively.

$$R_1 = a_{1,1}Q_1 + a_{1,2}Q_2 + a_{1,3}Q_3$$

$$R_2 = a_{2,1}Q_1 + a_{2,2}Q_2 + a_{2,3}Q_3$$

$$R_3 = a_{3,1}Q_1 + a_{3,2}Q_2 + a_{3,3}Q_3$$

The coefficients, $a_{i,j}$, are the individual calibration factors for the contribution of activity deposited at site j to that measured at site i and Q_i is the activity deposited in organ i. Anthropometric calibration phantoms containing precisely known quantities of ^{241}Am were measured to obtain the detector efficiencies, $a_{i,j}$. Calibration factors for the lungs and liver were determined using the Lawrence Livermore Thoracic Phantom. The NYU thorax phantom containing a labeled skeleton and the UC skull and knee phantoms were used to obtain independent calibration factors for the skeleton. For several calibration factors, the influence of chest wall attenuation was negligible. Arrays of six, three, four and two germanium detectors were used to measure the chest, liver, knees, and skull, respectively. Count rate contributions, as expressed by coefficients in the matrix where $i \neq j$, were greatest for lung measurements with activity deposited in the skeleton ($a_{1,3} = 2.457$) and in the liver ($a_{1,2} = 1.075$). Count rate contributions from all other sources of activity were less significant.