CHEST WALL THICKNESS MEASUREMENTS : THE NOVEL APPROACH CONTINUES

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EXTENDED ABSTRACT

At a previous conference we reported that the chest wall thickness could be measured by measuring the ratio of low energy photopeaks using phoswich detectors. We found that this method worked satisfactorily for enriched uranium; however, the method failed for ^{241}Am.

At the end of the presentation we issued a challenge to *in-vivo* facilities that had germanium detectors to evaluate this method using ^{241}Am. Since that time, nobody has taken up the challenge and the Human Monitoring Laboratory has acquired its own germanium lung counting system.

Chest wall thickness (CWT) measurements are an essential part of the process in estimating the amount of radionuclide deposition in the thorax. Many whole body counting facilities estimate the CWT using biometric equations. These equations are usually satisfactory for male subjects providing the photon energy is sufficiently high (>100 keV). However, CWT estimations of female subjects is not a simple process.

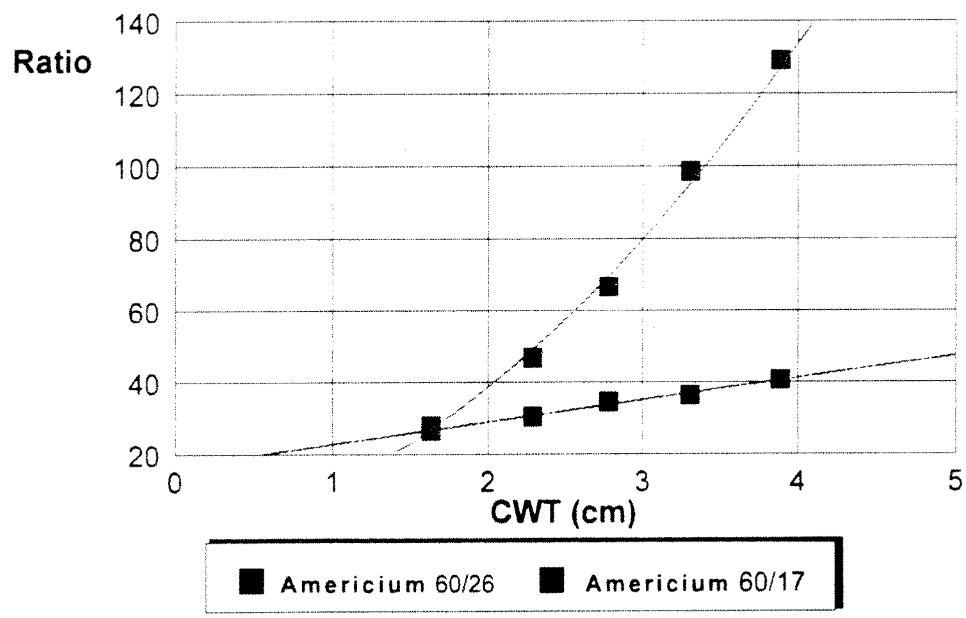
The biometric estimation of female CWT depends on age, abdominal circumference, thigh circumference, forearm circumference and percent body fat (Berger and Lane 1985). A further complication is that these measurements are made on the standing female whereas counting is usually supine and the CWT varies with the subject's position. Many of these problems can be overcome by performing ultrasound measurements on the subject that is being monitored. Recent advances using this methodology (Kruchten and Anderson 1990) show that it is capable of determining the chest wall to ± 1.5 mm with a resulting error of ± 15% in the detector calibration for Pu monitoring.

The technique described in this presentation was developed from other work performed using the torso phantom (Kramer and Webber 1992) when the simulated tissue composition of the phantom was verified using a Bone Densitometer. The Bone Densitometer measures the transmission of photons of energy 42 and 100 keV emitted from a ^{153}Gd source. If a bone densitometer can determine tissue thickness by the differential attenuation of photon energies separated by approximately 60 keV, then could a similar technique be developed for photons emitted In-Vivo?

Protocol

The Lawrence Livermore Torso phantom was used for the calibrations. The calibrations were performed using a ^{241}Am lung set. According to the manufacturer[a] the activity is homogeneously distributed throughout the simulated lung tissue. CWT was altered using series of four chest plates that simulated 50% adipose/50% muscle tissue. The range of chest plate thickness was 1.63 to 4.00 cm. Fig. 1 shows the experimental results from counting the lung set.

Figure 1



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[a] Radiology Support Devices Inc. 1904 E. Dominguez St., Long Beach, CA 90810

Discussion

The results obtained in this study show that a germanium detector can be used to measure the CWT if the internal contaminant is ^{241}Am in a similar manner to our earlier work (Kramer and Puscalau 1994). However, as before, there is a limitation to the usefulness of the method.

The practical MDA of this method was assessed by spectral subtraction. In this manner we were able to simulate the following lung burdens: 10.1 kBq, 5 kBq, 1 kBq, 505 Bq, 252 Bq, and 101 Bq. The practical MDA was assessed by calculating the bias of a result obtained from the simulated spectrum and comparing it to the known value. The bias varies with the CWT, but in general results are within 13% when using the 60/17 ratio and within 40% when using the 60/26 ratio if the activity is 1 kBq. As the activity becomes less the bias quickly rises. The bias values for the 60/17 ratio are shown below:

	CWT (cm)				
Equivalent activity (Bq)	1.63	2.29	2.78	3.31	3.89
10677	2%	-2%	-1%	2%	0%
5339	2%	-2%	0%	4%	1%
2669	2%	-2%	0%	13%	2%
1068	2%	-1%	2%	13%	9%
534	4%	3%	5%	-100%	19%
267	8%	5%	22%	-100%	-100%
107	-5%	54%	-100%	-100%	-100%

References

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