DEVELOPMENT OF THYROID MONITORING SYSTEM FOR RADIOIODINE IN THYROID GLAND

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ABSTRACT

A thyroid monitoring system consisting of a high-purity germanium (HPGe) detector and a spectrometry unit has been developed for measurement of thyroid radioiodines which could be released in nuclear accidents.

We report the characteristics of the system and results of the calibration experiment used realistic neck phantom and ORINS type IAEA phantom.

INTRODUCTION

In the early stage of the nuclear accidents, several radioiodines, such as ^{131}I, ^{132}I, ^{133}I, ^{134}I, and ^{135}I could be released together with other radionuclides. The mixture of these iodines varies from dependency on the time after the accident, fuel type, burn-up of fuel and protective measures of a reactor. These radioiodines in the thyroid are predominant cause of the exposure to the public in the early stage, and countermeasures such as sheltering or iodine prophylaxis should be considered. So, the evaluation of thyroid dose is very important for the risk assessment and medical treatment in point, and it is necessary to measure the thyroid burden of each radioiodine for individual dose estimates. The monitoring of iodines in the thyroid are made using lots of portable counters, such as NaI(Tl) thyroid detector (or even GM counters) in hospitals or nuclear institute. These counters should be calibrated correctly for these nuclides, and then the precise monitor for this calibration purpose is needed to be introduced and studied.

EXPERIMENTS

We developed a thyroid monitoring system consisting of a high resolution HPGe detector and a spectrometry unit in portable size as illustrated in Figure 1, and the spectrometry unit makes it possible to transport the system to monitoring places, hospitals and sheltering places. The HPGe detector is surface barrier type with 2 inch diameter and 2cm thickness for low energy photon detection, which is housed in a designed lead collimator of cylindrical shape of the 1 inch thickness. This collimator shields effectively background radiations from the body excluding a thyroid, and it makes the counting response of the detector uniform.

The high resolution detector makes it possible to identify gamma rays from the above nuclides separately and then to estimate the reasonable thyroid doses caused by these isotopes which offer a proper calibration factor the other counters such as GM counter used for actual thyroid iodine measurement of people. The energy resolutions obtained for gamma rays of 122 keV for ^{57}Co, 284 keV and 364 keV for ^{131}I are 0.67 keV, 1.18 keV and 1.25 keV respectively. Figure 2 shows characteristics of the isoresponce curve for different size collimators.

The present study for the calibration of the monitor is made using two phantoms, realistic neck phantom and ORINS type IAEA phantom of adult size. The realistic neck phantom (Photo 1) is made of tissue equivalent substitute for gamma rays and the thyroid model is made of plastic vessel of 20 ml volume for adult size. The obtained detection efficiency for ^{131}I is compared with 3 inch NaI(Tl) detector as shown in Table 1 for two different adult thyroid phantoms, in which 364 keV gamma ray used for evaluation and the distance between detector surfaces and neck surfaces is 5 mm.

CONCLUSION

Nevertheless its relatively low efficiency compared with NaI(Tl) detector, the HPGe detector has an advantage of high resolution which enables to get the proper calibration factor for mixed radioiodine in accident cases, and supports the monitoring of thyroid iodine of the people. Comparing the results for the two phantoms, we found that ORINS phantom is adequate enough for such a monitoring purpose.

REFERENCES

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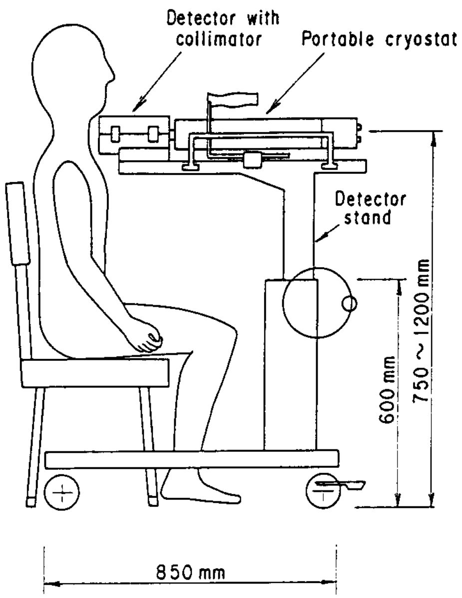
2. Likhtarev I. A., Grulko G.M., Sobolev B.G., Kairo I.A., Pröhl G., Roth P., and Henrichs K., 1995, Evaluation of the ^{131}I thyroid-monitoring measurements performed in Ukraine during May and June of 1986, Health Physics, 69, 6-15.



Detector : Hyper-pure low energy Ge detector (CANBERRA ACT-I)
Active area : 20 cm², Thickness : 20mm
Energy resolution : 640 eV for 122 keV γ-ray

Figure 1. Illustration of thyroid monitor in counting position of human thyroid.

Photo 1. Overview of realistic neck phantom.

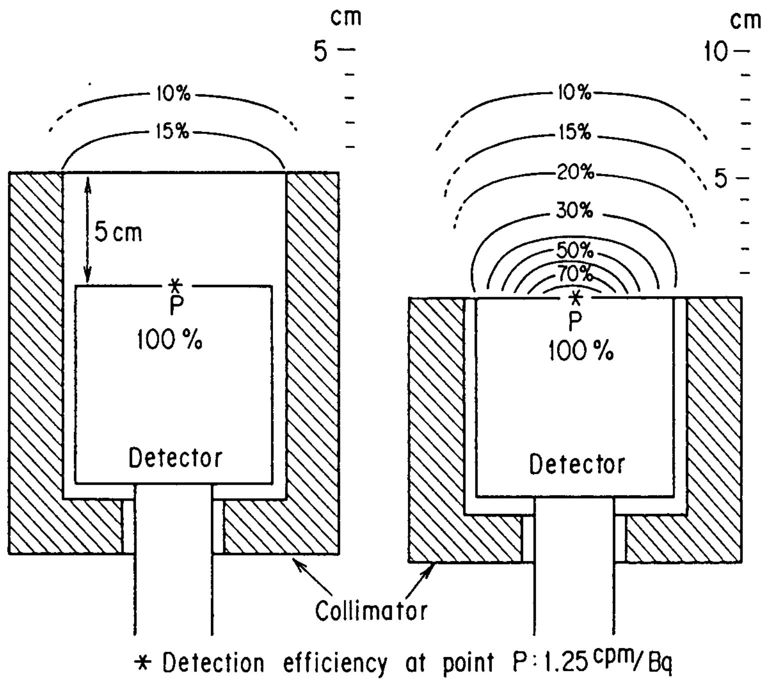


Figure 2. Isoresponse curves for different size collimators. (The relative values are normalized by detection efficiency at center of detector : *P.)

Table 1. Results of calibration experiment of thyroid iodine detectors using neck phantoms

Neck phantoms	detection efficiency(cpm/Bq)	
	2" ϕ HPGE detector	3" ϕ NaI(Tl) detector
Realistic neck phantom	0.15	3.10
ORINS neck phantom	0.16	3.19