

# Determination of Tc-99m Activity and Thyroid Uptake in Men and Women Patients using Gamma Camera

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## 2 DETERMINATION OF TC-99m ACTIVITY AND THYROID UPTAKE IN MEN AND WOMEN PATIENTS USING GAMMA CAMERA

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**Abstract**— The calculation of Tc-99m activity and thyroid uptake in men and women patients using gamma camera has been done. This study began with the selection of patients with hyperthyroid cases, ie 10 male patients, 10 hyperthyroid fertile And 10 menopausal women. After 5 minutes injection of Radiofarmaka, the new patient underwent thyroid examination using gamma camera. The calculation of absorbent dose in hyperthyroid cases was performed at 5 min, 10 min and 15 min imaging times. The calculation were done by making ROI on the thyroid region and make ROI in other areas besides thyroid that serves as background. The results showed that the uptake thyroid obtained in this study in normal women ranged from 2.10 to 2.55%, and in normal men ranged from 1.49 to 1.74. Meanwhile, for hyperthyroid cases, the thyroid uptake obtained in male patients ranged from 10.92 to 15.43%, in fertile women ranged from 12.42 to 14.57%, and in postmenopausal women ranging from 8.52 to 9.78%. These results indicate that the thyroid uptake in fertile female patients is significantly higher than in men and postmenopausal women.

**Keywords**—Thyroid uptake, hyperthyroid, Tc-99m, gamma camera, ROI.

### I. INTRODUCTION

Hyperthyroid is a thyroid disease caused by the excess iodine in the blood, causing the thyroid gland to produce excessive thyroid hormone. This is causing the body's metabolism take place very quickly and an imbalance in the body's metabolism [1-2]. In most hyperthyroid patients, the thyroid gland enlarges two to three times from the normal size, accompanied by multiple hyperplasia (excess cell growth) and folds of follicle cells into the follicle. The number of these cells is increased several times compared to the enlargement of the gland. Hyperthyroid more suffered by women than men with a ratio of 1: 5 [3].

Uptake thyroid scan is one of the examination techniques used to determine the capture of radioactive substances in both lobes of the thyroid gland, after injecting radioactive substances. Thyroid uptake is a thyroid capture of radioactivity from radiofarmaka injected into the patient [4]. The utilization of radioactive substances for hyperthyroid examination may use Technitium-99m (Tc-99m), Iodine-131 (I131) and Iodium-132 (I132).

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However, Tc-99m is the most commonly used radioactive material due to it is a pure gamma-transmitting radioisotope and has a short half-life of 6.03 hours with energy of 140.5 keV and is a metastable radioisotope [5].

On hyperthyroid examination, the dose of Tc-99m activity received by hyperthyroid patients is about 2-5 mCi, injected through intravenous mediana cubiti on the patient's arm folds and radioactive substances will follow the body's metabolism toward the thyroid organ. After the radiofarmaka is absorbed by the thyroid, the thyroid scan results of each patient will be processed using ROI (Region Of Interest)/computer (xeleris work station). ROI is a software contained in computer (xeleris work station) gamma camera that will display the results of imaging and displayed in units of counts. ROI contained in the gamma camera work station is expected to serve as the basis for determination of radiation exposure and accumulation for internal radiation (Radiation coming out of the body) [6].

In this study the authors conducted an analysis to observe the effect of Tc-99m absorption in male patients, fertile women and menopausal women. In addition, the ratio of absorption values of radioactive activity in male patients, fertile women, and menopausal women in both lobe glands was also analyzed in this study. The aim of this study was to determine the absorption activity for the duration of absorption in the thyroid organ based on sex, and to determine the absorption activity against the duration of absorption in the thyroid organ.

## II. METHODS

The study was conducted in several stages, i.e.: The study was conducted in several stages, dose measurement using dose calibrator, intravenous injection of Tc99m, delay test for  $\pm 5$  minutes, image taking with gamma camera, image processing using Region of Interest (ROI), and Analysis of uptake and activity.

### A. Preparation for Thyroid Examination

This study began with the selection of patients with hyperthyroid cases, ie 10 male patients, 10 hyperthyroid fertile And 10 menopausal women. After 5 minutes injection of Radiofarmaka, the new patient underwent thyroid examination using gamma camera.

### B. Examination Technique of Uptake Thyroid Scan

As the procedure prescribed by medical personnel, for 6 hours before examination the patient is not allowed to eat and drink, consume drugs and contrast materials containing iodine ion, this procedure was should be done at least 4 weeks before the examination.

### C. Image Taking

Thyroid uptake examination was performed 5 minutes after Tc-99m injection. Imaging was done in the position of AP (Anterior Superior) and taked in 5 minutes. Sources in patients will be captured by a collimator that serves to direct the gamma radiation to the scintilation crystal NaI (Tl).

### D. Data Collection

The calculation of absorbent dose in hyperthyroid cases was performed at 5 min, 10 min and 15 min imaging times, in men, fertile women and menopausal women. The calculation were done by making ROI on the tyroid region and make ROI in other areas besides thyroid that serves as background. The calibration value was obtained by measuring 1 mCi of Tc-99m and performed enumeration for 5 minutes with the same distance of 10 cm. Calculation was performed by using equation (1), with the standard value of Tc-99m activity is 1 mCi. To determine the value of thyroid activity in hyperthyroid patients was calculated by using equation (2).

The total of count full syringe:

$$A(\text{activity}) = K \times \text{counts}$$

$$k = \frac{A(\text{Activity})}{\text{counts}} \times 100\% \quad (1)$$

where:

A = activity = 1

K = calibration faktor

C = counts with 1 mCi (due to Tc<sup>99</sup> is considered as stable).

$$\text{Activity} = \frac{\text{count thyroid}}{s} \times K \quad (2)$$

Whereas for thyroid uptake value can be calculated by equations (3) and (4). According to Sukandar [7], to calculate the amount of thyroid uptake can be done by using the following equation:

$$\text{Uptake thyroid} = \frac{\text{count thyroid} - \text{count background}}{\text{Count injeksi}} \times 100\% \quad (3)$$

while to calculate the injection count may used the following equation:

$$\text{Count injeksi} = \text{count full syring} - \text{count empty syring} \quad (4)$$

### III. RESULT AND DISCUSSION

The observation of thyroid uptake activity in hyperthyroid patients using Tc-99m has been performed in some groups of patients, i.e. 10 male patients, 10 fertile women, and 10 postmenopausal women. Time variations used were 5, 10 and 15 minutes, for each patient group, using the ROI method.

#### E. Image of Thyroid's ROI

Measurements at full syringe were performed under a gamma camera with a distance of 10 cm. The image of full syringe measured with ROI method had resulted in Tc-99m activity of 248047. After completion of the measurement, Tc-99m present in full syringe was then injected in hyperthyroid patients via intravenous mediana cubiti. The remaining Tc-99m in the syringe is then called empty syringe. The empty syringe was then measured again under a gamma camera with a distance of 10 cm. The image results of empty syringe was measured by the ROI method. The remaining Tc-99m in the empty syringe is 4954. After 5 minutes, it was found that the absorption in the right thyroid organ was 101109 and the left organ was 48398. The absorption of Tc99m in every minute will be wider, restricted by RO, so it can be seen that the thyroid organ with a hyperthyroid case indicates the absorption of Tc-99m.

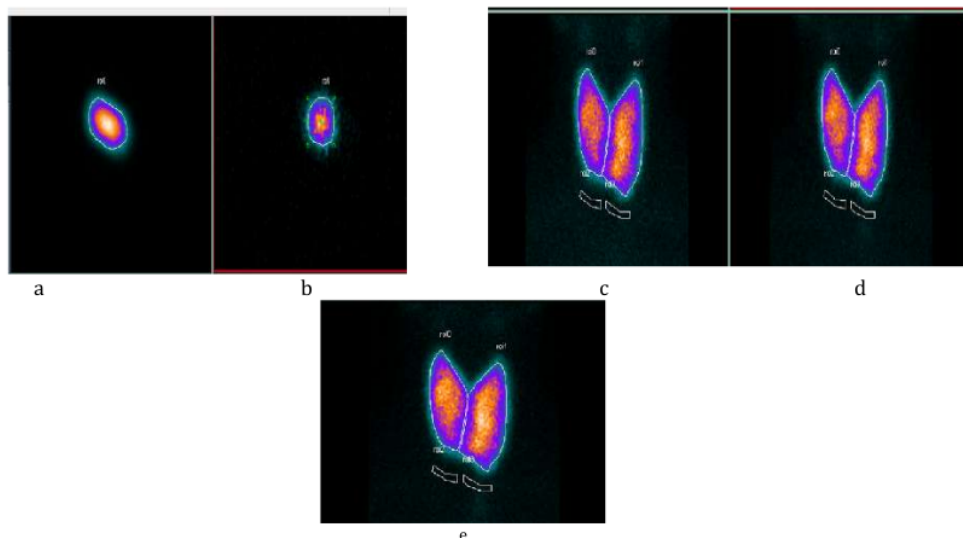


Figure 1. Images of ROI in (a) Full Syringe, (b) Empty Syringe, (c) 5th minute, (d) 10th minute, and (e) 15th minute, in hyperthyroid patients.

#### F. Thyroid Uptake in Hyperthyroid Patients

An initial calibration calculations were performed to obtain a standard value.

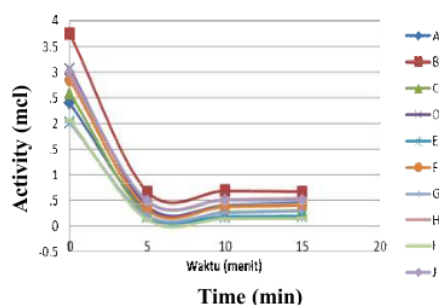


Figure 1. The curves of Tc<sup>99m</sup> activity vs absorption time in hyperthyroid men.

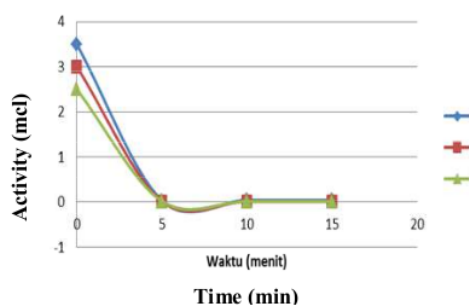


Figure 2. The curves of Tc<sup>99m</sup> activity vs absorption time in normal men

The calculations that performed using equation (2.5) and ROI method will result in units of Count/min. To obtain the calibration value was by measuring 1 mCi of Tc-99m and performed the enumeration for 1 minute with the same distance of 10 cm. The enumeration results for 1 mCi Tc-99m activity were 189848, 190377, 189705. Thus, it was obtained that the count value is 189976.67 and the activity value is  $5.2 \times 10^{-6}$ .

Figures 1 and 2 show the decrease activity values in hyperthyroid men and normal men, the significant decrease occurred in the first 5 minutes, whereas in the next 10 minutes and 15 minutes the value of Tc-99m activity tends to be stable.

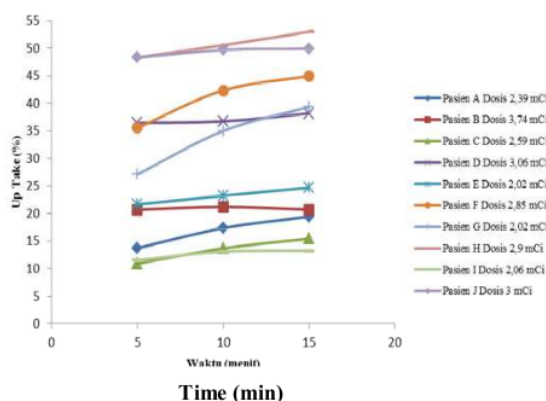


Figure 3. The curves of thyroid uptake vs Tc<sup>99m</sup> absorption time in hyperthyroid men.

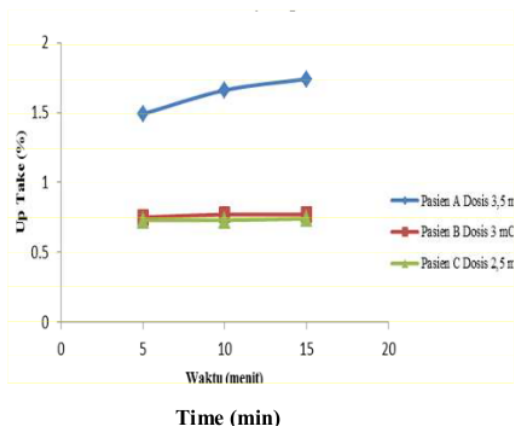


Figure 4. The curves of thyroid uptake vs Tc<sup>99m</sup> absorption time in normal men

Based on the results of this study, the normal men have a thyroid uptake ranging of from 1.49% to 1.74%, while in men patients with hyperthyroid abnormalities have a higher uptake thyroid ranging from 11.54 to 49.91%. The thyroid uptake values obtained in the hyperthyroid men show a very active thyroid state.

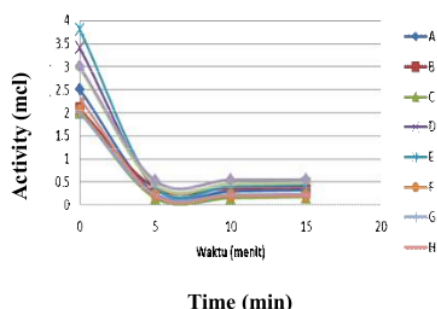


Figure 5. The curves of Tc<sup>99m</sup> activity vs absorption time in hyperthyroid fertile women.

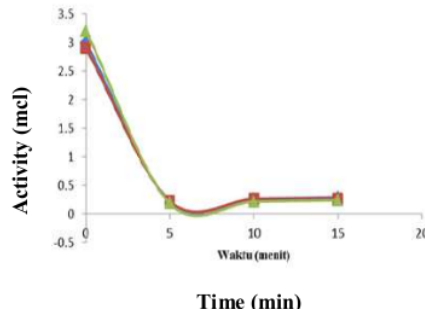


Figure 6. The curves of Tc<sup>99m</sup> activity vs absorption time in normal fertile women.

Figures 5 and 6 show the decrease activity values in hyperthyroid fertile women and normal fertile women, the significant decrease occurred in the first 5 minutes, whereas in the next 10 minutes and 15 minutes the value of Tc<sup>99m</sup> activity tends to be stable.



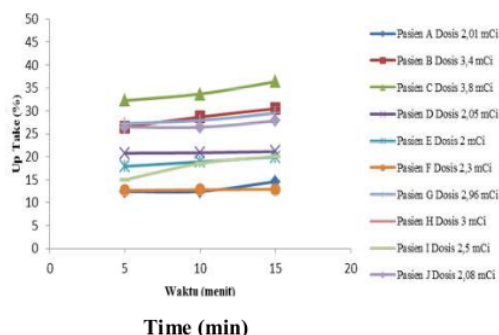


Figure 7. The curves of thyroid uptake vs  $Tc^{99m}$  absorption time in hyperthyroid fertile women.

The fertile women with hyperthyroid abnormalities showed the higher thyroid uptake compared with normal fertile women of 12.42 to 53.54%. This value indicates a very active thyroid state in fertile women.

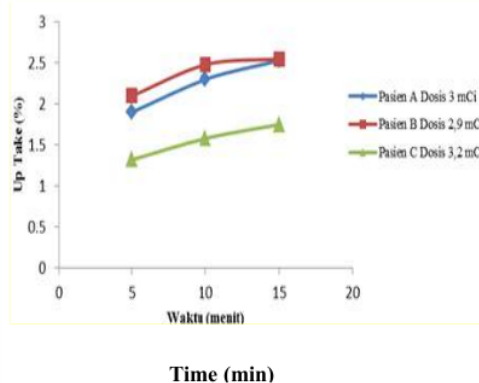


Figure 8. The curves of thyroid uptake vs  $Tc^{99m}$  absorption time in normal fertile women.

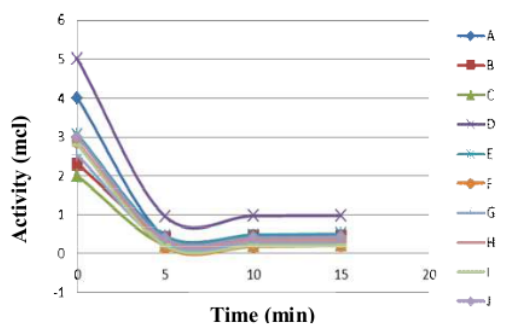


Figure 9. The curves of  $Tc^{99m}$  activity vs absorption time in hyperthyroid postmenopausal women

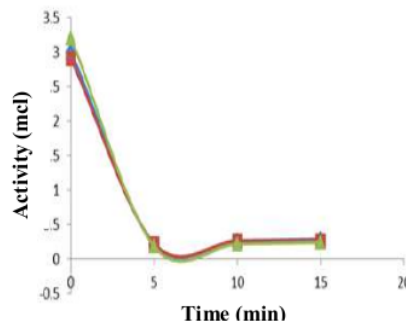


Figure 10. The curves of  $Tc^{99m}$  activity vs absorption time in normal women

Figures 9 and 10 show the decrease activity values in hyperthyroid menopausal women and normal fertile women, the significant decrease occurred in the first 5 minutes, whereas in the next 10 minutes and 15 minutes the value of  $Tc^{99m}$  activity tends to be stable.

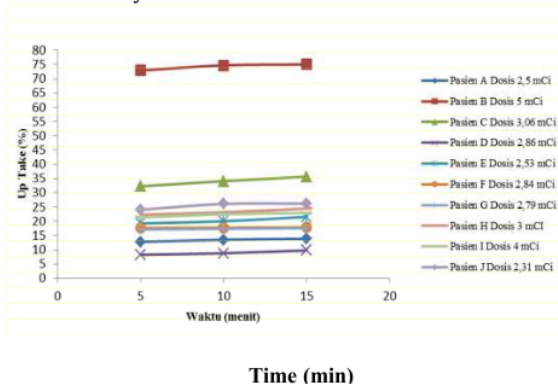


Figure 11. The curves of thyroid uptake vs  $Tc^{99m}$  absorption time in postmenopausal female patients.

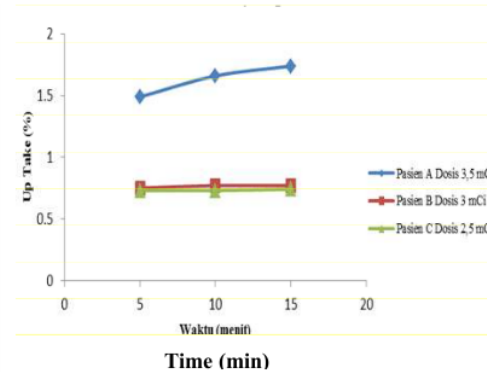


Figure 12. The curves of thyroid uptake vs  $Tc^{99m}$  absorption time in normal postmenopausal women



The percentage of thyroid up take in normal patients according to Mettler (2012), is in the range 1.6 to 7.6% [2]. Based on the results of this study, the postmenopausal female patients have a thyroid uptake ranging of from 1.9% to 5.3%, while in female patients with hyperthyroid abnormalities have a higher uptake thyroid ranging from 8.25 to 75.04%. The thyroid uptake values obtained in the fertile women show a very active thyroid state.

#### IV. CONCLUSIONS

Based on the results obtained in this study, it was concluded that:

The percentage of thyroid up take in both male and female hyperthyroid patients was higher than that of normal patients, in case post-injection. The normal uptake obtained by Mettler was ranged from 1.6 to 7.6%, while the uptake thyroid obtained in this study in normal women ranged from 2.10 to 2.55%, in normal men ranged from 1.49 to 1.74. Meanwhile, for hyperthyroid cases, the thyroid uptake obtained in male patients ranged from 10.92 to 15.43%, in fertile women ranged from 12.42 to 14.57%, and in postmenopausal women ranging from 8.52 to 9.78%. These results indicate that the thyroid uptake in fertile female patients is significantly higher than in men and postmenopausal women. The fertile women have higher thyroid uptake values compared with postmenopausal women; it indicates that the fertile women have the more active thyroid. While the addition of more than 10 minutes delay time for  $Tc^{99m}$  absorption in thyroid patients is not required in hyperthyroid examination using the ROI method.

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